Herefordshire Council

February 2022

ARCHITYPE

Environmental Building Standards

Draft Supplementary Planning Document

Good design embraces more than simply the aesthetics of new development and includes, how buildings are used, accessed and constructed.

Equally, for development to be considered sustainable, it must embrace the move to a low carbon future through designing buildings that are more energy efficient and increase the use and supply of renewables.

Herefordshire Council will seek and ensure that future developments are designed to enhance local distinctiveness but without stifling innovation and creativity, particularly with regard to energy efficiency.

- Herefordshire Local Plan Core Strategy, paragraph 5.3.28

Herefordshire Council appointed the award winning architectural practice Architype, to help draft the Environmental Building Standards Supplementary Planning Document.

Architype specialise in sustainable and Passivhaus building design with an approach that combines beautiful design with technical excellence. Their buildings perform as promised and by working holistically with clients, award-winning, inspirational and healthy environments are created.

Herefordshire Council
February 2022

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Introduction

Introduction Overview

In this section

Section one is an overview of the Supplementary Planning Document (SPD). It will introduce:

1 / Why the SPD was created

2 / What the SPD covers

3 / The national + local context to this point

4 / What the sustainability checklist and statement are, and how to use these.

Executive summary

> The Supplementary Planning Document (SPD) was created within the context of national and local Net Zero Carbon targets - and provides detail on what is required to deliver high quality construction that is ready to meet those goals.

> It will also look to address other environmental issues like biodiversity and resilience to climate change, which construction has a big impact on.

> The standards outlined in the document **are not new planning policies**, but supplementary planning guidance to existing policy. This guidance will be a material consideration for planning applications.

> The document builds on the 2015 Local Plan Core Strategy and is designed to work with primarily Core Strategy policies SS7 and SD1 and Chapters 12 and 14 of the National Planning Policy Framework.

> This draft SPD document contains a Sustainability Checklist and a Sustainability Statement, which planning applicants are strongly encouraged to use in support of the environmental, social and economic benefit of their scheme.

Purpose of the Environmental Building Standards Supplementary Planning Document (EBS SPD)

The purpose of this Supplementary Planning Document (SPD) is to drive up environmental standards of buildings in Herefordshire, consistent with the council's recognition of the climate and ecological emergency and our vision for a zero-carbon, nature-rich Herefordshire.

While the SPD cannot **introduce new policy**, it will encourage the adoption of even higher standards by developers and householders. It is designed to provide supplementary guidance to the Herefordshire Local Plan Core Strategy environmental quality policies, and will be a material consideration in planning applications. The Local Plan update will enable the consideration of revised policies for building standards.

This SPD will set out new, best-practice-level minimum standards in key areas including;

- energy efficiency
- embodied carbon
- waste
- water
- transport
- and nature protection.

Further Information

- Herefordshire Council Carbon Management Action Plan

Image 1:
Herefordshire Council Carbon Management Action Plan - Our Path to Zero Carbon

How the SPD fits with Herefordshire standards

Herefordshire Council declared a climate and ecological emergency on 8 March 2019. Following this, Herefordshire Council committed to becoming a carbon neutral council by 2030, and has in place a Carbon Management Plan to achieve this goal. However, it recognises that its own emissions are only a minor part of the county's overall carbon footprint, and that it has a key role to play in leading, encouraging and supporting action by other stakeholders to achieve local and national net zero targets. Herefordshire Council has also formally recognised the ecological emergency and committed to take similar action to protect and enhance biodiversity.

Planning guidance is urgently required to help shape development in the direction of zero carbon and nature-rich development. The Herefordshire Core Strategy identified the importance of this, but needs to go further in the direction of zero carbon.

This SPD will set out guidance of higher environmental building standards and highlight best practice to help strengthen existing policies in the Core Strategy to help achieve this.

The Commission on Climate Change Sixth Carbon Budget recommended pathway requires a 78% reduction in UK territorial emissions between 1990 and 2035. They have recommended four key steps; take up of low carbon solutions, expansion of low carbon energy supplies, reduction of demand for carbon intensive activities and land, and greenhouse gas removal.

The buildings sector has opportunities for emission reductions in four key areas; behaviour change, increasing the energy efficiency of the building stock, improving the energy efficiency of lighting and electrical appliances and switching away from fossil fuel heat.

Further Information

- The Commission on Climate Change Sixth Carbon Budget

2 **Image 2**:

How the SPD fits with the Future Homes Standard

In 2019 the Government set a legally binding target to reduce greenhouse gas emissions to net zero by 2050 [*Climate Change Act 2008 (2050 Target Amendment) Order 2019*]. The Ministry of Housing, Communities and Local Government have stated all homes and businesses will have to meet rigorous new energy efficiency standards to lower energy consumption to help protect the environment. The government has set out plans to radically improve the energy performance of new homes, with all new homes to be highly energy efficient, with low carbon heating and be carbon zero ready by 2025 [*The Future Homes Standard: 2019. Consultation on changes to Part L (conservation of fuel and power) and Part F (ventilation) of the Building Regulations for new dwellings: Summary of responses received and Government response*].

These homes are expected to produce 75-80% lower carbon emissions compared to current levels.

From 2021, it is expected new homes to produce 31% lower carbon emissions. Existing homes will also be subject to higher standards, and for extensions and replacement and repairs to be more energy efficient.

In response to this, in October 2020 Herefordshire Council's Cabinet recognised the need for urgent action at local level and formally endorsed the production of a Supplementary Planning Document to promote higher building standards through setting out best practice guidance for sustainable design, use, construction and access.

49% of all UK emissions came from buildings (*LETI*). In order for Herefordshire to reach net zero, there is a huge opportunity for more efficient building design and construction to drive down its emissions.

This document will outline what net zero-ready construction standards look like, and how to achieve them across all buildings types. It will work alongside the 2021 Herefordshire Future Homes document which sets out best practice in the housing sector.

The SPD will shift the focus for developers and stakeholders to considering the whole life impact of their developments on the environment, not just the construction process. In line with industry best practice, this includes accounting for how buildings perform in use, the emissions that maintenance and upgrades will generate and decisions prior to construction around building reuse and the transport of materials to the site.

2 **Image 3**: Net Zero Future Homes

Scope and status of this Supplementary Planning Document (SPD)

This SPD will elaborate upon existing policies set out in the Core Strategy and is guided by national and local planning policies. Supplementary planning documents (SPDs) should build upon and provide detailed advice or guidance on policies in an adopted Local Plan. As they do not form part of the development plan, they cannot change introduce new planning policies into the development plan.

An SPD cannot make changes to existing policy and should be used where they can to help applicants make successful applications or aid infrastructure delivery.

They should not be used to add, unnecessarily, to the financial burdens on development. The guidance set out in the SPD will be a material consideration in the determination of planning applications.

SPD contents will need to be taken into consideration from the earliest stages of the development process.

Since the Herefordshire Local Plan Core Strategy was published in 2015, a greater emphasis has been placed on tackling climate change locally, nationally and globally. Clearer guidance is required as to what meeting the Core Strategy Policies means in practice. As we look forwards reviewing the Herefordshire Local Plan, we recognise the need for net zero carbon as a fundamental framing principle and therefore the SPD gives us an opportunity to articulate what policies would be necessary for net zero carbon.

In the interim, this SPD will set out best practice guidance for higher building standards for developments to aspire to.

Whilst the policies contained in the SPD must be consistent with the Core Strategy, they also need to reflect the changing environmental circumstances and greater focus on energy performance within the life cycle of buildings, reduction of carbon emissions through waste reduction, improved materials and greater use of renewable energy.

Further Information

- SPD contents will need to be taken into consideration from the earliest stages of the development process

The SPD identifies opportunities to provide stronger guidance to drive up building standards. This will provide detail of how development can achieve higher quality buildings through design andhigher quality materials, as well of greater use of renewable energy technology in buildings.

Guidance set out in the SPD is directed to new build development, however retrofit and alterations may find guidance set out in the all of the chapters useful, where every effort should be made to improve the building as a whole. The SPD identifies ways that the new Local Plan can include future policy in order to ensure that it is full aligned with our carbon neutral, nature-rich goals for Herefordshire.There are a significant number of NeighbourhoodDevelopment Plans (NDPs) in Herefordshire. These form part of the development plan and many contain local level policies regarding housing design and sustainability, which have been developed at a specific parish level. Therefore, it is important that these are also considered.

For example, for a residential development the SPD will not:

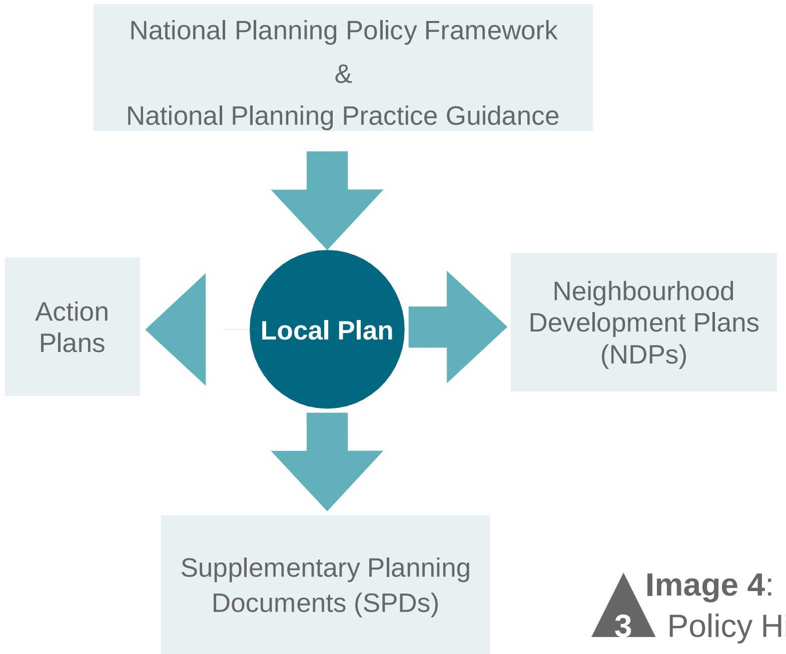
Introduce policy that dictates for example a minimum standard for airtightness on houses in Herefordshire or a pass or fail method of review.

But will:

Provide a checklist to be submitted as part of the planning application that allows the applicant to demonstrate for example how a fabric first approach has been taken, state the airtightness targets for the design and includes description on how the site supports biodiversity. Ultimately allowing the applicant to demonstrate the sustainability credentials of the project.

The policies contained within NDPs differ from parish to parish, and references to sustainable development vary.

It is important for NDPs to consider the guidance set out in the chapters in this SPD, which may help strengthen their sustainable design and environmental policies.



3 **Image 4**: Policy Hierarchy

What the SPD contains

The SPD sets out best practice minimum building standards in the following areas:

- energy efficiency
- water efficiency
- waste and pollution
- sustainable transport
- ecological impact
- carbon intensity

The SPD will set out best practice guidance on the measures and opportunities available to developers and householders to integrate sustainability into their development. It provides detailed guidance for officers, applicants and design and construction teams prior to design conception.

The guidance details how Herefordshire Local Plan Core Strategy policies SD1 and SS7, and parts of policies SD2, SD3, SS6, LD1, LD2, LD3, LD4 and MT1 in the Core Strategy should be interpreted and implemented, in order to support proposed development and help deliver sustainable buildings and communities.

A Sustainability Statement template and Sustainability Checklist for minor and large scale schemes are included in Appendix 1 of this document. It is encouraged for applicants and agents to utilise these in order to help them develop a more sustainable scheme.

Next steps

The draft SPD will be subject to consultation, review of feedback and then formal adoption by the council. Once adopted it will be a material consideration in the determination of planning applications. It should be taken into account in the preparation of planning proposals for residential and mixed use development from the pre-application stage onwards, and while negotiating and undertaking development feasibility.

Whilst the NPPF is referred in the document, it is important to note national policy and guidance are periodically updated and the latest guidance will be used in making planning decisions.

How to use this SPD

This guide sets out best practice for applicants to help increase the sustainability of their proposal. The five core chapters provides technical guidance in:

- improving building performance
- energy use
- external environment
- accessibility
- construction

The chapters included in the SPD provide an explanation of topic, along with technical definitions and standards and at the end of each chapter provides a summary of best practice recommendations. Following these chapters are case studies demonstrating best practice. The Sustainability Checklist and Sustainability Statement are for applicants to complete. Planning applicants should utilise the checklist for domestic, small and medium scale development. Householder applicants are advised to fill in the Sustainability Statement and for minor and larger proposals fill in the Sustainability Checklist, providing details where appropriate.

Who should complete the Sustainability Checklist/ Sustainability Statement?

The table below lists the types of development that are encouraged to complete the checklists/ statements in order to show how sustainability has been considered in the proposal. The checklist and Sustainability Statement template can be found in Appendix 1 of this document.

Sustainability Statement	Sustainability Checklist
• Householder applications (extensions/ small outbuildings/ replacement dwellings)	• Minor scale housing development 1-9 dwellings • Non-residential proposals below 1000sqm of floor space • Major scale housing proposals over 10+ dwellings • Large scale non-residential development 1000sqm and above floor space

What type of applications should complete the Sustainability Checklist/ Sustainability Statement?

It is strongly encouraged that full, outline and reserved matters applications complete the Checklist/ Sustainability Statement. It is recommended for householder applicants/ agents to complete the sustainability statement template, where applicable. For change of use proposals policies are applied to the proposed use. For example, if a non-residential building is being changed into dwellings, the proposal should respond to the requirements for dwellings and therefore it is recommended a Sustainability Checklist is completed.

When should the checklist and Sustainability Statement template be submitted?

The Sustainability Statement / Sustainability Checklist, should be submitted with the planning application, and include detail in compliance with the conditions where required .The Sustainability Checklist / Sustainability Statement should be submitted using the documents in Appendix 1.

These will be updated periodically to reflect changes in legislation, policy and practice.

Benefits of using the Environmental Building Standards recommendations for best practice

- Social benefits; higher quality buildings with lower maintenance and running costs for occupiers.
- Economic Benefits; Lower lifetime building cost, Supporting development of higher skills in local construction industry; boosting property values in context of growing demand for sustainable buildings; reducing energy wastage and reducing fuel poverty;
- Environmental Benefits, Overall carbon reduction in the lifecycle of a building, reducing waste.

Through the application of the standards within the Sustainability Statement and Sustainability Checklist and supporting guidance within this SPD, will be possible to reduce the detrimental impact from new development and ensure that social, economic and environmental benefits are provided for Herefordshire.

Planning and Policy Context

Planning and Policy Context Overview

In this section

This section will detail:

1 / Relevant national policy

2 / Emerging or upcoming national policy

3 / Relevant local policy

4 / The role of building standards

Executive summary

> The National Planning Policy Framework (NPPF) presumes a favourability for sustainable projects. That includes minimising waste, projects that move towards a low carbon economy and that use natural resources carefully. Local requirements for sustainability need to be consistent with national standards.

> There are several key pieces of policy that will have a big impact on sustainability in construction going forward. Those include The Environment Act 2021 and the Future Homes Standard that aims to reduce carbon emissions in housing by 75-80%.

> The SPD works with Herefordshire's Local Plan but builds on it in a number of areas in order to support the delivery of the a zero carbon county - alongside Herefordshire Council's Carbon Management Plan 2021-2026, and the 2021 Herefordshire Future Homes guidance.

> Existing building standards and design guides like Building Research Establishment's Environmental Assessment Method (BREEAM), Passivhaus and The London Energy Transformation Initiative (LETI) can help ensure projects deliver true, proven sustainability.

National Planning Policy

Effective planning is key to address the challenge of climate change, can play a key role in reducing greenhouse gas emissions. Planning can also help increase resilience to climate change impact through the location, mix and design of development. Addressing climate change is one of the fundamental land use planning principles which the National Planning Policy Framework expects to underpin both plan-making and decision-taking.

The National Planning Policy Framework (NPPF)

Published in July 2021, it sets out the Government's planning policies for England. It has a presumption in favour of sustainable development. This means planning to meet the needs of the present without compromising the ability of future generations to meet their own needs.

A fundamental principle for planning highlighted in Chapter 2, is that it should contribute to protecting and enhancing the natural, built and historic environment. This includes; making effective use of land, helping to improve biodiversity, using natural resources prudently, minimizing waste and pollution, mitigating and adapting to climate change and moving to a low carbon economy. The NPPF contains a range of policies which promote sustainable development by requiring good design,promoting healthy communities, meeting the challenges of climate change and flooding, and enhancing and conserving the natural and local environment.

Local planning authorities when setting any local requirement for a building's sustainability are expected to do so in a way consistent with the government's zero carbon buildings policy and adopt nationally described standards. Local requirements should form part of a Local Plan following engagement with appropriate partners, and will need to be based on robust and credible evidence and pay careful attention to viability.

4 **Image 5**: visitherefordshire.co.uk/see-do/scenic-trails/hills-herefordshire

Further Information

- The National Planning Policy Framework (NPPF)

Policy addresses:

- Climate change
- Low carbon construction
- Renewable energy
- Planning
- Circular economy
- Biodiversity
- Sustainable transport
- Reduces waste

NPPF Chapter 12 'Achieving well-designed places', states the importance of high quality, beautiful and sustainable buildings. Good designi s a key aspect of sustainable development. To provide maximum clarity about design expectations at an early stage, all LPAs should produce design guides consistent with the principles set out in the National Design Guide and National Model Design Code.

Paragraph 134 of the NPPF states the importance of giving significant weight to:

- a) development which reflects local design policies and government guidance on design, taking into account any local design guidance and supplementary planning documents which use visual tools such as design guides and codes; and/or
- (b) outstanding or innovative designs which promote high levels of sustainability, or help raise the standard of design more generally in an area, so long as they fit in with the overall form and layout of their surroundings. [*NPPF Chapter 12 'Achieving well-designed places' Paragraph 134*]

Chapter 14 of the NPPF 'Meeting the challenge of climate change, flooding and coastal change': "The planning system should support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change. It should help to: shape places in ways that contribute to radical reductions in greenhouse gas emissions, minimise vulnerability and improve resilience; encourage the reuse of existing resources, including the conversion of existing buildings; and support renewable and low carbon energy and associated infrastructure".

The chapter identifies that planning systems should support the transition to a low carbon future in a changing climate, taking into account of flood risk and costal change. Planning should help to shape places in ways and advises that new development should be planned for in ways that

- Avoid increased vulnerability to the impact arising from climate change
- Help reduce greenhouse emissions, through location, orientation and design.
- Help increase the use and supply of renewable and low carbon energy and heat, by providing a positive strategy for energy from these resources. Maximising the potential for sustainable development.

Further Information

- National Planning Policy Framework (NPPF): Chapter 12 'Achieving well-designed places'
- National Planning Policy Framework (NPPF): Chapter 14 'Meeting the challenge of climate change, flooding and coastal change'
- The Planning Practice Guidance (PPG)
- The Planning and Energy Act 2008

Planning Practice Guidance (PPG).

This national guidance provides clarity on the interpretation of the NPPF and makes planning guidance more accessible. The guidance advises on suitable mitigation and adaption measures in the process to address the impact of climate change.

The Planning and Energy Act 2008

This allows local planning authorities to set energy efficiency standards in their development plan policies that exceed the energy efficiency requirements of the building regulations. These policies must not be inconsistent with relevant national policies for England

The Written Ministerial Statement on Plan Making dated 25 March 2015 clarified the use of plan policies and conditions on energy performance standards for new developments. It states that local planning authorities should not set any additional local technical standards or requirements relating to the construction, internal layout or performance of new dwellings. Different rules apply to residential and non residential premises.

However, amendments in the Planning and Energy Act 2008 have not been enacted; the power given to local planning authorities through the Act to set energy efficiency standards still exists. LPAs are allowed to set standards above the building standard minimum.

Provisions in the Planning and Energy Act 2008 allow development plan policies to impose reasonable requirements for a proportion of energy used in development in their area to be energy from renewable sources and/or to be low carbon energy from sources in the locality of the development. It is expected this will be addressed in the new local plan.

Although this SPD does not set out new policies, it provides guidance and best practice recommendations for improving building performance, energy use, external environment, accessibility and construction. The guidance set out indicates the direction of travel of local policy; applicants and agents can expect that the revision of the Local Plan will set standards above Building Standards minimum. This SPD encourages voluntary adoption of higher standards in their schemes as soon as possible.

Further Information

- The Planning Practice Guidance (PPG)
- The Planning and Energy Act 2008
- The Written Ministerial Statement on Plan Making dated 25 March 2015

Emerging National Policy and Legislation

The Environment Act 2021

This sets out a new agenda for environmental reform and governance in the UK. The Act amends the Environmental Act 1995 and Water Industry Act 1991.This Act sets out new regulations on air quality, water usage, waste disposal and resource management, biodiversity, and environmental risk from chemical contamination. This act creates a new environmental watchdog, the Office for Environmental Protection OEP, to ensure environmental laws are complied with.

The Act is divided into eight sections, which can be grouped into three major areas: giving the secretary of state the power to amend regulations in areas of environmental concern, legally enshrining biodiversity targets and give local government powers to help enforce targets on air quality, water and waste management and conserving and enhancing biodiversity. The UK Government sees the bill as paramount to ensure both its 25 Year Environment Plan and its Net Zero Carbon Emissions by 2050 goal are met.

The National Design Code and Guide (NMDC)

This sets out the characteristics of well-designed places and demonstrates what good design means in practice. The National Model Design Code and Guide is part of a wider strategy set out in 'Living with Beauty' report published in January 2020. This forms part of the national planning practice guidance and is to be used alongside the planning practice guidance notes. The guide sets out 10 design characteristics for well designed places. Design coding is a tool to help define high quality design-this tool can be utilised by local planning authorities, developers and local communities. It is expected there will be a national code, a county level code and a neighbourhood plan code.

The Planning for the Future Consultation

This sets out to reform the planning system to streamline and modernise the planning process. This intends to bring a new focus to design and sustainability, improve the system of developer contributions to infrastructure, and ensure more land is available for development where it is needed. There is a strong focus to build and design.

Further Information

- The Environment Act 2021
- The National Design Code and Guide (NMDC)
- The Planning for the Future Consultation

better, and improve the sustainability of buildings. Building better, building beautiful chapter, highlights the importance of sustainable design and setting out clear expectations for the form of design development.

The Future Homes Standard Consultation

The changes proposed in 2019 to building regulations set out higher building requirements to reduce carbon emissions and waste.

The scope states: “As part of the journey to 2050 we have committed to introducing the Future Homes Standard in 2025. This consultation sets out what we think a home built to the Future Homes Standard will be like. We expect that an average home built to it will have 75- 80% less carbon emissions than one built to current energy efficiency requirements.”

The document sets out changes proposed for part L (Conservation of fuel and power) and F (Ventilation) of the current building regulations.

The initial Future Homes Standard consultation addresses: options to uplift standards for Part L of the Building Regulations in 2020 and changes to Part F, more stringent transitional arrangements for these standards to encourage quicker implementation, draft outline specification for future consultation about the Future Homes Standard, and clarifying the role of planning authorities in setting energy efficiency standards.

The two options to uplift energy efficiency and standards in building are:

- Option 1: 20% reduction in carbon emissions compared to the current standard for an average home. We anticipate this could be delivered by very high fabric standards (typically with triple glazing and minimal heat loss from walls, ceilings and roofs).
- Option 2: 31% reduction in carbon emissions compared to the current standard. We anticipate this could be delivered based on the installation of carbon-saving technology such as photovoltaic (solar) panels and better fabric standards, though not as high as in option 1 (typically double not triple glazing)

The preferred option from government is Option 2, delivering greater carbon savings and lower builds, but will have a higher householder cost.

Further Information

- The Future Homes Standard Consultation
- The National Design Code and Guide (NMDC)

Local Planning Policy

5 **Image 6**: Herefordshire Local Plan Core Strategy

The Herefordshire Core Strategy 2011-2031 was adopted in October 2015. This document sets out the vision and objectives that will underpin all the Council's planning policies. The Core Strategy recognises the importance of sustainable development and adapting to the impacts of climate change. This SPD will complement other policies contained in the Core Strategy. There are key policies that address environmental, ecological and climate policies within the Core Strategy detailed below. The Local Plan is currently under review, a pre-submission draft is expected to be produced by spring 2023.

This SPD supports Policy SS7: Addressing Climate Change. This promotes development in Herefordshire, for the most suitable location and supports design developments to reduce carbon emissions. It supports development that eencourages sustainable modes or travel such as cycling, walking and using public transport. The core sections of this document addresses climate change and sets out guidance for new development for applicant, agents and designers to consider when developing their scheme.

This key policy this SPD provides further guidance on is Policy SD1 Sustainable Design and Energy Efficiency (detailed below). In summary, development proposals should create safe, sustainable, well integrated environments for all members of the community.

Further Information

- The Herefordshire Core Strategy

Proposals should make efficient use of land and utilise physical sustainability measures including provision of water conservation measures, storage for bicycles and enable renewable energy and energy conservation infrastructure. Where possible, on-site renewable energy generation should be incorporated and sustainable construction methods should be utilised. This SPD provides detail on sustainable building design, improving building performance, improving energy use, enhancing external environment, improving the accessibility and suggesting ways construction can be more sustainable. This SPD sets out recommendations for best practice and details examples of case studies as exemplars of best practice.

The SPD also supports parts of Core Strategy policies that are:

Policy SS6 Environmental quality and local distinctiveness. Requires measures that conserve and enhances environmental assets that contribute towards the country's distinctiveness. This policy requires development proposals to take an integrated approach to the following environmental components from the outset that are; landscape, townscape and local distinctiveness, historic environment and heritage assets, light pollution, airq uality and tranquillity, waste, water environment, renewable energy and energy conservation. Historic settlement patterns and character were shaped by the climate, topography, communication routes and locally available materials but also reflected technological improvements, social patterns and fashion.

Sustainable development within a historic environment is not inconsistent with this, and should respond to contemporary societal needs and pressures and should not be a slavish or pick and mix copying of historic detail.

Policy SD2 Renewable and Low Carbon Energy Generation. Development proposals that seek to deliver renewable and low carbon energy will be supported when they meet certain criteria including not resulting in any significant detrimental impact upon the character of the landscape and can be connected efficiently to existing nation grid infrastructure if required.

Policy SD3 Sustainable water management and water resources. Requires measures for sustainable water management to be an integral element of new development to reduce flood risk, avoid an adverse impact on water quality as well as protecting and enhancing groundwater resources. It encourages proposals that are specifically aimed at the sustainable management of the water environment. It also seeks to reduce flows to sewage treatment works which would contribute to reducing nutrient levels in the receiving water courses.

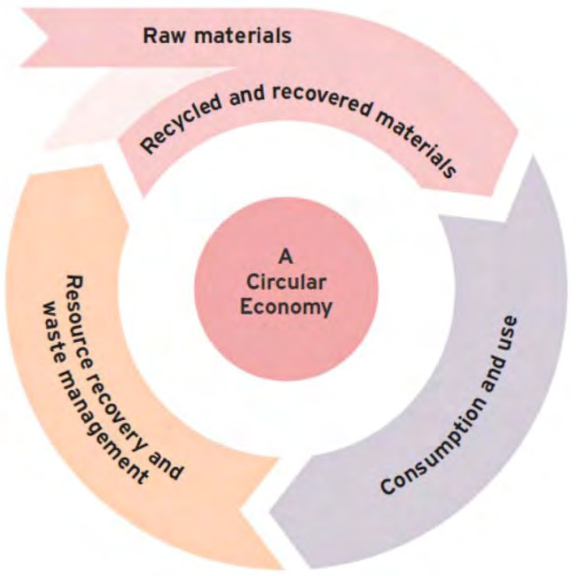
Policy LD1 Landscape and Townscape. Development proposals should demonstrate the character of the landscape and townscape has positively influenced the design, scale, nature, site section, protection and enhancement of the setting of settlements and designated areas. Proposals should conserve and enhance the natural, historic and scenic beauty of important landscapes and features.

Policy LD2 Biodiversity and Geodiversity. Development proposals should conserve, restore and enhance the biodiversity and geodiversity assets of Herefordshire through retention and protection of nature conservation sites and habitats and important species. They should restore and enhance existing biodiversity and connectively to wider ecological networks and create new biodiversity features and wildlife habitats.

Policy LD3 Green Infrastructure. Development proposals should protect, manage and plan for the preservation of existing and delivery of new green infrastructure. They should identify, retain and protect existing green corridors and linkages including tree, hedgerows, woodlands, water courses and the adjoining flood plain.

Policy LD4 Historic Environment and Heritage Assets. Development proposals affecting heritage assets and the wider historic environment should. protect, conserve enhance heritage assets. New development where it affects a historic asset or the wider historic environment will be supported where it can be demonstrated that it will result in the conservation and protection of its special interest. Heritage assets can provide a focus for regeneration schemes and proposals which result in the retention and imaginative re-use of redundant or under used structures will encouraged, and favoured above demolition and new build.

6 **Image 7**:
Ledbury Market House Heritage Asset
visitherefordshire.co.uk



7 **Image 8**:
The Circular Economy, Resources and Waste Strategy (Figure 5 from Herefordshire Minerals and Waste Local Plan 2021)

Policy MT1 Traffic Management, Highway Safety and Promoting Active Travel. Development proposals should promote and incorporate transport connections, including access to services by means other than private motorised transport. They should encourage active travel behaviour to reduce numbers of short distance car journeys through the use of travel plans and other promotional and awareness raising activities.

The Herefordshire Minerals and Waste Local Plan

Herefordshire Minerals and Waste Local Plan (MWLP) sets out the council's preferred strategy for meeting the county's minerals and waste needs until 2041.The plan is currently at pre-submission publication stage, and is anticipated for adoption in 2022. Policy W1, Waste Strategy, sets a strategy to reduce waste and promote the increase in reuse, recycling and energy recovery in Herefordshire, resulting in a reduction of waste disposed to landfill. Policy W6 sets out preferred locations for sustainable recovery of construction, demolition and excavation of waste.

This SPD sets out minimising waste caused from demolition and construction from the onset and has detailed guidance for applicant, agents and NDP policy makers.

Neighbourhood Plans

Herefordshire currently has 113 designated Neighbourhood Plan areas, with 82 made Neighbourhood Plans (November 2021).

Many of the plans include objectives and policies on sustainable design and renewable energy in their plan. This SPD provides guidance to help inform local communities to help expand existing policies, also develop sustainable policies that are locally responsive to their area.

Further Information

- The Herefordshire Minerals and Waste Local Plan
- Neighbourhood Plans

Definitions

- **Circular economy:** any practice that looks to reuse or repurpose existing building fabric. Circularity saves significant embodied emissions and can cut costs.

Herefordshire Council's third **Carbon Management Plan 2021-2026**, sets out of a 75% reduction in carbon emissions by March 2026 (vs 2008 baseline) and guidance indicating how Herefordshire Council can minimise carbon emissions. This is an interim target on the path for Herefordshire to be carbon neutral by 2030/2031.

In 2021 a **Carbon Management Action Plan** was produced to accompany the management plan. The action plan highlights areas that can help reduce Herefordshire Council emissions, and support green energy and future projects.

In response to the climate emergency declared by Herefordshire Council in March 2019, a 10-year construction programme to provide 2500 new affordable, zero carbon homes is underway.

The net zero affordable housing standard guide ***Herefordshire Future Homes*** sets out the standards for net zero homes developed by the Council and its partners in Herefordshire.

The 2021 **Herefordshire Future Homes (HFH)** sets out standards for all all stakeholders involved in housing. High level aims and detailed technical recommendations are given for Herefordshire's new and existing homes and communities. The recommendations listed detail a roadmap to net carbon delivery in Herefordshire. By harnessing the principles set out in the HFH, it is expected to not only produce zero carbon affordable homes, and improve the upgrade of existing homes, but also create jobs and skills in Herefordshire whilst supporting the local community.

The standard goes beyond energy use, and intends to create a wide-ranging design/ sustainability/ community framework to support this progressive and collaborative programme. This will work alongside the Environmental Building Standards SPD and raise the bar for environmental building standards across Herefordshire, inspiring others to provide greener, more efficient building in order to minimise carbon emissions and improve quality of life.

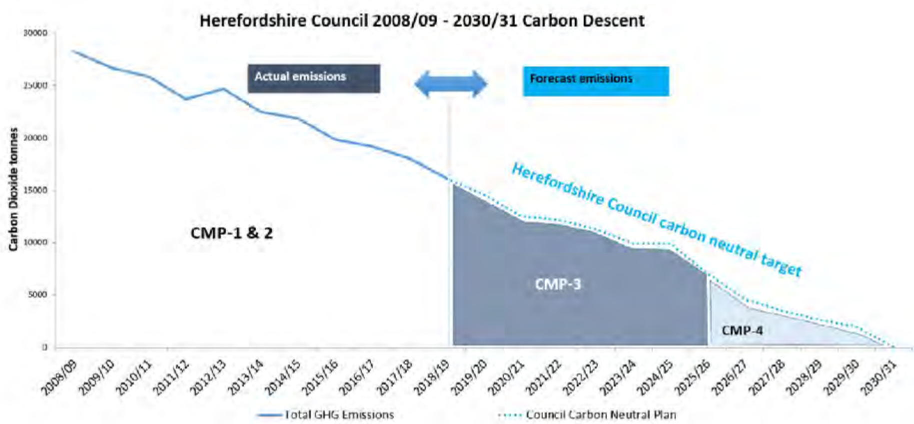


Image 9:
Herefordshire Council Carbon Management Action Plan

Further Information

- Herefordshire Council Carbon Management Action Plan

Building Standards

Existing building standards have been considered and included in this SPD are listed below. These standards have helped inform the guidance set out within the document and have help to set out the best practice recommendations included in each chapter. A detailed explanation of these standards and guidance of how these standards can be applied can be found throughout the core chapters of this SPD.

- Passivhaus - Featured in the building performance chapter, energy use and construction.
- LETI Design Guidance (The London Energy Transformation Initiative) - Featured in the building performance, energy use, construction chapters.
- BREEAM (Building Research Establishment Environmental Assessment Method) - Incorporated in several chapters.
- Built for Life - Featured in external environment chapter.
- Building with Nature - Featured in external environment chapter.
- RIBA 2030 Climate Challenge standard - Incorporated in several chapters.
- Bioregional One Planet Living Framework - Incorporated in several chapters.

The gap between current Building Standards and Passivhaus

The Standards set out in Passivhaus currently exceed existing UK Building Regulations, these are currently at a relatively low bar in terms of energy and fabric efficiency.

Part L of the Building Regulations and the requirement for energy certification does not align with the calculations provided under Passivhaus Standard. The standards included in the current UK regulations are significantly lower than the ones set out in Passivhaus standards but requirements will still need to be met under the Building Regulations.

If you require further information regarding Building regulations and compliance, please contact the Herefordshire Council Building Control department where they can provide further advice. Contact details are provided on the following link https://www.herefordshire.gov.uk/building-control/building-control-1/3

9 **Image 10**: Building Standards Logos

Building Standards Herefordshire Future Homes BS1

The Herefordshire Future Homes standard (HFH) lays out the best practice build standards and energy targets that Herefordshire Council believe would deliver sustainable, net zero housing in the county.

The standard works alongside this SPD, and the National Model Design Code. It sets out recommendations for energy, embodied carbon and water targets as well as targets for accessibility and sustainable transport.

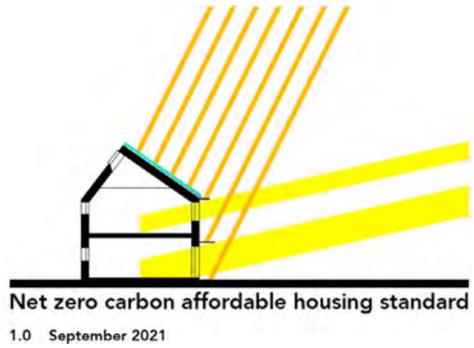
The key recommendations are:

- Undertaking a wholelife carbon and cost report
- Design for water use of less than 75l pp/day
- Delivery of buildings to Passivhaus Plus standards (total energy use <45kWh/sqm.yr) with heat pumps or other low carbon heating replacing fossil fuels
- Including on-site renewables on all homes, and designing a strategy to maximise storage
- Wholelife embodied carbon should be less than <625 kgCO^{2}e/sqm (RICS stages A-C)
- Residual embodied carbon emissions should be offset through a parallel programme of low-energy retrofits (to EnerPHit or AECB Carbonlite standards) – or through other robust offset schemes
- Pedestrian/cycle-friendly transport strategies
- All homes to be wheelchair-accessible
- All developments designed to be tenure blind
- Homes should pass CIBSE TM59 – using 2080 predicted weather files to ensure they are climate resilient. (GHA's overheating tool can be used for smaller developments)
- MVHR should be designed in to optimise cooling and ventilation
- A First Year soft landings programme should be planned to help residents get the most out of their new homes
- Post Occupancy Evaluation should be carried on 50% of new homes – monitoring energy, carbon emissions, running and maintenance costs as well as user satisfaction, at 1, 2 and 5-year set points.

The document will be reviewed annually, and will continue to add best practice examples as a way of raising expectations within the county.

Further Information

- Herefordshire Future Homes standard 2021



10 **Image 11**: HFH guide 2021

Herefordshire Council

Building Performance

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Building Performance Overview

In this section

This section will detail:

1 / How building performance affects energy + emissions

2 / The benefits of re-use or adaption

3 / How ‘passive design’ can help your project

4 / How a fabric-first approach can save energy and improve building performance

5 / How to create healthy + comfortable internal environments through building design.

5 / Embodied carbon is and how to reduce it

6 / Considerations when extending your home, and working with historic buildings

Executive summary

> Reducing a building’s energy demand should be a top priority, before efficiency measures and renewable generation.

> The better a building performs, the easier it is to achieve net zero emissions. Passive design, and a fabric-first approach are the most effective ways of delivering outstanding building performance, and low running costs.

> Factors like orientation, and appropriate ventilation and glazing strategies are key to providing a healthy, comfortable internal environment whilst reducing carbon.

> The embodied carbon used in the manufacture, transport and construction of a building must be minimised as much as possible, and properly accounted for.

Introduction

The UK - and Herefordshire - are in a climate emergency, requiring an urgent reduction in carbon emissions. With buildings in the UK contributing to 49% of the annual carbon emissions *(LETI)*, it is now more important than it has ever been to reduce and eventually eliminate this contribution, with all scales of development having an important role in enabling this to happen.

Carbon emissions from buildings can be attributed to two main areas:

1. the energy required to operate the building (operational carbon), including energy used to heat the building
2. the carbon associated with the building construction (embodied carbon), including the extraction and processing of materials, energy consumption in production, assembly and construction of the building. It also includes the ‘in-use’ stage (maintenance, replacement etc) through to ‘end of life’ stage (demolition, disassembly and disposal).

The chapters in this document are ordered in a way that follows a typical design process when considering a development.

When designing a building it is important to also consider the internal environment that is created, and this chapter explains the potential for overheating and actions to minimise this risk along with internal ventilation options and material choices to facilitate a healthy and comfortable internal environment.

This first chapter discusses the performance of a building and addresses the topics covered in Core Strategy policies SD1, SS6 and SS7, specifically related to design to reduce carbon emissions and efficient use of resource. Resilience to climate change, the efficient use of land and utilising passive design are also key themes within these policies and discussed in this chapter.

These topics are expanded upon with the inclusion of the fabric-first, Passivhaus approach to design.

The topic of retention and adaption is particularly relevant to Core Strategy policy LD4, and also when the approach to historic buildings is discussed later in the chapter.

Finally embodied carbon must also be discussed as early design decisions can impact greatly on this.

Policies

- Policy SS6 Environmental quality & local distinctiveness
- Policy SS7 Addressing climate change
- Policy SD1 Sustainable design and energy efficiency
- Policy LD4 Historic Environment and Heritage Assets

Most of the following pages discuss best practice for creating healthy, low carbon buildings. However,t he building with the lowest carbon impact is the one that is already built. The next two pages detail why you should first consider retention and adaption on your project.

Retention and Adaption

Worldwide, the construction industry consumes almost all the planet's cement, 26 per cent of aluminium output, 50 per cent of steel production and 25 per cent of all plastics (*Architects Journal: Retro First*). Approximately 49% of the UK's carbon emissions are attributable to the built environment *(LETI)*, while construction, demolition, and excavation activities generate approximately 62% of the UK's waste. *(DEFRA)*

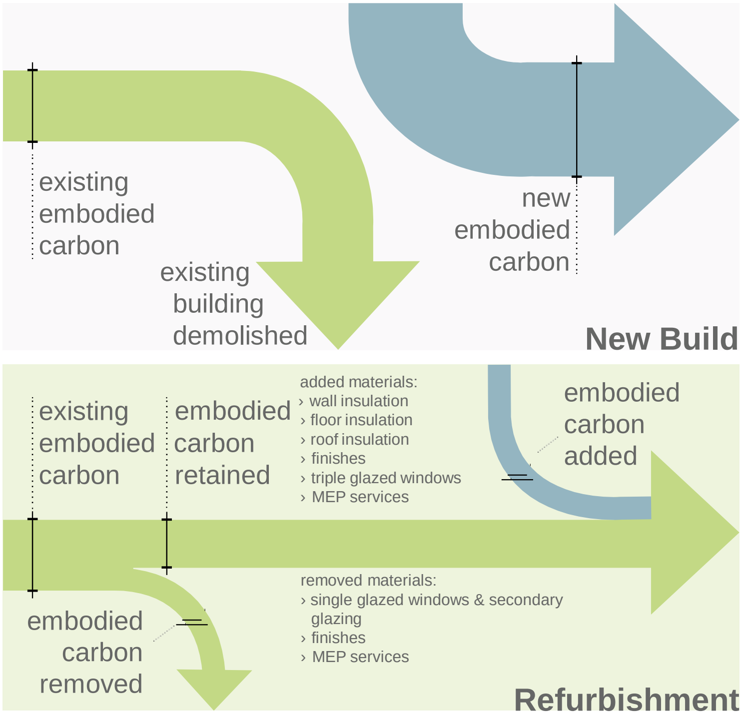


Image 12:
Embodied Carbon: New Build v's Refurbishment

Further Information

- National Design Guide, Ministry of Housing, Communities and Local Government (2021)
- Circular Economy Statement Guidance, Draft for Consultation (2020)
- DEEP DIVE: The choice between demolition or reuse: developer insights, UKGBC

Definitions

- **Embodied Carbon:** refers to carbon dioxide equivalent emitted during the manufacture, transport and construction of building materials, together with end of life emissions.

Best Practice Recommendations

- Prioritise the refurbishment and retrofit of existing buildings where possible. Also, aim to re-use elements of existing buildings if at all possible, for example foundations (subject to structural engineer input), bricks or even floorboards for a new purpose.

When an existing building is demolished and a new building built as a replacement, the emissions sealed in the original building, referred to as **embodied energy/carbon** are wasted. The construction and material manufacturing required for the new building then create new carbon emissions and so repurposing existing buildings has a large part to play in reducing the UK's carbon emissions, the embodied carbon within buildings and consumption of resources.

Before new development begins consideration should be given to whether existing buildings either on or off site can instead be developed as an alternative.

Image 13: Retrofitting Twyford Barn ©Architype

Fundamentally to do this the brief requirements for the project need to be reviewed and consideration given to whether an existing building could meet these, or if the brief can adapt to suit the building. Quite often financial implications, along with the physical condition of the existing building are large factors in this decision along with the sustainability requirements. However, with an increasing need for buildings to achieve **Net Zero Carbon** and the **circular economy** vision, this can lead to retention and adaptation being not only the most environmentally and socially sustainable solution but also the most financially viable.

Benefits:

- Reduced embodied carbon impact
- Minimises demolition waste and new resource depletion
- Often a less controversial development, that conserves and enhances existing places and neighbourhoods
- Reduces disruption to local neighbourhood from construction works, e.g. noise and dust, leading to better community relationships
- Reduced construction traffic impacts
- Cost and programme savings, depending on the scope of refurbishment
- Phased refurbishment could allow parts of the asset to remain in operation

Definitions

- **Net Zero Carbon:** achieving a balance between the carbon (carbon in this instance refers to CO2e, or 'carbon dioxide equivalent', which means other greenhouse gases are also taken into account) emitted into the atmosphere and the carbon removed from it. This balance will happen when the amount of carbon we add to the atmosphere is no more than the amount removed.
- **Circular Economy:** refers to a regenerative economic system aimed at continual use of resources to eliminate waste. This contrasts the traditional linear economic system: 'take, make, dispose.'

If retention and adaptation is not viable, recovery of the building elements and materials from the existing building should still be considered, contributing to circular economy goals.

Retrofit

In some instances for example when working with historic buildings or with existing housing stock demolition is not possible. In these cases a retrofit strategy should be implemented.

Retrofitting a building is required to ensure retained buildings contribute to reducing the UK's carbon emissions. Domestic energy use in buildings accounts for 69% of the operational emissions that come from buildings in the UK, which alone is responsible for 18% of the annual emissions *(LETI)*. Whilst reducing carbon emissions is the main driver, best practive retrofit should also reduce energy bills and also improve health and wellbeing.

The London Energy Transformation Initiative (LETI) published a Climate Emergency Retrofit Guide in November 2021, which provides an approach to retrofitting existing housing types to enable the Net Zero Carbon goals to be achieved.

The following hierarchical approach is advocated:

1. Reduce space heating demand and Energy Use Intensity
2. Remove fossil fuel heat sources and replace with low carbon alternatives
3. Generate renewable energy on site wherever feasible

An approach to historic buildings is discussed in more detail later in this chapter, although retrofit as a whole is a topic discussed in other publications.

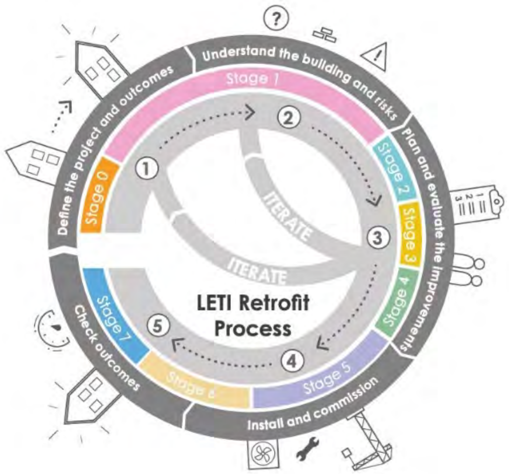


Image 14:

13 LETI Retrofit Process

Further Information

- LETI Climate Emergency Retrofit Guide (2021)

Definitions

- **Operational emissions:** The carbon dioxide and equivalent global warming potential (GWP) of other gases associated with the in-use operation of the building. This usually includes carbon emissions associated with heating, hot water, cooling, ventilation, and lighting systems, as well as those associated with cooking, equipment, and lifts (i.e. both regulated and unregulated energy uses).

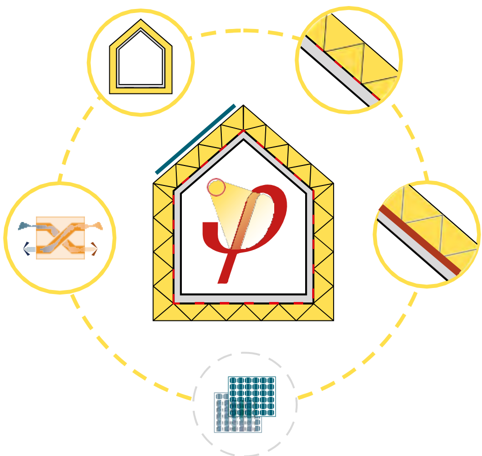
Passive Design

Minimising energy use through design needs to be factored in from the beginning of the design process. Implementing the **energy hierarchy** is an approach in support of this and one that should be applied to all development.

Buildings designed in line with the energy hierarchy prioritise lower cost passive design measures and take a fabric-first approach over high cost systems or and over-reliance on renewable energy technologies. In the long term this makes developments more cost-effective and allows investment costs to be recovered through operational savings.

An energy-led design approach starts with reducing the need for energy through passive design measures. Those include using form, orientation and fabric to maximise natural resources such as sun, ground, wind, and vegetation - and minimise the need for heating/cooling.

Proven standards like Passivhaus focus on minimising energy consumption, and provide a tested and measured route to achieving this. “”Passivhaus Plus provides a route to achieving Net Zero/Zero Carbon development by using additional renewable energy generation but with the emphasis remaining on step 1 of the hierarchy to minimise energy consumption..



Form and Orientation	1
Continuous Super Insulation	
Draught-free Construction	
Efficient Services (including MVHR unit)	2
On-site Renewables (Optional for Passivhaus Classic, required for Passivhaus Plus)	3

14
Image 15: Passivhaus Principles

Definitions

- **The Energy Hierarchy:**
  1. Reduce the need for energy through passive design measures including form, orientation and fabric;
  2. Install energy efficient mechanical and electrical systems, including heat pumps, heat recovery ventilation, LED lights, fittings and appliances;
  3. Maximise renewable energy through decentralised sources, including on-site generation, community-led initiatives and low and zero carbon technologies

Further Information

- Passivhaus Standards & Criteria

Site context - ie topography, existing built and natural environment: When looking at the building from an energy perspective, awareness of the surrounding area, and the impacts of over shadowing from vegetation, topography and surrounding buildings must be considered. A site design should aim to maximise the potential for solar gain (both for the building design itself, but also for the potential installation of solar panels), whilst also using land form and landscaping to provide shading to minimise heat losses in winter and provide shading in summer.

An awareness of sun paths and local climate provides energy benefits as well as a wider community benefit, creating character and pleasant bright spaces beside buildings. Evaluation of buildings once completed indicates spaces that are orientated sub-optimally so are heavily shaded most of the year and consequently underutilised. This does not lend itself to place making and creating community led social spaces.

Building form, orientation + layout: The internal and external design should work together to respond efficiently to overshadowing, internal heat gains, prevailing winds, light quality and spatial orientation with the building designed to minimise heating, lighting and cooling demand.

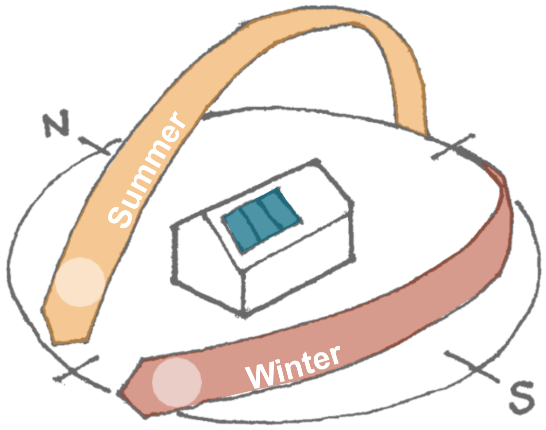


Image 17:
17 Sun Path Diagram

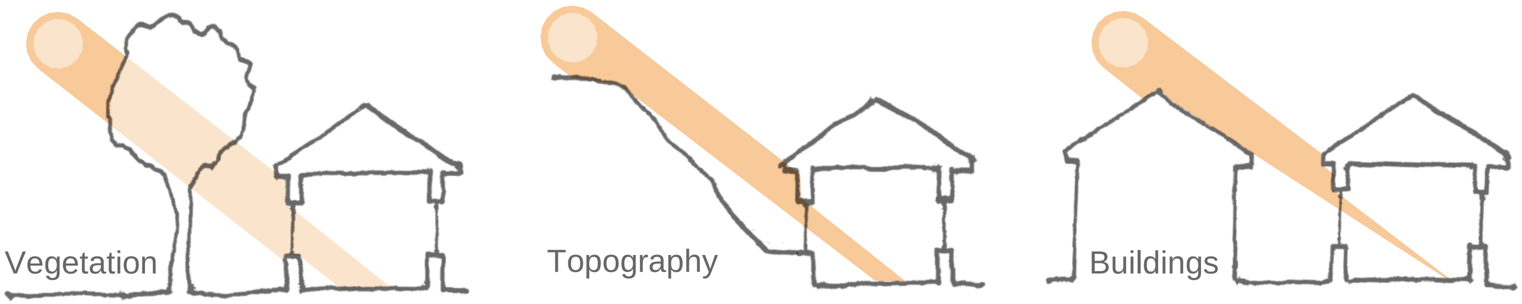


Image 16:
16 Site Context: Impacts of Overshadowing

An optimised orientation will have the main building facades and windows facing south and north (although north facing windows will lose more heat than they gain so should be assessed accordingly). Sometimes providing true north and south elevations is not possible due to site constraints and in this instance the '10 Degree Rule' can be applied. Solar gain drops off as the distance from true south increases but this isn't drastic until quite significant angles are achieved. For example, at around 20° off axis the building will still benefit from 90% of the available solar radiation. This maximises the amount of solar gains available to the building whilst maintaining consistent temperatures and daylighting inside through appropriate shading strategies. This does not exclude a building from having east and west facing windows however these present a higher risk of overheating and glare due to the lower angle of the sun.

Having a building oriented facing South to optimise solar gain means:

- Less onerous **building fabric** performance
  - Reduced Fabric **U-value** permissible
  - Less insulation (thickness) required
- More manageable internal comfort
  - Optimises beneficial solar gains
  - Lower overheating risk
  - Simpler to shade/ manage glare

Having a building orientated East to West means:

- More onerous fabric performance
  - More stringent Fabric U-value required
  - More insulation required
- Less manageable internal comfort
  - Undesirable solar gains
  - Greater overheating risk
  - Harder to shade/ manage glare

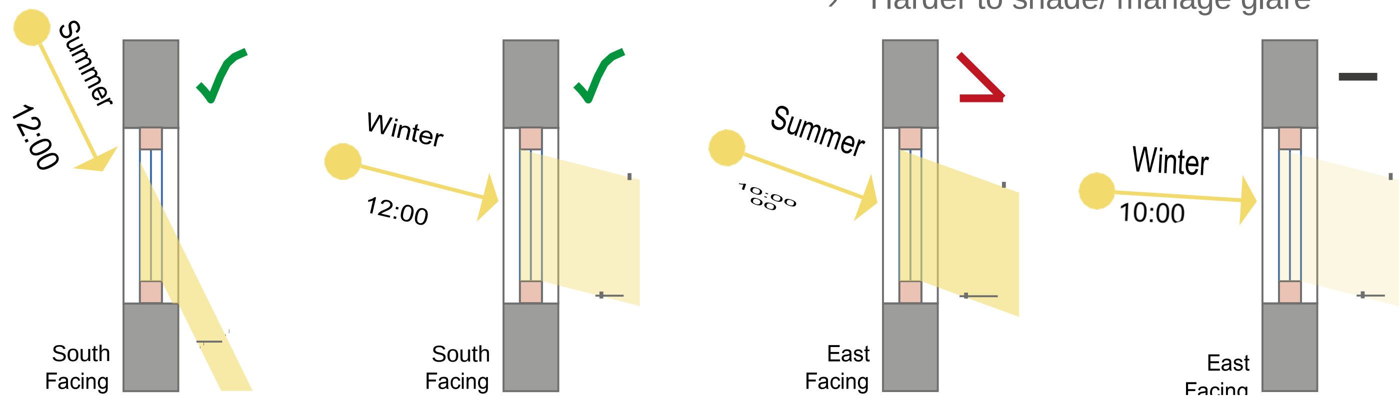


Image 18:
18 Orientation: Impacts on Solar Gains

Definitions

- **Building Fabric/ envelope:** consists of the external walls, roofs, floors, windows and doors and is the part of a building that protects the occupants from the external environment. It also controls the flow of energy and heat loss from inside to out.
- **U-value:** (measured in Wm2/K) – how readily energy (heat) will flow through a structure from inside to outside. It is a measure of the amount of energy (W) lost through a square metre (m2) of that material for every degree (K) difference in temperature between the inside and the outside.

A relationship between space requirements within the building and orientation should be incorporated from first principles. Positioning spaces so that those that require most warmth and daylight receive most passive solar gain and those spaces that need less warmth and daylight receive the least can ensure artificial lighting requirements are reduced as well as assisting the energy balance of the building. For example, in residential developments living and bedroom spaces are best located to the north and south, and bathrooms and circulation to the east and west. In a school it is best to have good daylighting in classroom spaces so these should be positioned with elevations to the north and south. In comparison, a workshop or plant room needs less daylight so could be positioned on the north or east elevations which also minimises the glazing requirement on these elevations and therefore less glare and overheating risk.

Optimising the massing of a building can create character and enhance wider social community involvement but must also be efficient in its design and placement. Creating an efficient form will often generate a higher density building rather than a low and spread-out building. However, there are many more factors such as orientation, daylighting, site constraints etc. that are important to consider when designing and the building form should be designed in conjunction with these. A compact building form does not guarantee an efficient building.

A buildings **form factor** is calculated by dividing the heat loss area (all external walls, roofs and floors) by the **Treated Floor Area (TFA)**, so relates to how much heat is needed to heat a space and how much heat is lost through the fabric.

A low form factor can reduce the heating demand and mean that the building specification can be relaxed whilst still achieving the same performance. Improving the form factor simplifies the building and can therefore result in cost savings by reducing the amount of building fabric and complex corner junctions. The form factor is only concerned with thermal elements. Architectural expression can still be achieved outside this envelope to give external space and elevation articulation.

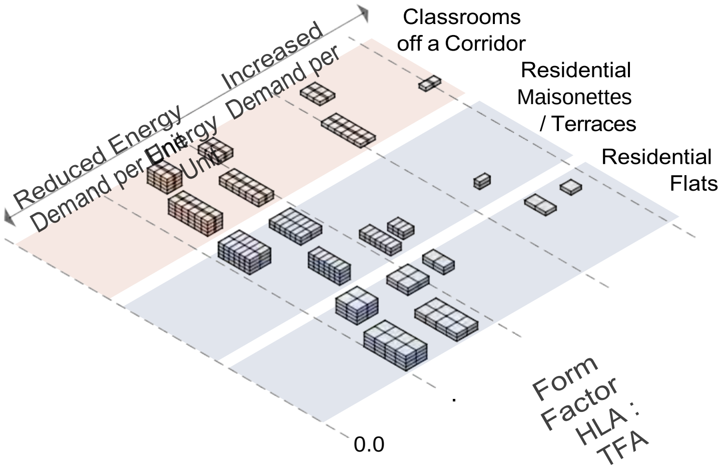


Image 19: Form Factor

Definitions

- **Treated Floor Area (TFA):** A measure of internal space, within the thermal envelope of a building. Areas that have lower head heights or are not classed as liveable areas are counted but a reduced percentage applied.
- **Form Factor:** a tool often used to assess a design at an early stage and provides an early indication of the efficiency of the building shape, the lower the number the better.

Daylight & windows: As the internal layout of a building is developed, consideration must be given to the depths of rooms and spaces, to ensure the room can be evenly well-lit throughout the day without a reliance on lighting and to promote internal comfort and well-being.

Outlook is important but it is also critical to minimise unnecessary glazing that will create a risk of the building overheating or losing excessive amounts of heat (as windows will perform worse than external walls).

Glazing ratios, specification and configuration have a significant impact on the energy performance of a building.

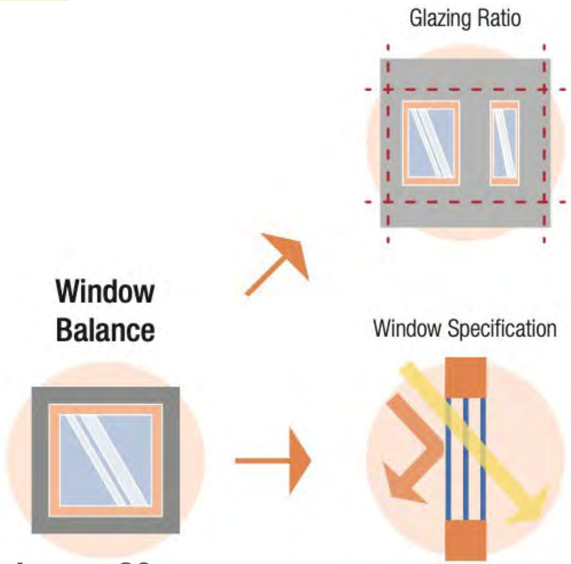


Image 20: Glazing Ratio and Specification Balance

Generally, south facing glazing with a **brise soleil** for solar shading is favourable as it affords good solar gains in winter months when the sun is low in the sky and minimal gains due to the solar shading when the sun is high during the summer. East and west facing glazing afford reasonable winter solar gains and high instant summer gains which are not ideal.

An exemplar elevation design achieves a balance between optimising free solar gains, window heat losses, daylighting and overheating risk, whilst working aesthetically.

These ratios are not always achievable due to brief constraints as well as daylighting, access to views or for acoustic reasons. It is, however, where the ratio deviates from the ideal that a different aspect of design will have to compensate for performance losses, such as improved building fabric U-values.

A balance can be found within the specification to compensate for additional glazing but this has a significant capital cost impact as well as potentially increased maintenance and replacement costs. The latter is especially true if the glass required is of high performance specification to compensate.

- **Brise Soleil:** A solar shading system that use horizontal or vertical blades fixed externally to a building.

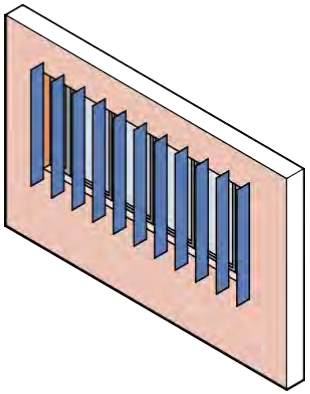
The sill heights and distribution of glazed area across the elevation (lots of little windows, versus a few large ones) are important factors in optimising the useful solar gains. Typically, windows down to floor level bring in higher levels of non-useful solar gain due to glazing below 800mm, or the 'working plane' in daylight modelling terms, by creating additional heat losses in winter, and additional heat gains/overheating in summer. This leads to thermal discomfort and requires complex services solutions to resolve.

Optimal glazing ratios have to be considered in conjunction with both designed and contextual shading as an overall approach and at each level of the building.

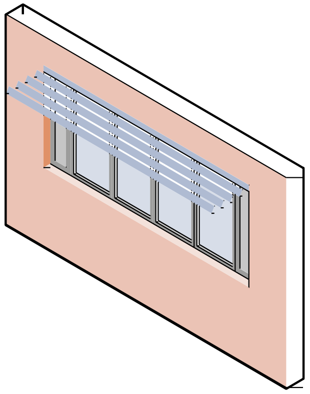
Shading: Shading is often required for buildings to control solar gains and glare. The shading of a building can be provided by the surrounding context, for example trees, topography and buildings as well as being designed as part of the building envelope.

Considered window and glazingdesign can help to reduce the need for it, but with the climate changing it is important to design an opportunity for further shading to be incorporated at a later date.

As explained in earlier sections it is easier to control solar gains to a building on the north and south elevations. External shading is advised over internal shading mechanisms as the heat has at that point already entered the building. Often internal shadingmechanisms can also be more costly. The use of shading systems such as **brise soleil** or vertical fins can be beneficial in reducing glare as well as overhanging eaves, deep window reveals and covered canopies and walkways. A general rule of thumb is that horizontal shading is more effective onsouth facing elevation and vertical shading on east and west elevations.



E/W-facing window



S-facing window

21 **Image 21**: Optimised shading orientations

Planting & Soft Landscaping: Vegetation, trees, and elements such as green roofs also have a role to play, improving outlook, managing air quality, stabilising microsystems and providing natural shading. Buildings should be designed to allow the benefits of planting to improve the internal conditions however they should not be reliant on them to do so; quite often the building's life expectancy exceeds that of the landscaping around it.

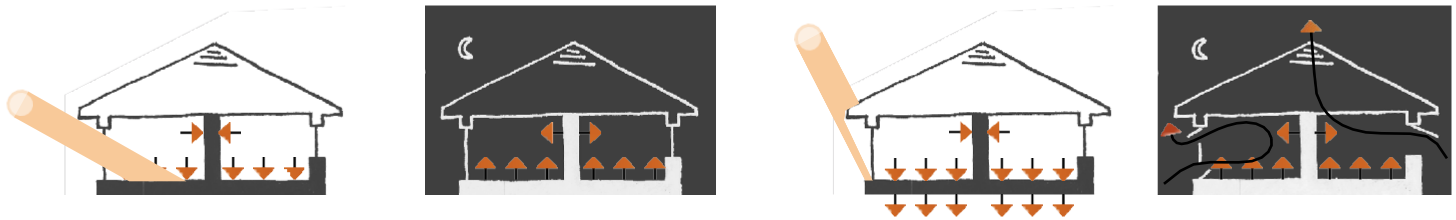
Thermal mass: Materials have the capacity to absorb and store heat and release this when temperatures are cooler. Some materials such as concrete and stone have a high thermal mass, whilst materials such as timber, a low thermal mass. The thermal mass of a building can be used to moderate the internal temperature of buildings, by storing the heat during the day and releasing it during the cooler night temperatures.

Generally, the more mass there is within the external thermal envelope the easier it is to control the possibility of overheating in summer months. A building with high thermal mass, exposed internally, will tend to have even temperatures and a good internal environment over the changing seasons, naturally reducing the risk of overheating. However, this does not require a building to be built in masonry. Solid ground floors and exposed plaster can both contribute to the thermal mass of the building.

Whilst thermal mass can be a benefit the impact is difficult to quantify and there is often a lag in response which needs to be considered along with the heating system design. Ensuring there is the ability to open windows securely, particularly at night time, is important in providing an opportunity to resolve this. Ultimately the design and benefit of thermal mass will depend on the context and will need to be considered in relation to the building.

In a Passivhaus building for example, large fluctuations in temperature are reduced through minimal heat loss, controlled ventilation and attention to avoiding overheating, so the benefits of thermal mass are reduced.

22 **Image 22**: Thermal Mass



Day (winter) - heat absorbed   Night (winter) - heat emitted   Day (summer) - heat emitted   Night (summer) - heat emitted

Fabric First Approach

A fabric first approach takes a design back to basics and is an approach to ensure the building itself reduces its energy consumption. An energy efficient building should achieve high thermal and airtight performance whilst also providing structural stability and weather protection. There are a few key principles that need to be addressed to achieve this:

Insulation: Firstly, it is important to minimise heat loss through the external fabric (which includes walls, floor, roof, windows and doors) by wrapping the building in a continuous layer of insulation. Each material has a calculated **lambda** value or 'λ value' which is then added to the other elements of the fabric in that section of construction (for example the wall) to provide a **U-Value.**

The thermal performance of a building structure is reviewed using U-Values. The lower the U-Value the better the thermal performance, as less heat is being transferred through this element. Building Regulations have set minimum requirements for the U-Values of each element but it is recommended that buildings should achieve the highest possible standards of thermal insulation, not minimum requirements.

Thermal bridging: Continuity of insulation is essential. The need for structural integrity, and the need to allow light and access into a building leads inevitably to the use of different materials with different thermal properties. Good design of each of these details to minimise the thermal loss is crucial both to keep heating demand down and to avoid cold spots or thermal bridging where condensation and mould might form. The effect that thermal bridging can have on the overall thermal performance of a dwelling can be significant.

Definitions

- **Lambda (λ) value:** (measured in W/(mK)) – measures the thermal conductivity of a material and is a value that indicates how well a material conducts heat. It indicates the quantity of heat (W), which is conducted through 1 m² wall, in a thickness of 1 m, when the difference in temperature between the opposite surfaces of this wall equals 1 K (or 1 ºC). The lower the λ value, the better the insulation property of the material.

- **U-value:** (measured in Wm2/K) – how readily energy (heat) will flow through a structure from inside to outside. It is a measure of the amount of energy (W) lost through a square metre (m2) of that material for every degree (K) difference in temperature between the inside and the outside.

- **Thermal bridging:** A thermal bridge, also called a cold bridge, is an area of a building construction which has a significantly higher heat transfer than the surrounding materials. This is typically where there is either a break in the insulation, less insulation or the insulation is penetrated by an element with a higher thermal conductivity.

Recent research undertaken has shown that thermal bridging can be responsible for up to 30% of a dwelling's heat loss *(BRE).*

Airtightness: Ensuring a building is airtight also contributes to eliminating draughts and cold spots, safeguarding internal comfort and energy efficiency. It has been identified that current building regulations must dramatically improve the airtightness requirements of buildings if we are to achieve the Government energy targets.

An air test to establish a building's airtightness should be completed on all new and renovated buildings. When carrying out an airtightness test, a steady-state condition is established, when the air blown out of the building by the fan is balanced by the air re-entering the building through various cracks, gaps and openings. Typically, this is at a pressure of 50 Pascals (Pa).

Current Building Regulations requirements are for a building to achieve an airtightness of <10m³/h.m² @50pa. The National Future Homes Standard which comes into force in 2025 (although there will be an intermediate uplift ahead of this date) and replaces the Building Regulations Part L 1A standard for conservation of fuel and power in new dwellings, will require a change to <5m³/h.m2 @50pa. This is the equivalent to a hole the size of a 20p piece in each square metre of external fabric. In contrast building to achieve the Passivhaus standard requires an airtightness of <1m³/h.m² @50pa for refurbishment (to the Passivhaus enerpHit standard) and <0.6m³/h.m2 @50pa for new build. To put this in perspective this is a hole the size of a 5p piece every 5 square metres of external fabric.

An end airtest will often be required upon completion for certification but it is advisable that earlier tests are completed as a check and to allow rectification if needed. Good design requires decision on an air barrier strategy, deciding what products and processes are required to deliver an agreed target airtightness. On larger developments assigning an airtightness champion will help achieve an airtight design and the quality assurance needed. Failing an airtest can often be costly requiring additional works and delay.

Windows: Window design is important in a fabric first approach, forming a significant part of the buildings envelope. Careful consideration needs to be given to creating the right size and proportion of windows and the right orientation so that the resultant solar gain reduces the need for heating, as discussed earlier. Triple glazed windows shouldb e installed which effectively act as radiators in the winter. These combined with the high levels of insulation also mean that other every day activities such as people and appliances also contribute to heat generation in winter, resulting in a home that requires very little heating.

Definitions

- **Airtightness:** the ‘leakiness’ or ‘draughtiness’ of a building. It is a factor in the energy performance of a building; less airtight buildings can waste energy by losing warm internal air to the atmosphere and taking in cold air from the outside during the heating season.

The detailing around windows and openings are often potential areas for cold bridges and airtightness issues. A window forms part of the insulation and airtightness layer and so the window must be positioned in alignment with the insulation (ideally centrally) and detailed (often with tapes and membranes) to ensure it is not a weak point in the airtightness layer.

Consideration regarding glazing configurations was discussed earlier in relation to solar gain and shading. The configuration is also important from a fabric first approach. When designing a highly insulated building triple glazing provides the best energy balance and is needed to meet comfort requirements and to avoid condensation and mould at the edges. The U-Value of a window the manufacturer provides is for the whole component, frame and glazing. Each of these also has a U-Value which when assessed in relation to amount of frame and glazing a whole window U-value can be calculated.

Generally, frames perform worse than triple glazing so small windows, or those with lots of mullions and transoms should be minimised - could one larger window provide the desired daylight into a space rather than 2 smaller? Equally where possible consider glazed doors as these generally perform better than solid doors. Tilt and slide doors and inherently more airtight than parallel slide versions, whilst bi-fold doors are generally more expensive if they achieve a good level of airtightness. Note that rooflights are very difficult to shade from overheating in summer.

Although outward opening windows are more common in the UK market, when planning to use a high performance energy efficient window it is worth noting that a high proportion open inwards. Inward opening windows allow external shutters, blinds or insect mesh to be fitted, and are usually easier to wrap in insulation, thus helping achieve better thermal performance. This will need to be factored in to the design particularly if there is the cill were to be a feature, such as a window seat.

Image 23:
23 Architype, image by Richard Kiely

Best Practice Recommendations

- A fabric first and building physics approach to be implemented during all design stages.
- Achieve an air permeability of below $3m^3/h.m^2$ @50pa in all new developments. However an airtightness of <$0.6m^3/h.m^2$ @50pa required for Passivhaus is encouraged. For an airtightness of below $3m^3/h.m^2$ @50pa this will need to be in combination with a mechanical ventilation heat recovery system.

Overheating

When applying the earlier guidance to improve the fabric performance and maximise solar gain it is essential that these are considered alongside measures to address overheating. Energy efficiency measures and external temperatures as a result of urbanisation and climate change are increasing the risk of overheating in existing buildings especially in those that primarily rely on passive measures to achieve year-round internal comfort.

Image 24:
24 HARC, Architype ©DennisGilbert/VIEW

High internal temperatures are detrimental to internal comfort and productivity and excessive or prolonged high temperatures have significant impacts on the safety, health and well-being of the ooccupants. Summer temperatures are set to rise by half a degree in the UK by 2050, with urban areas set to experience higher temperatures and so overheating must be addressed.

In the past air conditioning has been a solution to higher temperatures, particularly in non residential buildings in the UK but the focus on reducing energy consumption and carbon emissions now mean these are not economically or environmentally viable.

Methods to manage solar gains, such as window design, shading, the surrounding context and orientation have been discussed in earlier sections to minimise energy consumption. These measures also help to control overheating, with the ratio of glazing on building elevations critical to achieving this. The Good Homes Alliance has published a helpful tool to identify overheating risks in new homes such as ensuring single aspect buildings should also be avoided as these are more prone to overheating due to lack of cross ventilation and solar gains occurring at the same time, thereby increasing the peak solar gains.

Best Practice Recommendations

- All new development to be designed and built to meet CIBSE TM59 overheating standards. Future climate scenario modelling to also be completed. The Good Homes Alliance overheating tool could be used for smaller developments.

Further Information

- The Good Homes Alliance Overheating in New Homes

Managing solar gain is one element to managing the overheating risk alongside a robust ventilation strategy. Natural ventilation should be provided where suitable, with cross ventilation encouraged.

However passive design principles should not be relied upon as the only method to combat the risk of overheating and natural ventilation should be evaluated in relation to site constraints to its effectiveness in mitigating overheating. Additional to this a whole building mechanical ventilation heat recovery system is recommended, ensuring a consistent amount of fresh air into each room of a building.

Analysis of the building is important at the early design stages to establish if overheating is a risk.

Thermal modelling software, that for example is used when designing a Passivhaus building can analyse the buildings performance and if internal comfort will be affected throughout the year. The Chartered Institution of Building Services Engineers (CIBSE) has published criteria for assessing overheating along with future climate scenarios which should be used when completing overheating assessments.

Post occupancy evaluation and in-use monitoring are recommended to assess the buildings real life performance against performance that was anticipated at design stage (**the performance gap**) to establish if the building performs as expected and if not allows rectification measures to be put in place.

Definitions

- **Post Occupancy Evaluation (POE):** the process of obtaining feedback on a building's performance in use.
- **Performance Gap:** the difference in how a building was anticipated to perform at design stage and the in-use energy consumption.

Further Information

- Overheating, CIBSE
- CIBSE TM52 The Limits of Thermal Comfort: Avoiding Overheating in European Buildings (2013)
- CIBSE TM59 : Design Methodology for the Assessment of Overheating Risk in Homes (2017)
- Overheating in new homes: Tool and guidance for identifying and mitigating early stage overheating risks in new homes, Good Homes Alliance (2019)

Ventilation

In the past buildings have relied on the opening windows and air permeability through the building fabric for ventilation. Designing energy efficient buildings which are highly insulated and with minimal air permeability requires a considered approach to ventilation to minimise build-up of moisture, CO^2 and other internal pollutants.

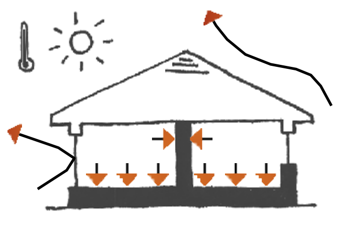
Studies show that the average Indoor Air Quality (IAQ) in modern homes with natural ventilation via trickle vents is poor. As the majority of the day is spent in-doors, a long-term exposure to polluted and oxygen-depleted air is likely to have negative health implications. A building that is well ventilated, will provide a healthy and comfortable environment for the occupants along with minimising the risk of overheating.

Natural Ventilation & night time cooling: Where local environmental conditions permit (e.g. noise, air quality), openable windows should be included as they allow building users the opportunity for natural ventilation. Cross ventilation is encouraged, and single aspect buildings should be avoided.

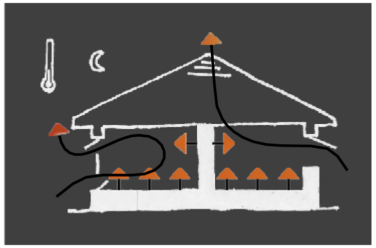
Buildings should be designed, where possible to allow for windows, panels or louvres to provide ventilation at night as it is important that heat built up during the day is allowed to escape at night (night time cooling). The location, size and controls of these must be designed to ensure adequate ventilation can be achieved simply and securely. Concerns over security at night and complicated controls can result in these systems being underutilised or disabled.

Building Regulations require mechanical ventilation to be installed in spaces where heat and moisture is created, for example bathrooms, kitchens and utility rooms. The regulations require a level of extraction depending on room function, with the warm moist, stale air extracted to outside. Consequently, heat loss from the building is significant.

Passive Ventilation with Heat Recovery (PVHR): Systems such as Passive Ventilation with Heat Recovery rely on natural ventilation but recover heat from the stale exhaust air, helping to reduce heat loss from the building. These wall and roof mounted systems can also provide secure night time cooling.



Day - heat absorbed



Night - heat emitted

25 **Image 25** Night Cooling

Mechanical Ventilation with Heat Recovery (MVHR): As natural ventilation relies on wind speeds and temperatures, which an airtight building will not have, only natural ventilation in a building with a good level of airtightness should be avoided. In these buildings, a mechanical ventilation heat recovery (MVHR) system should be installed to retain the heat and provide a constant supply of fresh oxygen filled air (that is also filtered for pollutants and pollen). These systems cut out most of the ventilation heat losses which make up to 30% of the heating demand of a dwelling *(PAUL, MVHR)*.

MVHR is a mechanical ventilation system that uses very little energy, extracting warm stale air from kitchens and bathrooms and transfering about 90% of that heat into the fresh air entering the building. This warmed fresh air is then supplied to all other rooms in the building.

The summer bypass mode allows the MVHR unit to circumvent the heat recovery mode during warmer months. This ensures ventilation is provided continuously without warm and humid air entering unnecessarily which can assist in reducing summertime overheating.

The inclusion of an MVHR system should be considered at the very beginning of the design process as there must be space for the unit itself and ducting as well as the requirement to set a good level of airtightness to be achieved. An air permeability of no more than 3m^3/h.m2 @50pa should be set for the inclusion of an MVHR system.

The primary maintenance requirement for an MVHR system is low tech and requires changing the filters. Some ventilation units maintain a constant air flow rate when filters get clogged, but in so doing the fans get noisier. So regular filter changes are important and should be factored into a maintenance regime/contract.

The main advantages of an MVHR system are:

- I mproved energy efficiency of the building due to a substantial reduction in heat loss .
- Reduction in Noise – an MVHR system is a ventilation solution that does not require windows to be opened, particularly if a building suffers from external noise e.g traffic.
- Air quality improvement – If the air quality of a building is problematic, for example external pollutants, smells, pollen etc the MVHR filtration system can reduce/eliminate the impact of these.
- Reduced humidity – an MVHR system will dehumidify the building when outside is colder than inside.
- Higher comfort levels – a constant supply of fresh air, that is draught free.

Best Practice Recommendations

- Installation of Mechanical Ventilation Heat Recovery (MVHR) in all buildings where possible.

Image 26:
26 Passivhaus Logo

The Passivhaus Standard:

The Passivhaus Standard is an integrated design methodology. It began as a piece of research into how to deal with the **performance gap**; the difference between how simulated buildings perform, and real buildings perform. The research found that comfort and construction quality were the two key areas leading to the performance gap. This research led to the creation of a comfort standard that has a very low energy demand with minimal performance gap, known as the Passivhaus Standard. Many years later, thousands of projects have been completed and certified with an abundance of **post occupancy evaluation** data proving that the standard delivers.

At its core, the Passivhaus Standard is a comfort, quality and energy standard. The comfort and quality criteria are what deliver the low energy performance that Passivhaus has become famous for. Integrated thinking is key to achieving the Passivhaus Standard. The Passivhaus Planning Package (PHPP) should be used as a tool to optimise design as well as to demonstrate compliance.

There is a hierarchy of building design aspects needing to be addressed, and how these affect building performance. In order of significance they are: form and orientation, façade, fabric and **MEP**/ services specification.

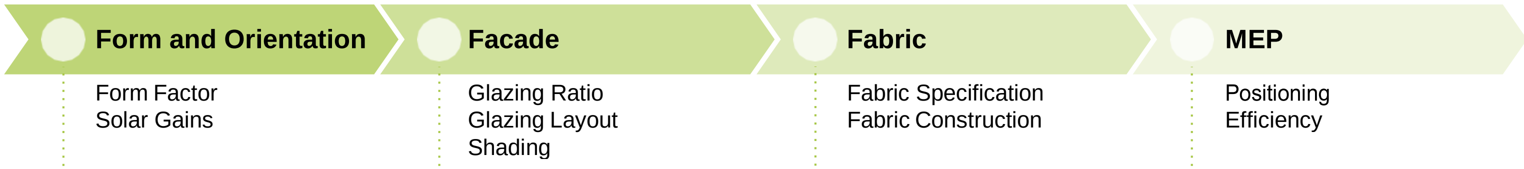


Image 27:
27 The Passivhaus Hierarchy

Definitions

- **Performance Gap:** the difference in how a building was anticipated to perform at design stage and the in-use energy consumption.
- **Post Occupancy Evaluation (POE):** the process of obtaining feedback on a building's performance in use.
- **MEP:** stands for Mechanical, Electrical and Plumbing systems.

Best Practice Recommendations

- All new building to achieve the Passivhaus Plus Standard, incorporating renewable energy within the design, thus leading to a Zero Carbon future.

Key features of Passivhaus:

Super insulation
Stringent levels of airtightness
Minimal thermal bridging.
Optimisation of passive solar gain
Mechanical ventilation with heat recovery
Triple glazed windows

As the Classic standard does not specify where the energy comes from, it is the Passivhaus Plus and Premium standards that can allow a Zero Carbon development to be achieved through the use of renewable energy. For difficult cases, where building for a variety of reasons, may not meet the Passivhaus criteria, the Passivhaus Low Energy Building Standard may be suitable.

The EnerPHit standard: For low energy retrofit projects, the standard is slightly relaxed to take into account the existing building and potential conservation constraints that mean the Passivhaus standard is not feasible.

Passivhaus comfort criteria focuses on thermal, air, and acoustic quality.

- **Thermal comfort** / Passivhaus buildings have stable, even temperatures throughout. This is a result of criteria for temperature, ventilation and airtightness criteria that minimise draughts.
- **Air Quality** / Passivhaus buildings deliver constant high levels of fresh air to where it is needed, which improves air quality substantially compared to other buildings.
- **Acoustic Quality** / Passivhaus buildings typically require triple glazing which, along with the high levels of insulation and reduced requirement for opening windows for ventilation, helps to significantly reduce external noise pollution.

Passivhaus is a route to minimising the energy consumption of a building. It is important that the design is approached holistically, considering also embodied carbon, water use, ecology and waste management. When all of these areas are addressed can the development be truly sustainable.

Heating Demand	Or	Heating Load	Airtightness	Or Frequency of Overheating
15 kWh/m²a		10 W/m²	0.6 ACH	10% ideally <2%
Cooling Demand	**Or**	**Cooling Load**	**Primary Energy**	**Or Primary Energy Renewable**
15 kWh/m²a		10 W/m²	135 kWh/m²a	60 kWh/m²a

All figures relate to **Treated Floor Area (TFA)**

Image 28: Key Passivhaus Classic Requirements

Definitions

- **Treated Floor Area (TFA):** A measure of internal space, within the thermal envelope of a building. Areas that have lower head heights or are not classed as liveable areas are counted but a reduced percentage applied.

Why Passivhaus?

- Excellent comfort levels and improved indoor air quality
- Consistent fresh air throughout the building
- Very low energy and running costs, which is important as energy prices continue to rise
- Durable, robust and well detailed construction

Healthy Internal Environments

Material Choice: Building biology considers the relationship between occupants and the spaces designed for living and working. It is about the creation of healthy, beautiful and sustainable buildings through the selection of materials and t he design of the internal environments. Much of that discussed earlier in this chapter and in later chapters contributes to the creation of this healthy environment.

The interior design and selection of internal finishes and materials is an important element to creating this and the following should be considered in material selection:

- Low or non toxic materials without VOC's (Volatile Organic Compounds)and formaldehyde contents - Choose low VOC or water based paints, avoid using caulk which has high levels of VOC's and choose solid timbers over products made to look like wood.
- Water-based finishes – choose paints, varnishes that are water based rather than chemically based.
- Natural materials and fibres -The more natural the product the better it will be for air quality inside the home. Choose for material finish to be its natural finish such as lime plaster walls, stone floors rather than applying a chemical sealant as this will reduce its benefits. Alternatively there are a number of natural sealant options available.
- Responsibly sourced wood products and timber – Choose FSC certified timber, which ensures it grown in well-managed forests preferably in the UK.
- Locally sourced materials, products and crafts – Support local businesses and reduce a products carbon footprint.

RIBA 2030 Climate Challenge target metrics for all buildings

Best Practice Health Metrics		References
Overheading	25-28 °C maximum for 1% of occupied hours	CIBSE TM52, CIBSE TM59
Daylighting	> 2% av. daylight factor, 0.4 uniformity	CIBSE LG10
CO_2 levels	< 900 ppm	CIBSE TM40
Total VOCs	< 0.3 mg/m³)	Approved Document F
Formaldehyde	< 0.1 mg/m³)	BREEAM

Image 29:
29 RIBA 2030 targets

Further Information

- Building Biology

Embodied Carbon

Embodied carbon refers to the emissions produced by the products, construction, in-use maintenance and end of life processes associated with the b uilding. The embodied emissions can range from 30-70% of the life cycle emissions of a building. As buildings become more energy efficient and electricity decarbonises, embodied carbon will represent a higher proportion of the whole life carbon than it currently does.

The embodied emissions are broken down into life cycle stages A, B and C. In essence, stage A emissions have been emitted by the completion of the building, stage B emissions are emitted throughout the life of the building, and stage C emissions are emitted at the building's end of life.

Stage A	**Product Stage:** extraction and processing of materials, energy and water consumption used by the factory and transport of materials and products.
	Construction Stage: building the development.
Stage B	**Use Stage:** maintenance, repair, refurbishment, replacement and emissions associated with refrigerant leakage.
Stage C	**End of Life Stage:** demolition, disassembly, waste processing and disposal of any parts of product or building and any transportation relating to the above.

30 **Image 30**:
Building Lifecycle Stages

Throughout the life cycle of a building, the certainty of its carbon emissions decreases, particularly given that a building's life cycle is typically assumed to be 60 years. Emissions from Stage A are very predictable. Stage B is dependent on when maintenance is required, and how much manufacturing improves emission rates over time. Stage C is dependent on when the building is demolished, and what improvements are made to waste management streams by that point. To minimise variables, life cycle analysis considers what would happen in all stages under current day circumstances. It would therefore be fair to consider that emissions further into the future are less significant than those now.

31 **Image 31**: CO^2 contributions of a building

Some definitions often referred to when discussing embodied carbon include:

Sequestration: refers to the process by which organic materials sequester carbon during growth e.g. a tree absorbing carbon then being cut down and used as construction timber would typically sequester an amount of carbon.

The concept of quantifying carbon sinks within landscape has a wider potential and appeal to link also to ecology and biodiversity agendas. All parts of the soft and hard planning of a site provide an opportunity for carbon capture/sink devices and give a more holistic integrated view of carbon within a development.

Carbonation: refers to the process by which some materials absorb carbon through their life cycle e.g. exposed concrete continues to absorb carbon for years after curing.

The London Energy Transformation Initiative (LETI) have published useful guidance regarding Embodied Carbon, including where the largest proportion of embodied carbon can be found within each building typology and also within each building element, along with targets to take us to 2050.

Design and material choices throughout the development will have associated carbon impacts and so decisions can be taken to reduce the embodied carbon of a building.

Reduce	i. consider retention and adaptation of existing buildings ii. reuse existing materials on site where possible iii. simplify the design iv. provide efficient space design, creating flexible, multifunctional spaces v. review the use of materials and if they could be used more efficiently and sparingly vi. Reduce transportation by choosing locally sourced materials.
Context	Design to work with the existing site topography, minimising the need for excavation and removal of land from site
Efficiency	i. Minimise waste by designing to standard material sizes or repetition (which also minimises waste on site) ii. Consider the structure and lightweight construction methods to minimise foundation and transportation requirements iii. Consider openings sizings and open plan spaces and minimise the need for large structural elements iv. Design for multifunctionality, such as the structure also providing shading requirements v. Design well and eliminate the need for materials, such as exposing services.
Longevity	Consider the life span of products and ensure longevity.
Low-carbon	Minimise materials with high embodied carbon content, choosing materials that have a recycled content (such as GGBS instead of cement and low carbon concrete mixes)where possible
Natural	Choose natural, responsibly sourced materials and renewable materials and avoid treatments as often these can limit recyclability options
Adaptability	i. Design for flexibility and adaptability to allow the building to be repurposed in the future if needed ii. Design for ease of demolition (mechanical fixings as opposed to adhesive) at the end of the buildings life and to allow for materials to be re-used or recycled

The London Energy Transformation Initiative (LETI) is a network of over 1000 built environment professionals that are working together to put London on the path to a zero carbon future. However, these targets are not specific to London and can be applied to buildings across the whole of the UK. LETI have produced a number of informative publications including one-pager guides that are in alignment with other initiatives including the RIBA 2030 Climate Challenge, with the ultimate aim to achieve the Government target of net zero carbon for the whole UK building stock by 2050.

LETI, along with others such as RIBA 2030 believe that in order to meet our climate change targets all new buildings must operate at net zero carbon by 2030 and all buildings must operate at net zero carbon by 2050.

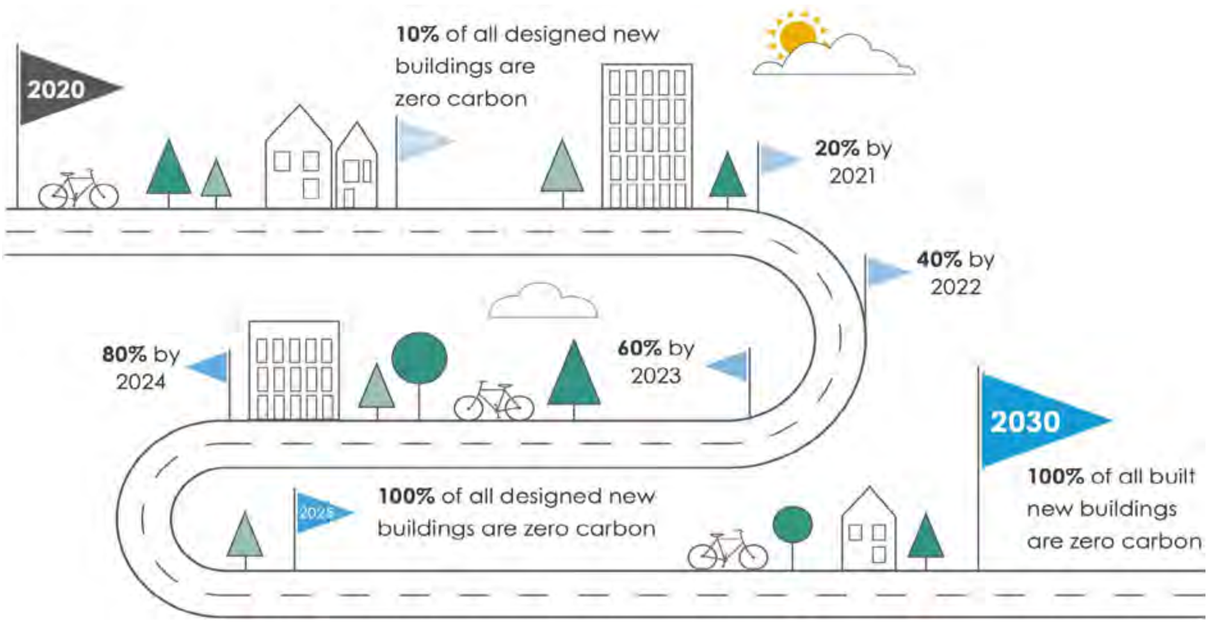
LETI identifies a number of elements to achieving net zero carbon by 2050, including operational energy and embodied carbon, with targets set to ensure this is achieved. Importance is also given on data disclosure, to provide opportunity to learn from the existing building stock and eliminate the ‘performance gap’.

LONDON ENERGY TRANSFORMATION INITIATIVE

32 **Image 32**: LETI Logo

Further Information

- LETI Climate Emergency Design Guide: How new buildings can meet UK climate change targets
- LETI Climate Emergency Retrofit Guide (2021)



33 **Image 33**: LETI Getting to Zero

Embodied emissions benchmarks are an evolving area for the construction industry. The RIBA 2030 Climate Challenge forms sensible reference benchmarks for different building typologies (see below).

There are several tools for measuring embodied carbon, but embodied carbon should be analysed using the RICS Whole Life Carbon Assessment for the Built Environment professional statement 2017 methodology and approach and include modules A1-5, B1-5, C1-4 (including sequestration), including a minimum of 95% of the cost allocated to each building element category (0-7 of Table 3, page 11 of RICS Whole Life Carbon Assessment).

On projects where Whole Life Carbon assessments are not being undertaken as part of the project team's core services, effort should be focussed on reducing embodied carbon following the hierarchy in LETI design guidance, and reasonable endeavours should be made to quantify the embodied carbon savings achieved. Analysis tools such as ECCOLAB may be used assist the process.

Best Practice Recommendations (for New Developments)

- Target an embodied carbon performance of <750 $kgCO^2e/m^2$ for non-domestic office buildings and <625 $kgCO^2e/m^2$ for domestic buildings, <540 $kgCO^2e/m^2$ for education buildings and <535 $kgCO^2e/m^2$ for retail by 2030 (minimum 40% reduction in embodied carbon compared to the current business as usual benchmarks) by using low carbon materials that are responsibly and ethically sourced.
- Evaluate embodied carbon using the RICS Whole Life Carbon Assessment for the Built Environment professional statement 2017 methodology.
- On projects where Whole Life Carbon assessments are not being undertaken, effort should be made to reduce embodied carbon and quantify the embodied carbon savings achieved.

Further Information

- LETI Embodied Carbon one-pager
- RIBA 2030 Climate Challenge
- ECCOLAB, web based decision support tool for design of low impact buildings
- RIBA Embodied and Whole Life Carbon Assessment for Architects (2017)

	Office ($kgCO^2e/m^2$ [GIA])	Residential ($kgCO^2e/m^2$ [GIA])	Education ($kgCO^2e/m^2$ [GIA])
Business as usual	<1400	<1200	<1000
2025 RIBA Target	<970	<800	<675
2030 RIBA Target	<750	<625	<540

34 **Image 34**: The RIBA 2030 Climate Challenge embodied carbon targets

Householder Extensions

Regardless of scale all development has an important role in reducing the impact the built environment is having on the Earth's natural resources. By applying many of the measures discussed in this document to the design, will ensure an energy efficient extension which minimises its impact on the environment but will also save the homeowner money and improve the internal comfort of the space. Although some measures may increase the cost of the build, the saving over time or payback period must be factored in as the cost of energy is likely to continue to rise.

36 **Image 36**: dempseydecourcyarchitects.co.uk/passivhauslowene.html

Best Practice Recommendations (for Householder Extensions)

- Consider and implement the nine householder environmental building considerations.
- Consider extending the environmental improvements to the existing property, and look to achieve the Passivhaus EnerPHit standard as a whole house approach.

Could the existing space within the property be repurposed, avoiding the need for the extension? Will the extension make some parts of the existing property redundant?	Can demolition be avoided and if not can materials be salvaged and reused?	Develop a passive design approach- consider the orientation and form, insulation and detail design, windows and shading
Develop the surrounding context as well as the extension – consider the inclusion of vegetation, soft landscaping and water management features to improve the setting	Review the ventilation approach and potentially adding mechanical ventilation, whilst also ensuring there is adequate natural ventilation	Consider the materials used in the build and choose those which will reduce your carbon footprint
Installation of efficient services, fixtures and fittings	Installation of renewable energy (such as solar hot water or solar panels)	Water recycling

35 **Image 35**: The nine householder environmental building considerations

Historic Buildings and Buildings within a Historic Setting

To meet the Governments climate targets we need to reduce the energy consumption in all buildings, not just new developments. Maintaining existing buildings is an important climate action as even after refurbishment the embodied carbon is significantly less than the new build option.

Climate change can impact the historic environment, for example erosion of archaeological sites through severe weather and flooding, harm to historic landscapes and weathering of the building fabric. Similarly energy efficiency measures if not appropriately considered can have a negative impact on the historic environment, for example causing damage to fabric by changing the conditions in which it was designed to exist.

When considering the historic context a balance must be found that allows the character and appearance to be preserved and enhanced but that also limits the impact further damaging emissions and allows adaption to climate change. Choosing high quality and fit for purpose materials and appropriate design measures is fundamental.

Where a historic or listed building forms part of a wider development whole estate goals can be considered.

Adaption to energy requirements and climate changes can and must happen to avoid the deterioration and redundancy of heritage assets, avoiding prioritising an asset for ourselves over future generations. Conservation by definition is the managed preservation of a resource to avoid destruction.

Historic buildings have fundamental differences in how they have been designed to manage heat and moisture, and the skills and materials needed to maintain, repair, and responsibly adapt them. Consequently, some solutions developed for modern day construction may not be appropriate and could be damaging to the building and potentially causing harm to the health of the occupants.

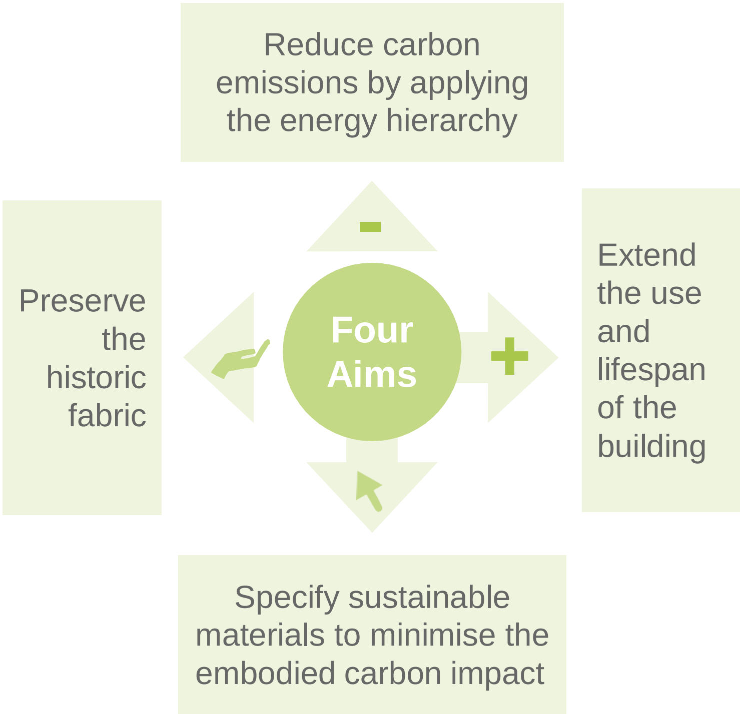
Building Performance Historic Buildings 3.11

When improving the energy importance of a historic building it is important to consider a wholeh ouse approach/strategy. It may not be possible to complete all works at the same time and so the impact a phased approach will have on the buildings performance must be considered. The four aims when improving the sustainability of heritage assets are illustrated opposite.

Ultimately the most effective way for a historic building to be as energy efficient as possible is to keep it in good repair, avoiding the requirement for energy to rectify a problem.

Ensuring a building can regulate the moisture levels within it and its structure is also important as moisture effects thermal performance and creates unwelcome internal environments.

Before undertaking any works to a listed building or building in a conservation area seek advice and approval from the conservation team in Herefordshire Council.



37 **Image 37**: Four Aims for Improving Heritage Assets

Best Practice Recommendations (for historic buildings)

- Consider all 4 Aims when working with a historic building.

Further Information

- Climate Change, Sustainability and Energy Efficiency, Historic England
- Energy Efficiency and Historic Buildings (2018)
- Energy Efficiency and Traditional Homes (2020)
- Planning responsible retrofit of traditional buildings, Sustainable Traditional Buildings Alliance (STBA)(2015)

Best Practice Recommendations

PF1 Prioritise the refurbishment and retrofit of existing buildings where possible. Also, aim to re-use elements of existing buildings if at all possible, for example foundations (subject to structural engineer input), bricks or even floorboards for a new purpose.

PF2 A fabric first and building physics approach to be implemented during all design stages.

PF3 All new building to achieve the Passivhaus Plus Standard, incorporating renewable energy within the design.

PF4 Achieve an air permeability of below $3m^3/h.m^2$ @50pa in all new developments. However an airtightness of $<0.6m^3/h.m^2$ @50pa required for Passivhaus is encouraged. For an airtightness of below $3m^3/h.m^2$ @50pa, this will need to be in combination with a mechanical ventilation heat recovery system.

PF5 All new development to be designed and built to meet CIBSE TM59 overheating standards. Future climate scenario modelling to also be completed. The Good Homes Alliance overheating tool could be used for smaller developments.

PF6 Installation of MVHR in all buildings where possible.

PF7 Target an embodied carbon performance of <750 $kgCO^2e/m^2$ for non-domestic office buildings and <625 $kgCO^2e/m^2$ for domestic buildings, <540 $kgCO^2e/m^2$ for education buildings and <535 $kgCO^2e/m^2$ for retail by 2030 (minimum 40% reduction in embodied carbon compared to the current business as usual benchmarks) by using low carbon materials that are responsibly and ethically sourced.

PF8 Evaluate embodied carbon using the RICS Whole Life Carbon Assessment for the Built Environment professional statement 2017 methodology.

PF9 On projects where Whole Life Carbon assessments are not being undertaken, effort should be made to reduce embodied carbon and quantify the embodied carbon savings achieved.

PF10 Householder Extensions: consider and implement the 9 householder environmental building considerations.

PF11 Householder Extensions: consider extending the environmental improvements to the existing property, and look to achieve the Passivhaus EnerPHit standard as a whole house approach

PF12 Consider all 4 Aims when working with a historic building.

Energy Use

Energy Use Overview

In this section

This section will detail:

1 / How to approach energy efficiency + renewable energy generation on your project

2 / Alternative low carbon heating and cooling systems

3 / How ‘passive design’ can help your project

4 / How to set and report robust energy targets

5 / Why lifecycle carbon + cost calculations matter

Executive summary

> Renewable generation using photo voltaic (PV) panels is complicated and should not be over-relied on to reach net zero. Reducing energy demand is critical and will reduce the size of the PV array.

> There are a range of alternatives to gas heating which are far more sustainable, and can lower the demand on the national grid at peak times. However the difference in gas and electicity pricing means that efforts to reduce the heating demand are essential to maintaining low running costs.

> The RIBA and LETI provide accessible, achievable energy use targets for different building typologies that can help guide projects from the outset.

> Lifetime cost and carbon analysis is valuable in helping place design and construction choices in context, and determining where the best value lies.

Introduction

Herefordshire Council declared a climate emergency on 8 March 2019. Following this the council committed to becoming carbon neutral and nature rich by 2030/31, launching a Carbon Management Plan with an interim target for a 75% reduction by 2025/26.

Carbon emissions from energy use have reduced due to reductions in demand and the national decarbonisation of the electricity supply. In 2020 over 42% of the UK's grid electricity came from renewable energy *(Energy Savings Trust)*. However there has been less progress in reducing these emissions in relation to gas consumption. The Climate Change Committee (CCC) has advised of the need to eliminate gas from new developments and in response the Government has outlined in the Future Homes Standard that fossil fuel heating, such as gas boilers cannot be installed in new build projects from 2025 onwards. Renewable energy will soon become our only option.

The previous chapter covered the first two steps in the energy hierarchy; to reduce the need for energy and improve energy efficiency. This chapter discusses renewable energy, the next and final step in the energy hierarchy and supports Core Strategy policies SD1, SD2, SS6 and SS7. Core Stratgy policy SS6 requires development proposals to take an integrated approach to environmental components, including renewable energy with the potential for renewable energy generation to be considered from the outset. As set out in Core Strategy policy SD1 development must take into consideration the efficient use of land to enable this, with Core Strategy policy SD2 focussing on renewable and low carbon energy generation and the requirement for efficient connection to the grid without significant detrimental impact upon the landscape character. Ultimately and as set out in SS7 climate change must be addressed and developments must be designed to reduce carbon emissions.

This chapter begins by revisiting the energy hierarchy, followed by an explanation of what is meant by renewable energy. The options for on-site energy generation are discussed, along with the renewable and low energy options available for heating and replacement for the traditional gas boiler, both small scale and at district level. A brief overview of current energy targets follows, set by various UK bodies looking to ensure the UK ends its contribution to global warming by 2050 and achieves net zero targets. The chapter concludes with a description of assessments that enable a developments carbon impact to be analysed and how this can inform the design of a development at the early stages.

Policies

- Policy SS6 Environmental quality & local distinctiveness
- Policy SS7 Addressing climate change
- Policy SD1 Sustainable design and energy efficiency
- Policy SD2 Renewable and low carbon energy

Further Information

- Energy Saving Trust: How can renewable energy help the UK reach net zero?

Energy efficiency and hierarchy in buildings

This is a series of steps that minimise the energy consumption in a building.

The energy hierarchy:

1. **Reduce** the need for energy - through passive design measures including form, orientation and fabric.
2. **Improve** energy efficiency - install energy efficient mechanical and electrical systems, including heat pumps, heat recovery ventilation, LED lights, fittings and appliances.
3. **Maximise** renewable energy - through decentralised sources, including on-site generation, community-led initiatives and low and zero carbon technologies.

The first and second steps of the energy hierarchy are to reduce the need for energy through passive design measures and to improve energy efficiency which has been the main focus of the previous chapter. Once the demand has been reduced the next step is to supply energy to the building efficiently and by low carbon and renewable means.

In order to achieve a Zero Carbon development a combined approach to steps one, two and three of the hierarchy will be required, although the emphasis must always be on step one and minimising energy consumption.

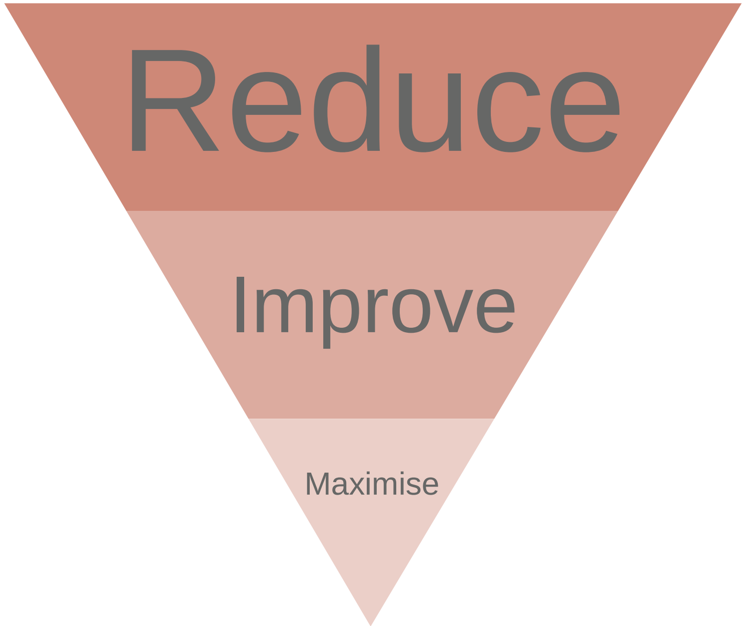


Image 38: 38 The Energy Hierarchy

Integration of renewables for energy generation

Renewable energy is created from natural sources or processes that are constantly replenished, such as sunlight and wind. Low carbon or zero carbon energy is whereby energy is generated and emits low levels or zero carbon dioxide, such as nuclear power.

Net zero challenges with renewables: The ultimate goal to adding renewables on site is to generate as much energy as your use, this balance between use and generation is often referred to as 'Net Zero Carbon in Operation'. A building designed to use less energy will therefore need less renewable energy generation on site.

However, this approach can be more complicated if looking to achieve a truly new zero development

1. Due to daily and seasonal differences in when renewable energy is generated, and when it is used, and
2. Due to renewable energy generation having an embodied carbon associated that is usually omitted from the renewables calculation.

To achieve true net zero these must also be factored into the amount of renewable installed.

There are a number of methods of electricity generation, but those most feasible for onsite generation are photovoltaic (PV) solar panels or tiles and wind generation. For both the early design decisions regarding site context, building form and orientation are important in establishing the efficiency of the installation.

PV systems are described in terms of the amount of power they generate (kWp). The orientation and angle of installation has an impact on the solar collection efficiency, with a directly south facing 30-40 degree pitch achieving maximum efficiency.

A drop in efficiency will require an increase in panels to achieve the same energy generation.

39 **Image 39**:
PV panels, Beacon View, Architype

In some instances where visual impact must be considered, such as in conservation areas a large array may be deemed inappropriate. In these instances PV tiles, recessed panels or installation on ancillary buildings may instead be possible.

If the building has been designed with a low energy demand, for example a Passivhaus building the number of PV panels required to match the consumption and allowances for embodied energy and seasonal differences should be achievable within the roof area.

Studies show that building to less stringent targets can mean onsite renewables cannot meet the energy demands and alternative options such as funding offsite generation may need to be investigated.

Small-scale wind generation is often considered a less viable solution than PV installation and so in the main wind generation is only considered on larger developments where large scale generation can be installed. Site context is important in deciding whether wind generation is viable, for the siting of the turbines themselves and if the conditions as well as the local context are suitable. Average wind speeds, required separation distances from neighbours, grid connection, site access and environmental and/or landscape designations all need to be considered.

It is acknowledged that the suitability of technologies may change over time and new technologies may also be developed.

Orientation Chart showing output for different orientation and tilt angles (% of maximum)																			
Tilt (°)	West									South									East
	90	80	70	60	50	40	30	20	10	0	10	20	30	40	50	60	70	80	90
0	87	88	90	91	92	92	93	93	93	93	93	93	92	92	91	90	89	87	86
10	84	87	90	92	94	95	95	96	96	97	97	96	95	94	93	91	89	87	84
20	82	85	90	93	94	96	97	98	99	99	98	97	96	95	93	91	88	84	81
30	78	83	87	91	93	96	97	98	99	100	98	97	96	95	93	89	85	81	78
40	75	79	84	87	92	94	95	96	96	96	96	95	94	92	90	86	82	77	72
50	70	74	79	83	87	90	91	93	94	94	94	93	91	88	83	80	76	73	70
60	65	69	73	77	80	83	86	87	87	87	88	87	85	82	78	74	71	67	63
70	59	63	66	70	72	75	78	79	79	79	79	79	78	75	72	68	64	61	56
80	50	56	60	64	66	68	69	70	71	72	72	71	70	67	66	60	57	54	50
90	41	49	54	58	59	60	61	61	63	65	65	63	62	59	60	52	50	47	44

40 **Image 40**:
UK Solar Orientation Chart from PVNI.org.uk

Low carbon heating and cooling systems

The heating demand of buildings currently accounts for more than 40% of UK energy consumption *(LETI)* with the majority still coming from fossil fuelled natural gas. This will change when natural gas boilers can no longer be installed from 2025.

In applying the first two steps of the energy hierarchy, reducing the need for energy and improving energy efficiency the amount of heat actually needed will also reduce. All electric solutions seem a possibility, as they are readily available and can provide an approach to net zero due to the decarbonisation of the grid.

However, if we were all to take this approach the demand would soon outweigh the supply capacity, with other large sectors such as transport also reliant on access to renewable energy sources, with fewer other opportunities available.

The UK government has also committed to making the cost of electricity more competitive vs gas, however currently electricity is four times more expensive than gas and so switching directly to electric heating without reducing consumption will drastically increase energy bills. Other heating options need to be considered although selection of these will need to be carefully considered and likely require specialist input.

Solar thermal

how it works: Solar thermal panels use the suns energy to directly heat up water, offsetting the carbon emissions due to gas water heating. The heat from the sun is absorbed through the panel, called collectors. The heated water or heat transfer fluid then runs to a hot water cylinder or thermal store, with a boiler or immersion heater often used to heat the water further if needed.

41 **Image 41**:
Rooftop Solar Thermal Panels at Wahroonga

considerations: Although they have low maintenance costs, solar thermal panels do not offer a solution for heating a building and rarely a complete solution for the hot water system (as they are less effective during the winter months) and for this reason other solutions are deemed more favourable.

Hydrogen The development of hydrogen boilers as an alternative to a gas boilers is still in development. The Government 10-point plan for a green industrial revolution puts investment in low carbon hydrogen high on its agenda, aiming to develop capacity to power 1.5 million homes by 2030. Producing hydrogen at a scale to decarbonise heating is not simple; hydrogen is currently expensive to produce (although costs are expected to fall) and currently it is not low carbon.

how it works: Hydrogen produced from natural gas contains no carbon itself, but carbon is given off in the process. That carbon must be captured and stored indefinitely for use as a low carbon gas ('blue' hydrogen). It is also possible to produce low carbon 'green' hydrogen through a process called electrolysis, using renewable electricity to extract hydrogen from water.

However, the renewable capacity requirements would be huge to produce enough 'green' hydrogen to replace all existing natural gas boilers.

considerations: Current thinking is that hydrogen could be used in areas where electrification will be difficult.

In some respects the switch from gas boilers to hydrogen could be straightforward with gas boilers replaced with hydrogen with the infrastructure to supply hydrogen in place, but as yet there is no precedent for changing a gas grid to hydrogen.

Heat Pumps (Low Carbon Heating Solutions)
There are a number of heat pump solutions as set out below. To coincide with the decarbonisation of new developments from 2025 and regulations updated to require low carbon heating solutions instead, it is likely that heat pumps will become commonplace on most, if not all new developments.

Air Source Heat Pumps (ASHP)

how it works: ASHP's absorb heat from the outside air to heat the building and provide hot water. They are able to extract heat during temperatures as low as minus 15 degrees. An ASHP does need electricity for power, but as they are extracting heat from the external environment the heat input is greater than the electrical and therefore renewable. The ratio of electrical energy needed to power the pump to the amount of energy produced for the building is called the Coefficient of Performance (CoP).

Higher CoPs equate to higher efficiency, lower energy (power) consumption and thus lower operating costs. An ASHP replace gas energy and can be used to heat the building and hot water. As an ASHP is subject to fluctuating temperatures during the winter months it will use more electricity as it works harder to produce heat.

considerations: The positioning of the ASHP needs to be considered as they can have a negative visual impact as well as creating a modest amount of noise. Different ASHP require slightly different installation requirements and locations, but all should be located away from opening windows and doors and sewer systems. Manufacturer's state required clearance distances from the unit, but if these are met the pump can be screened to minimise visual impact. The external unit is then connected to a thermal store containing a heat exchanger and sometimes an electrical heating element which allows the heated water to be stored until it is needed.

Image 42:
42 ASHP. Image Source: Nu-Heat.

There are 2 types of ASHP air-to-water and air-to-air, the first being the most common in the UK.

Exhaust Air Heat Pumps (EAHP)

how it works: EAHP's combines the functions of an ASHP with those of a mechanical ventilation heat recovery system.

The technology uses the wasted warm stale air found in areas such as bathrooms and kitchens, and transfers the air through a series of ducts which run within the walls and floor. They comprise of a hot water cylinder, heating coil, extract fan, and a heat pump.

considerations: An exhaust air heat pump unit can also work alongside a standard air source heat pump, providing hot water storage and hot water production at times when the air source heat pump unit is not required for heating, usually during the summer months. These systems are generally suited to smaller buildings, for example flats where the heating requirement is low and there is not available space externally for an ASHP.

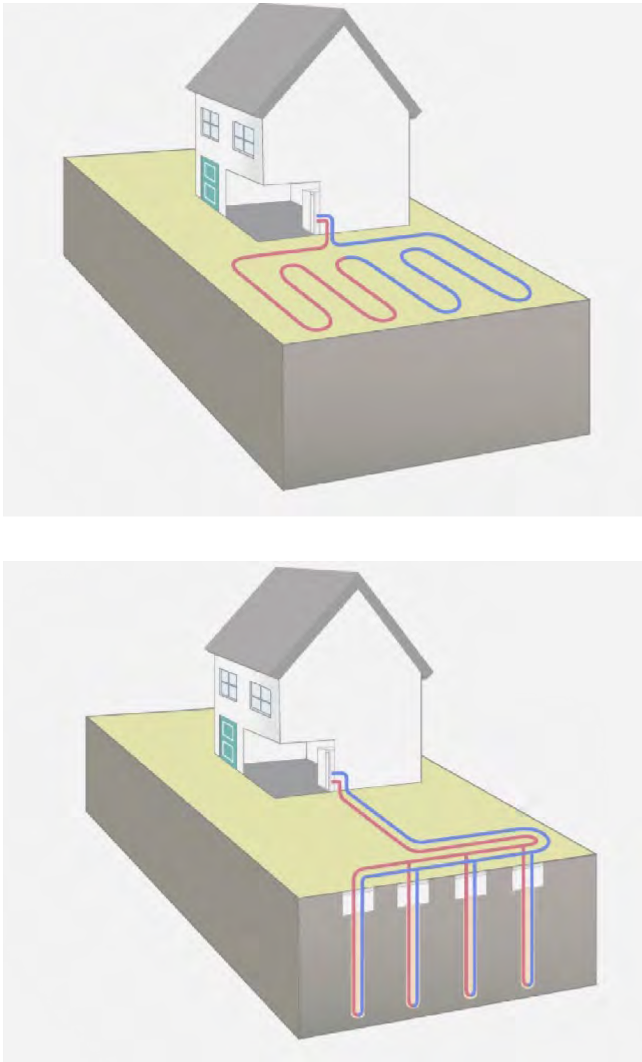
Ground Source Heat Pumps (GSHP)

how it works: GSHP's use pipes that are buried underground to extract heat from the ground for space heating and hot water.

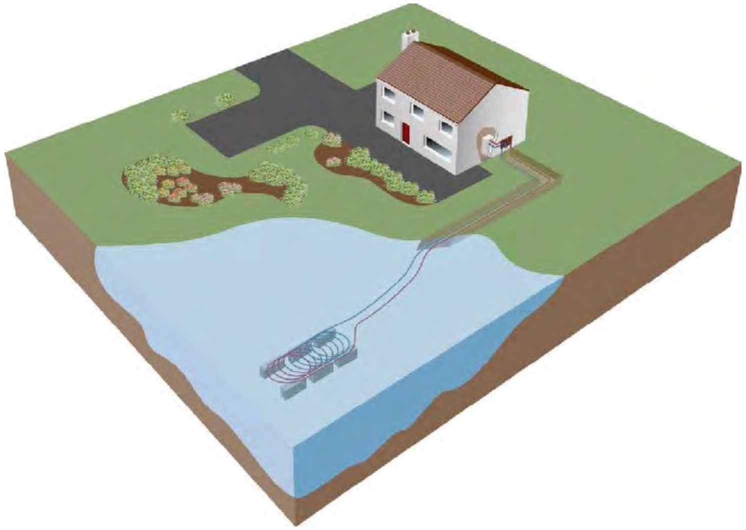
A mix of water and antifreeze is circulated around the pipe work, called a ground loop, which is buried in the ground external to the building. The heat from the ground is then absorbed into the fluid which then passes through a heat exchanger and into a heat pump. The length of the loop is dependent on the size of the building to be heated but is typically around 1m below the surface.

Alternatively vertical boreholes can be drilled typically between 90 and 160m if clear space is limited.

considerations: An advantage of a GSHP is the consistency of ground temperature, allowing this system to be used throughout the year and be unaffected by external changes in temperature. As with an ASHP electricity is required to run the system but the heat extracted is constantly being renewed.



43 **Image 43**:
Ground Loop and Bore Hole GSHP.
Image source: Nu-Heat



44 **Image 44**:
https://www.treco.co.uk/news/article/systems-approach-installing-biomass-boiler

Water Source Heat Pumps (WSHP)

how it works: WSHP's work on a similar principle to GSHP's whereby heat is extracted from a body of water and converted into useful heat for space heating and hot water. A series of submerged pipes containing a working fluid absorb the heat from a river, lake, large pond or borehole. This fluid is then compressed so that emits the heat at a higher temperature.

considerations: WSHP's require a specific set of requirements and so for this reason are infrequently used. Only certain bodies of water can be utilised, to avoid the temperature of natural water courses and features increasing. There also needs to be a substantial volume of water available to limit water temperatures increasing, which would reduce the efficiency of the system.

In 2015, the UK government drafted a map for water source heat pump suitability, recommending that urban areas on fast-flowing rivers were the most suited for this technology and that it would be more suited to larger scale development.

Biomass

how it works: There are two main types of fuel used to fuel a biomass boiler, biodiesel and wood pellet. Either of these fuels may be referred to as bioheat, they are both renewable forms of fuel.

Biodiesel is made out of animal fat, and oils. These fuels can be made very quickly, and are biodegradable.

considerations: The scale of the biomass requirement depends on the size of the building, with even a private dwelling requiring the space equivalent to a single garage for storage of fuel and the unit itself. Delivery and the position of the flue also needs to be considered and for these reasons biomass is rarely considered appropriate on sites where space is limited.

Best Practice Recommendations

- No onsite combustion of fossil fuel for new development.
- All development shall assess the viability of onsite renewable generation and design a strategy to maximise storage.
- Major development shall match total energy demand through a combination of renewable energy generation capacity, energy storage and smart controls.

Further Information

- Energy Saving Trust

In addition, while biomass itself is considered renewable, the fuel is often transported long distances on lorries that emit carbon and burning t he fuel itself also emits carbon so is it is unclear if this will remain to be considered as a low carbon heating option. The availability of heat pumps and prioritising an electricity led heat source that benefits from grid de-carbonisation has also lead to biomass being a less viable option.

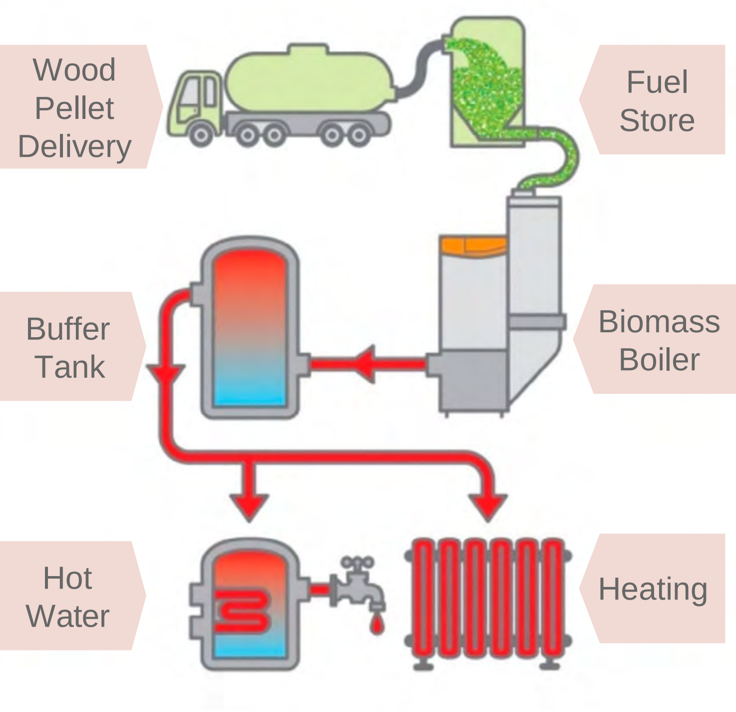


Image 45: https://www.treco.co.uk/news/article/systems-approach-installing-biomass-bo

District approach to energy provision

A district heating scheme provides heat from a central source and distributes it to multiple buildings. Combined Heat and Power (CHP) is a technology that produces electricity close to the point of use and captures the waste heat that is normally lost to provide heating, hot water and sometimes cooling.

There are a number of options when considering a centralised approach to heating along with pros and cons for having a central energy centre or using an individual building strategy. Ultimately the suitability needs to be decided on a site by site basis, with the distance from the energy source and subsequent distribution losses a key driver. Design of these networks should achieve best practice standards of the ADE and CIBSE Code of Practice for Heat Networks.

Large scale renewable energy installations adjacent to new development could also be considered, for example solar arrays linked to battery storage and electric vehicle charging provision to create a smart grid to energy infrastructure.

Further Information

- ADE and CIBSE Code of Practice for Heat Networks

Energy Targets

In 2019 the UK Government passed a law to require the UK to end its contribution to global warming by 2050 by bringing all greenhouse gas emissions to net zero. With the built environment contributing significantly to these emissions it is important that industry targets are set to ensure that the net zero is met and in advance of this regulation.

UK bodies RIBA (Royal Institute of British Architects), the UKGBC (UK Green Building Council) and LETI (London's Energy Transformation Initiative) have issued voluntary performance targets that cover a number of areas such as operational energy use, water use, low carbon energy and embodied carbon aiming to achieve the significant reductions necessary by 2030 in order to have a realistic prospect of achieving net zero carbon for all UK buildings by 2050.

A review of these has led to a set of Best Practice targets for development to be included within this document. To understand these targets requires an understanding of the terminology used and how this equates to the building performance.

Operational energy is the energy consumed by a building associated with heating, hot water, cooling, ventilation, and lighting systems, as well as equipment such as fridges, washing machines, TVs, computers, lifts, and cooking.

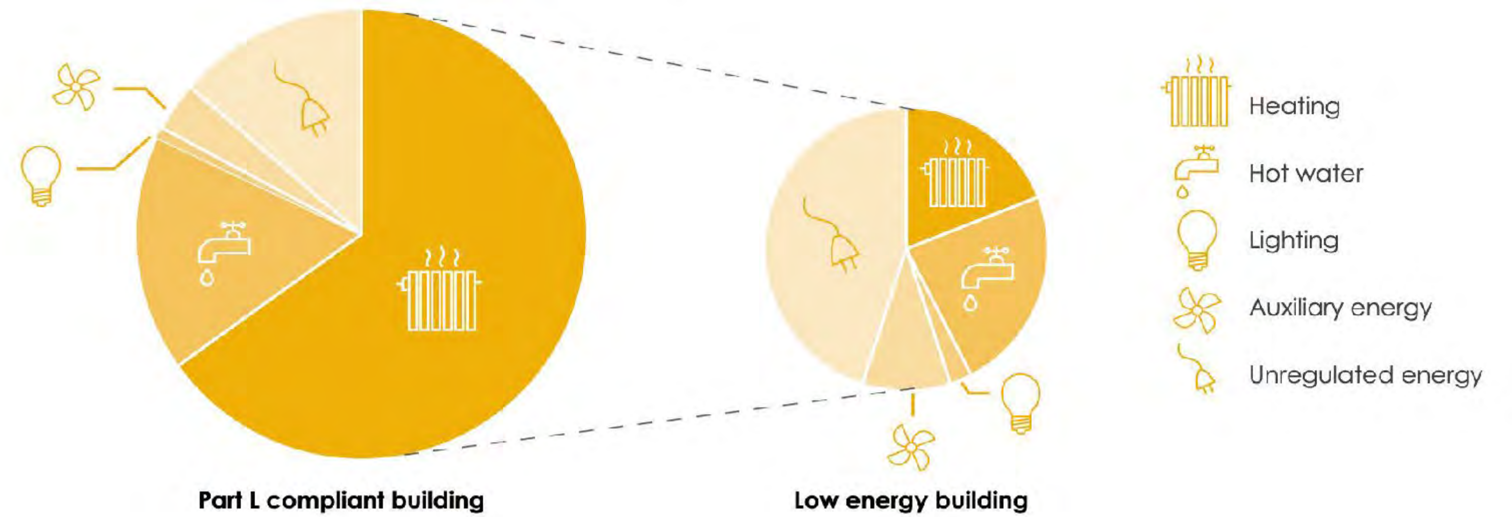


Image 46:
46 LETI Best Practice Residential Energy Breakdown

	Office	Residential	Education
2025 RIBA Target	< 75 kWh/ m²/year	< 60 kWh/ m²/year	< 70 kWh/ m²/year
2030 RIBA Target	< 55 kWh/ m²/year	< 35 kWh/ m²/year	< 60 kWh/ m²/year

47 **Image 47**: RIBA 2030 climate challenge operational energy targets (Targets based on GIA. Figures include regulated & unregulated energy consumption irrespective of source (grid/ renewables)).

Operational carbon is the carbon dioxide and greenhouse gases which are emitted as a result o f the above factors. It has a direct and consistent environmental impact throughout the life of a building and can account for between 40% and 65% of the total life cycle emissions.

How to reduce energy use: The simplest and most effective way to reduce carbon in operation is to lower the amount of energy required in the building. Passivhaus is a design approach that e nables this. Using a fabric first approach and a focus on efficient servicing it is possible to reduce the energy loading and in turn the carbon emissions of a building by around 80%.

The RIBA 2030 climate challenge operational energy targets listed above and the Passivhaus and LETI target of under 15 kWh/m²/year for heating demand only provide achievable goals for lower energy use and lower operational emissions. It is important to commit to these targets from the outset and ensure that design decisions reflect them.

LETI have also published indicative design measures for building typologies which if applied should help achieve these energy targets.

Creating a low energy or Passivhaus building changes the energy breakdown of a building. Where traditional buildings have a large portion of the energy use attributed to the heating and cooling of the space, energy efficient buildings have a more even distribution of energy loading in an overall smaller total use figure. The diagram on the previous page shows LETI's best practice outcomes and distribution of energy use across the building.

Achieving net zero in operation requires not only a reduction in energy demand, but relies on the decarbonisation of the grid and a form of onsite renewables to balance the remaining carbon emissions. Though challenging, this is achievable with close monitoring of the buildings energy and carbon emission from the outset of the design.

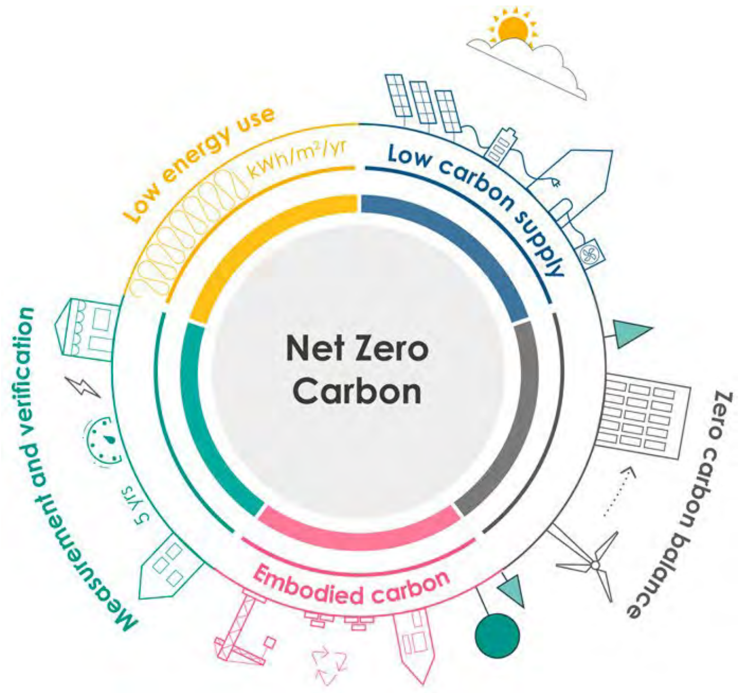
The following LETI performance standards set the Best Practice targets for renewable PV energy generation on-site:

- Small scale residential: Generate 100% of annual energy requirement on-site
- Medium and large scale residential: Cover 70% of roof area
- Offices: Generate the annual energy requirement for at least two floors of the development on-site
- Schools: Cover 70% of the roof area

Along with this, attention should be given to reducing the embodied carbon, which was discussed at the end of the previous chapter along with the Best Practice targets.

In summary to achieve Net Zero targets for development the following actions are required:

- A Reduction in Operation Emissions
- Decarbonisation of the Grid
- On-site Renewables
- Reduced Embodied Emissions



48 **Image 48:** LETI: Key Requirements for New Buildings to achieve Net Zero Carbon

Further Information

- [LETI Climate Emergency Design Guide: How new buildings can meet UK climate change targets]
- [LETI Net Zero 1-Pager]

Best Practice Recommendations

- Compliance of the evaluation of operational energy shall be demonstrated through performance methods such as the Passivhaus Planning Package (PHPP), CIBSE TM54 or Better Buildings Partnership Design for Performance (2019).
- Offset remaining carbon emissions by contributing to renewable energy projects that will help facilitate decarbonising the national and/or local grid. Alternatively, offset through investment in a retrofit programme, requiring certification to Passivhaus EnerPHit or another agreed target.

Robust targets are a key tool in delivering a true net zero building.

The Royal Institute of British Architects (RIBA) has developed a set of voluntary targets for operational energy, water use and embodied carbon. A set of core health and wellbeing metrics are also included and can be seen on page 44 of this SPD. These targets form the basis of the 2030 Climate Challenge and provide a stepped approach towards reaching net zero.

These targets have been developed in consultation with other UK construction bodies and provide an approach that will realise the significant reductions necessary by 2030 in order to achieve the Government target of net zero carbon for the whole UK building stock by 2050.

The RIBA Climate Challenge does not provide accreditation, instead performance targets to aim towards, many of which are included as best practice recommendations within this SPD. Ultimately the purpose of setting these targets as with those set out by LETI is to encourage us to take action now and not lock in poor performing buildings that will require expensive interventions later on.

The targets are set out to allow progression to the 2030 targets, with buildings today built to the 2025 targets as a minimum, with the aspiration that all should be designed to achieve the 2030 targets. A checklist has also been developed to aid the design process.

As highlighted in this SPD these targets should form the basis of any design and consequently are included as best practice recommendations throughout.

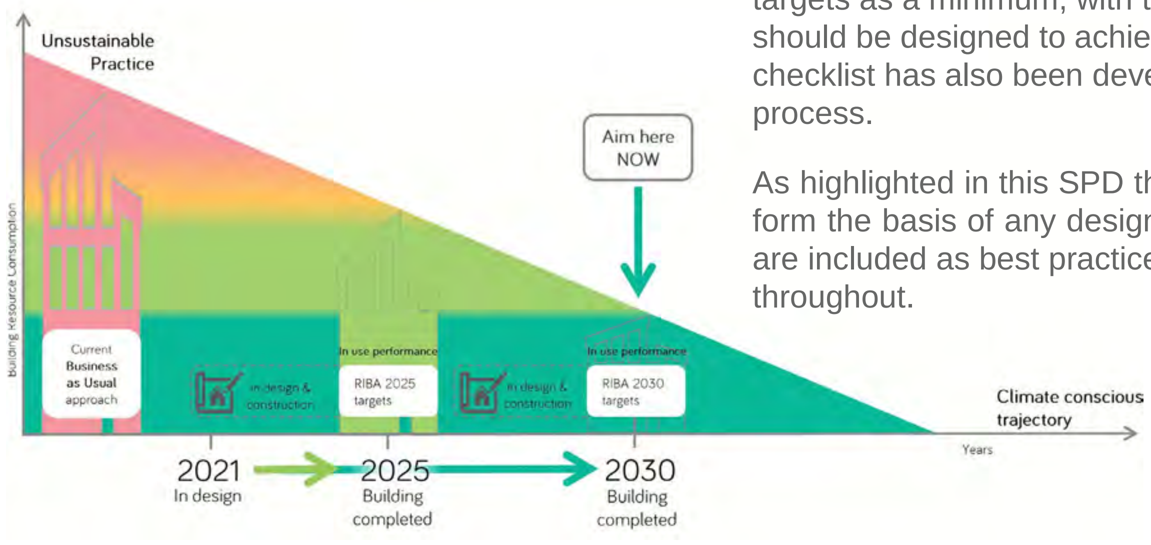


Image 49:
RIBA 2030 Climate Challenge as built target trajectories

Further Information

- [RIBA 2030 Climate Challenge]

Whole Life Cycle Carbon and Cost Assessments

Life Cycle Carbon Assessments look at the carbon emissions of a development and include an assessment of embodied carbon and operational carbon.

Life Cycle Cost Assessments look at the costs associated with the development and include the construction costs, through to maintenance and replacement costs as well as energy costs.

These studies particularly if completed at early design stages allow comparisons to be made between different construction approaches and standards, understanding the carbon and cost implications long term, allowing these to inform the design.

Assessing both upfront costs and those required for future maintenance, replacement etc often provides a convincing argument for the upfront investment in quality materials and achieving a higher energy performance.

Whole life carbon and cost assessments are recommended by leading advocates within

the sector including the RIBA and LETI, and are increasingly being written in as a policy requirement.

Image 50: ECCOLAB by Architype

There are a number of assessment tools now available such as ECCOLAB, which may be used to assist this process.

Further Information

- ECCOLAB, web based decision support tool for design of low impact buildings

Best Practice Recommendations

EU1 No onsite combustion of fossil fuel for new development.

EU2 All development shall assess the viability of onsite renewable generation and design a strategy to maximise storage.

EU3 Major development shall match total energy demand through a combination of renewable energy generation capacity, energy storage and smart controls.

EU4 Compliance of the evaluation of operational energy shall be demonstrated through performance methods such as the Passivhaus Planning Package (PHPP), CIBSE TM54 or Better Buildings Partnership Design for Performance (2019).

EU5 Offset remaining carbon emissions by contributing to renewable energy projects that will help facilitate decarbonising the national and/or local grid. Alternatively, offset through investment in a retrofit programme, requiring certification to Passivhaus EnerPHit or another agreed target.

Herefordshire Council

External Environment

ARCHITYPE

External Environment Overview

In this section

This section will detail:

1 / Decisions over retaining and enhancing biodiversity on your site

2 / How to integrate blue + green infrastructure to improve your building's climate resilience

3 / Sustainable water strategies

4 / Strategies to minimise pollution and polluting behaviours

Executive summary

> When it comes to construction impacting on local biodiversity the following hierarchy should be applied; avoid, mitigate, compensate. Biodiversity is key to the Herefordshire Core Strategy and the goal should be to deliver biodiversity net gain.

> A sustainable drainage system than manages surface water run-off - from swales to green roofs - can have a big impact on your site's resilience to climate change, whilst also enhancing biodiversity and providing amenity opportunities.

> As with renewable energy generation, a water strategy should look to reduce demand, to make systems more efficient, and then to consider sustainable drainage solutions like rainwater harvesting.

> In order to create a healthy environment air quality should be prioritised and monitored. Creative site design and landscaping strategy can reduce air and noise pollution - when in support of a sustainable transport strategy that encourages low-polluting, active transport.

> Light design must avoid impact on wildlife, neighbours and road users. Light design must be efficient, and energy wastage minimised.

Introduction

The natural species in Britain is in decline with 15% threatened with extinction and native woodlands now covering only 2.5% of the country *(Rewilding Britain)*. The built environment has contributed greatly to this decline over the years, with habitats destroyed for development and species displaced. The challenge is to halt this decline for the benefit of our generation and future generations.

Enhancing and conserving **biodiversity** is an important element of sustainable development. National Policy (NPPF) outlines that 'new development has a key role in the preservation, restoration and re-creation of priority habitats, ecological networks, green infrastructure and the protection and recovery of priority species populations'.

51 **Image 51**: Otter Holt at Kington Medical Practice

52 **Image 52**: Hazelnuts for Doormice at Kington Medical Practice

Conservation and enhancement of environmental assets and biodiversity along with creation of new habitats and biodiversity are required for compliance with Core Strategy policies SS6, LD1 and LD2. Identification of green infrastructure and protection of existing green corridors are also fundamental to Core Strategy policy LD3. This chapter begins by looking at how this can be considered within development both within the setting and as part of the built environment. Alongside the green infrastructure, blue infrastructure is an important consideration not only for improving biodiversity but also for water management. Core Strategy policies SS6 and in particular SD3 highlight the importance of water consumption and conservation with key design considerations on this topic discussed in this chapter. The chapter concludes with a brief discussion on air, light and noise pollution in alignment with Core Strategy policy SS6.

Policies

- Policy SS6 Environmental quality & local distinctiveness
- Policy SS7 Addressing climate change
- Policy SD3 Sustainable water management and water resources
- Policy LD1 Landscape and Townscape
- Policy LD2 Biodiversity and Geodiversity
- Policy LD3 Green Infrastructure

Definitions

- **Biodiversity:** is the variety of all life on Earth (see p73 for full definition)

Further Information

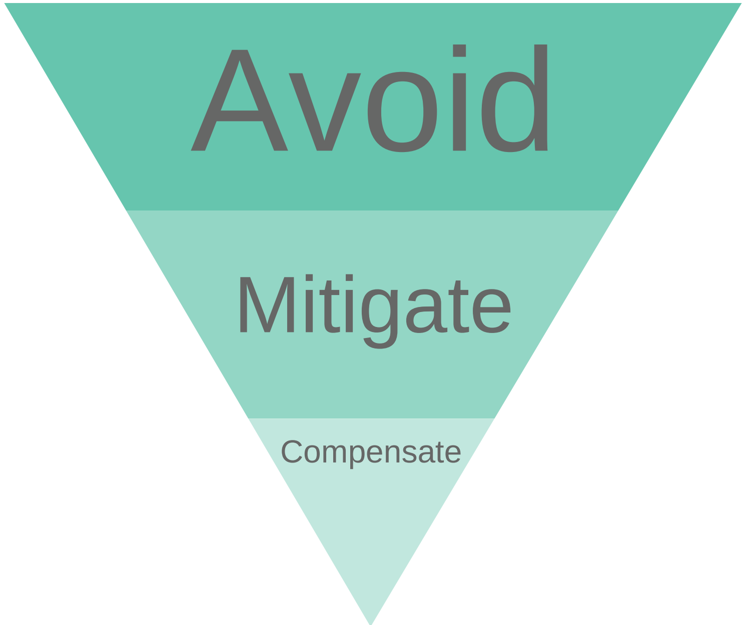
- Rewilding Britain

Biodiversity and natural habitats

Mitigation hierarchy: Development should minimise the impacts on **biodiversity** by implementing the mitigation hierarchy to first avoid and then mitigate. In doing so this will minimise the impacts on **biodiversity** and will lead to achieving **biodiversity net gain**.

The choice of site, siting and layout of a building can allow existing habitats to be retained and avoid development having an impact on the existing natural environment. The development of brownfield sites is actively encouraged over nature rich sites, with **designated sites** protected from development. The design of the site should consider the requirements of the building, but also the natural environment with the retention of existing natural features contributing to the protection of the landscape character and enhancing the **biodiversity** of the site.

When avoidance is not possible, mitigation is critical and measures to reduce impact must be applied. Buffer zones to minimise habitat disturbance, screening and planting can be used. Finally, if the first two options are not feasible compensation measures either on or off site must be applied.



53 **Image 53**:
Mitigation Hierarchy

Best Practice Recommendations

- Achieve a **Biodiversity Net Gain** across the development.

Definitions

- **Biodiversity:** is the variety of all life on Earth, among living organisms from all sources, including land, sea, and other aquatic ecosystems and encompasses the genetic variety within species, between species and the variety of ecosystems the species create.
- **Biodiversity Net Gain:** an approach to development that leaves the biodiversity of a site in a better state than before. It relies on the application of the mitigation hierarchy to avoid, mitigate or compensate for biodiversity losses.
- **Designated Sites:** for example Special Areas of Conservation, Special Protection Areas, Ramsar Sites, Sites of Special Scientific Interest, National Nature Reserves and Local Nature Reserves

Retain plants and protect living creatures: It is important to protect and conserve the plants and animals that already live on the site. Ecological and Arboricultural surveys will identify the flora and fauna on the site that need to be protected. These surveys may need to be completed at certain times of the year appropriate to the different species. Priority must be given to rare or critical habitats and species and protection measures will need to be put in place both during and after construction. The design should allow to retain these existing areas of valuable biodiversity where feasible and appropriate whilst also exploring the opportunities for enhancement.

54 **Image 54**:
Green and Blue Bat Box

Enhance and create new habitats and support biodiversity: Enhancing existing areas of valuable biodiversity can be delivered in all scales of development; at neighbourhood, street and household level. Habitats can be a physical part of a new development, without impacting on the aesthetic and functionality of the building. Measures can include:

- Nest and bat boxes, integrated into the building facades (see Bat Conservation Link for examples)
- Integration of sustainable drainage systems, reducing presssure on the underground network whilst also providing ecological benefits
- Creating habitats, for example wildflower meadows, ponds, wetlands and marshes.
- Establishing green corridors and creating connections between existing habitats
- Green roofs and walls, often providing new habitats in areas where it could not seem feasible
- Tree planting (right tree, right place) and soft landscaping
- New planting to support local species, incorporating wildlife friendly native planting, to extend existing habitats

These proposals will not only enhance biodiversity, they will also provide spaces that will benefit the health and well-being of the occupants in the buildings within these landscapes.

Further Information

- CIRIA (2019)
- Bat Conservation Trust
- Woodland Trust: Tackling climate change with the right trees in the right place

Rewilding: Rewilding is an approach to supporting biodiversity. It involves the restoration of e cosystems to the point where nature is allowed to take care of itself. It seeks to reinstate natural processes and, where appropriate, missing species – allowing them to shape the landscape and the habitats within.

Such an approach encourages a natural balance between people and nature and can provide opportunities for communities to diversify and create nature-based economies, but ultimately results in reversing biodiversity loss. Although often discussed at large and national scale rewilding can happen in all developments, from connecting habitats and setting aside large areas for nature to creating wildlife friendly gardens.

Multifunctional green & blue infrastructure: Green and blue infrastructure refers to water and vegetation and is used to describe integrated networks of natural and semi-natural spaces that can bring many useful benefits, for example clean air and water.

These benefits are vitally important in the context of climate and biodiversity emergencies and ensuring these are considered from the outset within the design can potentially offset the negative impact of a development and provide opportunities for biodiversity contributing to important targets, sucha s achieving Biodiversity Net Gain. They also have a wider value in placemaking and health and wellbeing.

Examples of green and blue infrastructure ranges from green roofs, hedgerows, ponds, and urban tree planting to park creation and river restoration.

55 **Image 55**: Wild Flower Grassland at Kington Medical Practice

Further Information

- National Design Guide, Ministry of Housing, Communities and Local Government (2021)
- Rewilding Britain

Living roofs: Green infrastructure and landscape design can influence the microclimate positively and in cities help to minimise the urban heat islandeffect. Where green space is scarce in urban areas **green roofs** can provide a protected habitat which can add to the biodiversity of a site.

56 **Image 56**: Green Roof, Architype

There are a number of benefits to creating a **living roof** these include:

- Reducing the internal temperature of a building in the summer
- Improving the life span of a flat roof
- Providing sound insulation
- Reducing storm water run-off, vegetated roofs are able to retain, on average, around 82% of rainfall
- Improvements in air quality adjacent to the roof
- Reductions in heating bills
- Improvements to water quality when passing through a green roof
- Habitat creation

Living roofs can have a dual and layered function, with PV panels mounted above the vegetation layer. **Brown roofs** are particularly worth considering on brownfield sites to provide a habitat for the flora and fauna that previously inhabited the site. The inclusion of large expanses of green roofs should be reviewed as part of a whole site water management strategy as sometimes the loss/retention of such high levels of rainfall isn't always desirable as the amenity benefits of creative rainwater design (at street level) are lost. The potential for a **living roof** should be considered early on in the design process.

Definitions

- **Green or living roof:** A roof that has vegetation and a growing medium planted over a waterproof membrane. There are many variations, but typically they are categorised as either intensive (roof gardens) or extensive (that provide ecological value rather than recreational).
- **Brown roof:** A roof where the growing medium is left to self-vegetate from windblown and bird lime seed disposal. Brown roofs provide an opportunity to recycle some waste material such as cleaned rubble from the construction process.

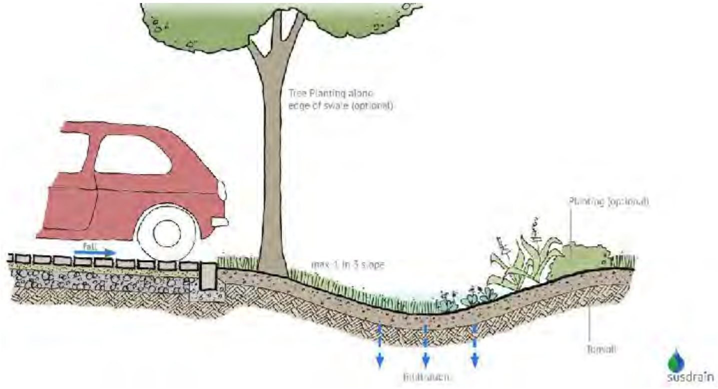
Best Practice Recommendations

- Incorporate living roofs as part of the whole sustainable water management strategy, minimising large expanses of flat roof.

Water consumption, conservation, drainage and reuse

Sustainable drainage: The integration of a Sustainable Drainage System (SuDS) should be facilitated as a primary drainage solution and is a requirement of the Flood and Water Management Act 2010. The aim is to manage surface water runoff from a development taking into account water quantity (flooding), water quality (pollution), whilst enhancing biodiversity and providing amenity opportunities. SuDS are generally designed to store and slowly release run-off - either to the ground (infiltration), to a watercourse, or to the surface water sewer system. Natural SuDS systems provide the greatest losses (evaporation and evapotranspiration), biodiversity, and amenity benefits, and they are very effective at removing pollution.

It is important to consider SuDS within a development from the very start, with a maintenance strategy in place for the lifetime of the development. This will ensure that the proposed Green and Blue Infrastructure is fully integrated in the landscape, to achieve the greatest range of benefits. Whilst this approach is preferred it is not always possible and some engineering options may need to be installed, such as soakaways etc. However, Green and Blue Infrastructure should always be the preference.



57 **Image 57**: Swale, Image by Susdrain.

As identified by Susdrain there are a number of components to SuDS, and these are enabled by features such as green roofs, rainwater harvesting, permeable paving, swales, rain gardens, trenches, basins, ponds and wetlands.

Development should be directed, where possible, to areas with the lowest risk of flooding, taking into account the impacts of climate change. However, in Flood Zone areas where flood mitigation is required, the inclusion of a SuDS strategy is particularly important in this instance. Other flood mitigation measures can include:

- Impermeable boundary walls, fences and gates
- Bunds/landscaping at the perimeter of the development; and
- Sizing of rainwater goods to contain larger volumes of water when required.

Definitions

- **Sustainable drainage systems (SuDS):** a method of drainage design to manage surface water runoff locally (as close to source as possible), to mimic natural drainage and encourage its infiltration, attenuation and passive treatment.

Best Practice Recommendations

- Implement SuDS as the primary drainage solution through Green and Blue Infrastructure.
- Development should not add to surface water run-off and should aim to reduce existing run-off rates and volumes.

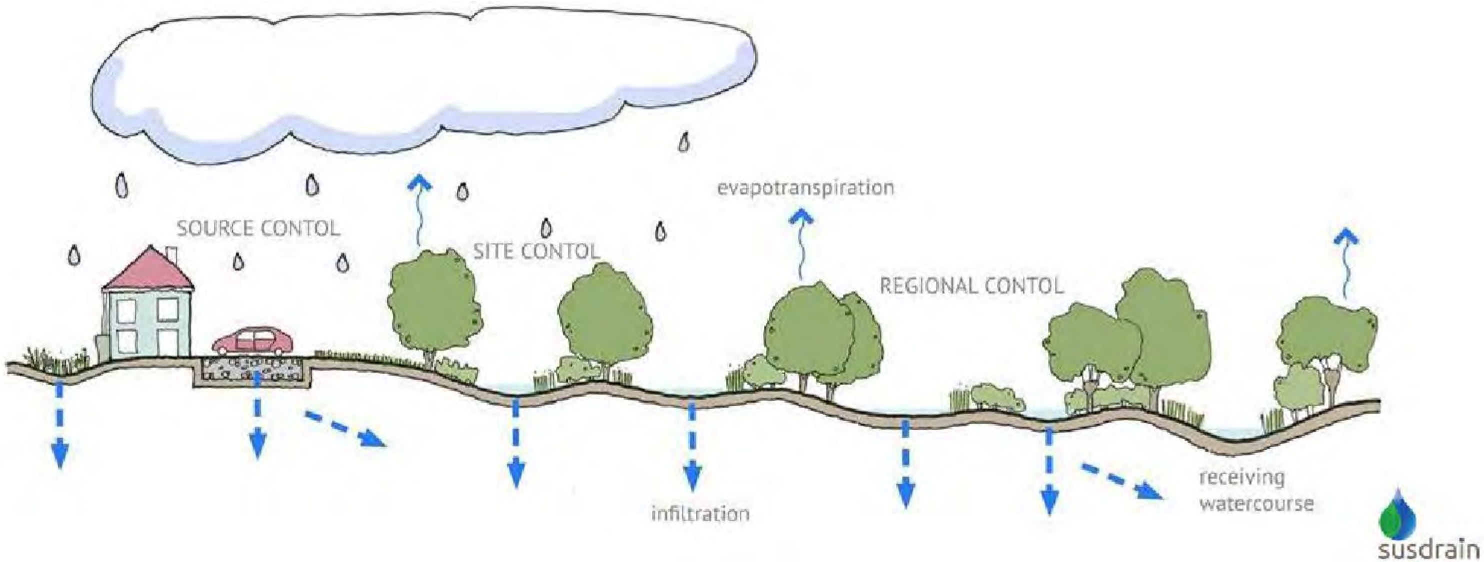
Urban drainage & surface water runoff:
Traditional drainage solutions in built-up areas, are designed to quickly carry water away by using gullies and underground pipe systems in order to avoid flash flooding. Water quality and amenity aspects of drainage have largely been ignored. In urban areas it is important that areas of hard landscaping such as parking, are broken up with soft landscaping and large expanses of impermeable surfaces are avoided. SuDS can and should be utilised in these settings.

Building design to improve water management:
When designing a building the reduce, reuse, recycle hierarchy for water conservation should be followed. It is worth noting that the cost usually increases with the hierarchy, while the benefits decrease, and so spending time in implementing reduction measures is a worthwhile investment.

Low flush or dual flush WC's, flow restrictors on taps and low flow shower heads, percussion or sensor taps, waterless urinals and leak detection should all be installed to help reduce water consumption and reduce water stress.

Best Practice Recommendations

- New build residential water efficiency of 75 litres/person/day as a minimum.
- New build non-residential equivalent to BREEAM 3 for water consumption as a minimum.



Further Information

- Sustainable drainage
- Saving water
- CIRIA (2019)
- SuDS Handbook for Herefordshire Council

58 **Image 58**: Sustainable Urban Drainage Systems (SuDS), Image by Susdrain.

Heating water is one of the largest energy requirements in buildings. Reducing the amount of water to heat will help keep running costs down, whilst also reducing operational energy demand.

It is most effective to reduce water consumption before considering rainwater and greywater harvesting (reuse and recycling). Both methods reduce the demand for mains water, relieve pressure on supplies, reduce the risk of flooding and pressure on drainage systems whilst also reducing water bills for those whose water is metered. Because of these benefits rainwater and greywater recycling is classed as a sustainable drainage solution. However, rainwater harvesting is not necessarily appropriate for all buildings and needs to be balanced with the operational energy used to operate the system.

As our climate changes, flooding is becoming a greater risk to the built environment. Development should be designed to adapt to flood risk, and should not only be a feature for those in medium and high risk areas, Flood Zones 2 and 3 respectively. Examples include; setting appropriate finished floor levels, with habitable rooms in homes lifted above flood level, locating services at higher than usual positions, fixing points for flood shuttering and flood resilient fittings, such as tiling of walls and floors at ground floor.

Provision should also be made for safe access to and from a development in the event of a flood.

Recycling provision: The design of a building should consider how buildings operate in practice and how people access and use them on a day-to-day basis both now and in the future. Provision must be made for the storage and collection of waste, designing for recycling and separation. The location must allow for ease of use for occupants ensuring they are well-integrated into the design of streets, spaces and buildings, to minimise visual impact, unsightliness and avoid clutter, particularly when incorporated onto a street frontage.

59 **Image 59**:
Integrated Bin Stores at Goldsmith Street by Mikhail Riches

Further Information

- Harvesting rainwater for domestic uses: and information guide
- Avoiding Rubbish Design

Definitions

- **Rainwater harvesting:** the collection of clean/treated runoff from roofs and hard surfaces for use for toilet flushing, laundry water supply or irrigation.
- **Greywater recycling:** the use of waste water from baths, showers and hand basins for toilet flushing, irrigation or washing machine supply.

Building with Nature

Image 60:
60 Building with Nature Logo

Building with Nature is a voluntary approach that enables developers, who want to go beyond the statutory requirements, to create places that really deliver for people and wildlife. It brings together guidance and good practice to recognise high quality green infrastructure at all stages of the development process including policy, planning, design, delivery, and long-term management and maintenance. It has been developed by practitioners and policy makers, academic experts and end-users, and has been tried and tested in multiple schemes from Cornwall to Scotland.

The framework of standards is divided into four themes: core, wellbeing, water and wildlife.

There are three levels of accreditation:

- **Design Award:** High quality green infrastructure demonstrated at the planning and design stage of development;
- **Good Award:** High quality green infrastructure, delivering benefits within the boundary of the scheme;
- **Excellent Award:** Exemplary quality green infrastructure, delivering benefits within and beyond the boundary of the scheme. This accreditation seeks to ensure the natural environment is considered holistically.

This accreditation seeks to ensure the natural environment is considered holistically.

Further Information

- Building with Nature

Air Pollution

All development should adopt sustainable design principles that lead to lower emissions and an improved environment. Air pollution in development can arise from many sources and activities, including traffic and transport, industrial processes, domestic and commercial premises, energy generation, agriculture, waste storage/ treatment and construction sites. The primary impacts on air pollution are from transport, and the support of green transport methods and traffic management schemes will help improve the air quality. Sustainable transport and design to reduce the need to travel and promotion of active travel are covered in Section 6.

The location of outdoor space for recreation in relation to sources of air pollution, such as busy roads should be considered, and the distance between them maximised. If distance cannot be achieved screening must be considered. Routes through developments should be located away from busy roads and new development should not create a ‘street canyon ‘effect or building configuration, that could lead to pollution not dispersing effectively.

Green infrastructure not only improve biodiversity on the site but can also contribute to reducing a mbient air pollution by trapping fine particulates whilst also absorbing gases. For these reasons green infrastructure must be a part of the design.

Hedges and large planting can also be used for screening from a pollution source, with some plants more beneficial than others.

Basic good design should result in no additional exposure to increased air pollution for existing or future occupants.

How to manage pollution through design: New development should be designed to minimise public exposure to pollution sources by:

- Locating habitable rooms away from busy roads
- Avoiding building configuration along busy roads that inhibits effective pollution dispersion (street canyons),
- Considering the proximity of sensitive receptors such as schools, hospitals and play areas to busy roads.
- Introducing green infrastructures and barriers to reduce pollutants
- Installation of on-site renewable and/or low carbon energy
- If gas boiler installation is required installing one with low NOx emissions
- Providing good ventilation – this could be through natural ventilation (if external conditions are appropriate) or mechanical ventilation
- Good onsite management during the construction phase

New development provides an opportunity to reduce and improve overall emissions in the area. This can be done by incorporating new, cleaner and sustainable technologies from the outset to generate heat and energy. The use of efficient and/or renewable sources, such as solar water heating or air and ground source heat pumps in developments can help minimise polluting emissions.

All gas-fired boilers must have low NOx emissions and meet a minimum standard of 40mgNO×/kWh, although the use of ultra-low technology (less than15mgNO×/kWh) is encouraged. Where gas fired Combined Heat and Power (CHP), biomass or biofuel boilers are proposed the applicance should meet an emissions standard of:

- Spark ignition engine: less than less than 150 mgNOx/Nm3
- Compression ignition engine: less than 400 mgNOx/Nm3
- Gas turbine: less than 50 mgNOx/Nm3 *(IAQM)*

Good natural ventilation to a building should be provided. However, fitting an MVHR ventilation unit, which is required to achieve the Passivhaus standard minimises the impact outdoor air pollution will have on the indoor air quality. This is particularly relevant to overcome exposure to poor air quality and for sensitive developments such as hospitals and schools. MVHR units include filters which filter particulates from entering the system along with pollen etc.

If design cannot fully reduce the impact to an acceptable level then mitigation measures may be used to either protect receptors or minimise the need for vehicle use. Many developments will require a mix of design and mitigation measures that have been tailored to be appropriate for the site. Mitigation measures are in the main related to support and promotion of sustainable transport as well as supporting the development of alternative technologies.

Offsetting by providing money for schemes that improve overall air quality should be a last resort but may need to be combined with good design and mitigation in some circumstances. Appropriate contributions can be negotiated or contributions can be calculated using Defra's damage cost approach. This as with mitigation is related to support of sustainable transport, allowing financial contributions to be made to improving traffic management measures, public transport and new services, improvements in walking and cycling facilities along with air quality improvements.

It is important that the impact on air quality is also considered during the demolition and construction phase. Good site management and the use of low emission technology will enable emissions to be reduced during this phase.

Further Information

- Review of interventions to improve outdoor air quality and public health
- Institute of Air Quality Management

Temporary emissions of dust during the construction phase are of concern as they add to the overall exposure of particulate matter to residents, visitors and site workers. Each stage should be considered through demolition, site preparation, ground works, construction as well as materials storage, transport and handling, both on and off site. For larger developments a dust management plan should be included as part of the Construction Environmental Management Plan (CEMP).

Air Quality Assessments should be completed f or larger developments. Such assessments will assess current baselines in the area, consider the cumulative impact of known future developments in the area and predict the future impact with and without the proposed development, including any mitigation measures. Air Quality Neutral Assessments will be instead be required for developments near Air Quality Management Areas (AQMA)

Light pollution

External lighting schemes must be well designed to ensure they do not have an adverse on neighbours and road users or the wider landscape and ecology in both rural and urban settings. Light design must minimise glare and spillage. Ultimately light pollution is a sign of wasted energy and poor efficiency and only the minimum for security, safety and operational reasons should be installed. To minimise wastage lights should be switched off when not required for these purposes.

Light pollution can occur as:

- Sky Glow – upward light, often seen from a distance from urban areas with streetlights the main contributor
- Light Trespass/Nuisance – light spillage beyond a property's boundary, with security lights normally being the cause of this
- Glare – the uncomfortable brightness of a light source, particularly against a night sky

Artificial light can be classed as a statutory nuisance and so the design is important ensuring the intensity and direction does not disturb others. The affect lighting has on the night sky should also be minimised to avoid impacting on wildlife and disturbing the natural habitats and behaviours of nocturnal animals and birds.

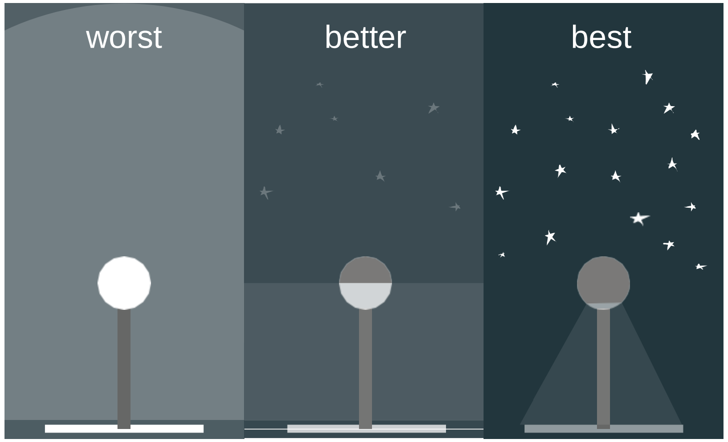
Best Practice Recommendations

- Development above householder level to be Air Quality Neutral or better

Artificial lighting should be sited in the most appropriate locations to cause minimal disturbance to occupiers and wildlife, while still illuminating the intended area. Consideration should be given to lighting associated with buildings of special historic and architectural interest in order to avoid harm to the significance of the heritage asset and that of the wider area, including conservation areas.

To achieve the necessary minimisation of obtrusive light the applicant should adhere to the following general principles taken from the Institute of Lighting Professionals, Guidance Notes for the Reduction of Obtrusive Light, GN01: 2011.

A light impact assessment can be required for some developments.



61 **Image 61**: Light directed downwards and at a lower intensity reduces light pollution

Noise pollution

Noise pollution can be detrimental to health and quality of life and so consideration should be made in the planning of a new development for this. This may mean that noise sensitive development is located away from existing sources as well as the possible introduction of noise sources to be a consideration in planning approval. Noise within the living and working environment is a key aspect of sustainable development. It is important that good acoustic design is considered at an early stage in the development management process. In accordance with the Noise Policy Statement for England (NPSE) (March 2010) the following principles should be applied:

- Avoid significant adverse impacts on health and quality of life from **environmental**, **neighbour** and **neighbourhood noise** within the context of Government policy on sustainable development.
- Mitigate and minimise adverse impacts on health and quality of life from **environmental**, **neighbour** and **neighbourhood noise** within the context of Government policy on sustainable development.
- Where possible, contribute to the improvement of health and quality of life through the effective management and control of **environmental**, **neighbour** and **neighbourhood noise** within the context of Government policy on sustainable development.

Definitions

- **Environmental noise:** includes noise from transportation sources
- **Neighbour noise:** includes noise from inside and outside people's homes
- **Neighbourhood noise:** includes noise arising from within the community such as industrial and entertainment premises, trade and business premises, construction sites and noise in the street

Further Information

- Noise Policy Statement for England (NPSE) (March 2010)

62 **Image 62**: BREEAM Logo

Building Research Establishment’s (BRE) Environmental Assessment Methodology (BREEAM) is one of the most renowned standards for non-residential development. There are different BREEAM schemes, including new construction which relates to individual buildings and BREEAM Communities for development on a wider scale

Assessment and certification can take place at a number of stages in the built environment life cycle, from design and construction through to operation and refurbishment.

The main output from a certified BREEAM assessment is the rating. A certified rating reflects the performance achieved by a project and its stakeholders, as measured against the standard and its benchmarks. The rating enables comparability between projects and provides reassurance to customers and users, in turn underpinning the quality and value of the asset. The

BREEAM ratings range from Acceptable (In- Use scheme only) to Pass, Good, Very Good, Excellent to Outstanding and it is reflected in a series of stars on the BREEAM certificate.

Embodied carbon assessment should be completed independently to a BREEAM standard to ensure a rounded approach to both operational and embodied carbon.

Further Information

- BREEAM

63 **Image 63**: BREEAM Assessment Categories

Best Practice Recommendations

EN1 Achieve Biodiversity Net Gain across the development.

EN2 Incorporate living roofs as part of the whole sustainable water management strategy, minimising large expanses of flat roof.

EN3 Implement SuDS as the primary drainage solution through Green and Blue Infrastructure.

EN4 Development should not add to surface water run-off and should aim to reduce existing run-off rates and volumes.

EN5 New build residential water efficiency of 75 litres/person/day as a minimum.

EN6 New build non-residential equivalent to BREEAM 3 for water consumption as a minimum.

EN7 Development above householder level to be Air Quality Neutral or better.

Accessibility

Accessibility Overview

In this section

This section will detail:

1 / Key considerations to ensure your development supports and promotes active travel + sustainable transport

2 / How site design can enable car-free environments

3 / Cycle and Electric Vehicles charge points + provision

Executive summary

> Developments should prioritise car-free travel. Providing viable active alternatives like walking and cycling, as well as adequate access to public transport, should be done in a way that promotes safety and accessibility for all.

> Transport emissions in the UK have fallen by less than 5% since 1990. Large-scale developments can have a significant impact in shaping behaviour change in this area through decisions in areas such as parking design.

> Charge points for Electric Vehicles should be integrated into your site to coincide with the phasing out of petrol and diesel cars. Increased homeworking should be considered for domestic schemes. Appropriate cycle storage and parking should also be a key consideration.

Introduction

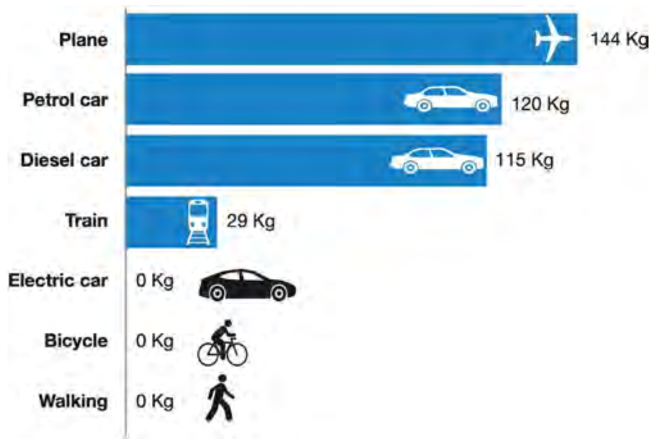
The Road to Zero sets out the Government's ambition to put the UK at the forefront of the design and manufacturing of zero emission vehicles and to end the sale of new petrol and diesel cars and vans by 2040. By 2050 it is the intention that almost every car and van will be zero emission. Although today's new vehicles are more efficient than those bought in 1990, transport related greenhouse emissions have fallen by only 2% since 1990 *(Road to Zero DfT)*. Consequently, transport is the largest contributor to UK greenhouse gas emissions at 27%, *(2021 Annual Report DfT)* which also has negative effects on air quality and noise pollution.'

Driving the manufacture and use of electric cars is one approach to reducing greenhouse gas emissions, another is to change our behaviours, through the promotion and increased use of sustainable transport methods.

This section looks at options around improving the sustainability of projects from the perspective of reducing car dependency and prioritising pedestrian and cycle use - or, at very least, targeting options that future proof the built environment, by allowing flexibility and access to renewable energy, such as electric car charging.

Core Strategy policy SS4 identifies a need to develop in sustainable locations, which is discussed at the beginning of this chapter in the SPD.

Alternatively, promotion of sustainable modes of transport and active travel should be encouraged, which can facilitate sustainable development. For example; designing out the car and car-free development to ease of accessibility to cycle storage and electric charging. Such actions would be in alignment with Core Strategy policies SS7, SD1 and MT1. This chapter of the SPD demonstrates how design can facilitate this.



Indicative GHG emissions for a passenger travelling from London to Edinburgh, 2018

Plane journey excludes travel to/from airports

Car emissions exclude tyre and brake wear

Train emissions are based on an average for diesel and electric trains; if a route is fully electrified, emissions would be lower than those presented

Image 64:
64 Energy Saving Trust

Policies

- Policy SS4 Movement and transportation
- Policy SS7 Addressing climate change
- Policy SD1 Sustainable design and energy efficiency
- Policy MT1 Traffic management, highway safety and promoting active travel

Further Information

- The Road to Zero, Department for Transport (July 2018)
- Decarbonising Transport Setting the Challenge Department for Transport(March 2020)

Large scale developments have a significant role to play in achieving a focus on sustainable modes of transport and shift away from reliance on the private car, although most developments have the opportunity to take a step in the right direction.

Proposals should therefore consider:

- Removing the need to travel where possible;
- Prioritising pedestrian routes through neighbourhoods
- delivering cycling, walking and passenger transport networks, thereby facilitating and prioritising car free movement;
- Adopting initiatives that encourage alternative behaviours around car usage; such as, the redesigning of parking areas.
- Future-proofing new developments through the introduction of adaptable technologies and allowing change in behaviour to be accommodated;
- Facilitating deliveries and servicing, without impacting on a pedestrian and cycle priority environment.

From the outset, measures can be introduced in the design of a development that can reduce the overall need to travel, particularly by private car.

Sustainable locations

When choice of site is an option, look to develop a site that minimises the need to travel, by utilising and supporting existing infrastructure that is in close proximity. Where larger developments are proposed ,that are more distanced from existing facilities, there should be an aim to strengthen existing sustainable transport links, such as public transport and cycleways, whilst also implementing community transport initiatives, such as ring and ride.

Design out the need for the car

Mixed use development helps to minimise car use for small journeys, with shops and other services in close proximity.

Increasingly, working from home is more common and designing new homes which facilitate this should be encouraged, as this will, in turn, minimise the need to travel. Additional space will be required in new homes, along with a reliable broadband connection. Another option is for development to incorporate community working areas/hub spaces for individuals to use.

Car-free environments

To create sustainable communities, the infrastructure must be designed around people rather than cars. Creating a car-free or pedestrian dominant scheme is one way to do this; enabling

Best Practice Recommendations

- Prioritising pedestrians and cyclists over vehicles; delivering cycling, walking and passenger transport networks.
- Large developments to strengthen existing public transport, cycleways and implement community transport initiatives.

Further Information

- Gear Change: A bold vision for Walking and Cycling. Department for Transport
- Cycle Infrastructure Design Department for Transport LTN 1/20

places where vehicles are greatly reduced or eliminated. Pedestrian and cycle access, to and within the site, should be prioritised over vehicular. The design of shared space schemes, that remove or reduce the distinction between the pavement and carriageway, must take into consideration the needs of people with disabilities, particularly visual impairment.

Designing routes and pathways that create a hierarchy through the scheme is important and this can be successfully implemented by using different surface materials, colour, texture, signage etc. Routes for cyclists should be well considered and must feel direct and logical, whilst also ensuring that they connect to existing cycle paths. Whilst the emphasis should be on pedestrians and cyclists, it is important that cyclists are treated as vehicles and are separated from pedestrians, to ensure safety.

65 **Image 65**:
Shared Space, Marmalade Lane

Movement plans help to demonstrate that sustainable transport is at the forefront of the design, prioritising pedestrians and cyclists; making it easier for them to move across the site that it would be for car users.

When developing a car-free environment, a considered access strategy must also be developed from the site to wider destinations. This will ensure that continuous and useable routes to key locations are within acceptable walking and cycling distances. Such a strategy is crucial in the success of developments which seek to ensure that the use. of private cars is not required.

The Department for Transport's guide 'Manual for Streets' provides guidance on the planning and design of new residential streets, and modifications to existing ones. It aims to increase the quality of life through good design and to meet the needs of pedestrians and cyclists in order to create more people orientated places.

Multi-purpose parking

Parking, both in curtilage and as part of a car park, can create expanses of hard surface, which during large parts of the day are unoccupied by cars. Consideration should be given to allowing these areas to become an integral part of the landscaping strategy, by repurposing the space during day and considering alternative softer, or more environmentally friendly, surface materials.

Further Information

- Energy Savings Trust
- Local Government Association
- Manual for Streets
- National Design Guide, Ministry of Housing, Communities and Local Government (2021)
- Transport for New Homes

Sustainable transport

The sustainable travel hierarchy is a useful tool in considering sustainable travel options. The most sustainable option is walking, followed by cycling, both of which are classed as **active travel**.

There are a number of community transport initiatives that reduce the reliance on the car and that can be encouraged and designed within developments.

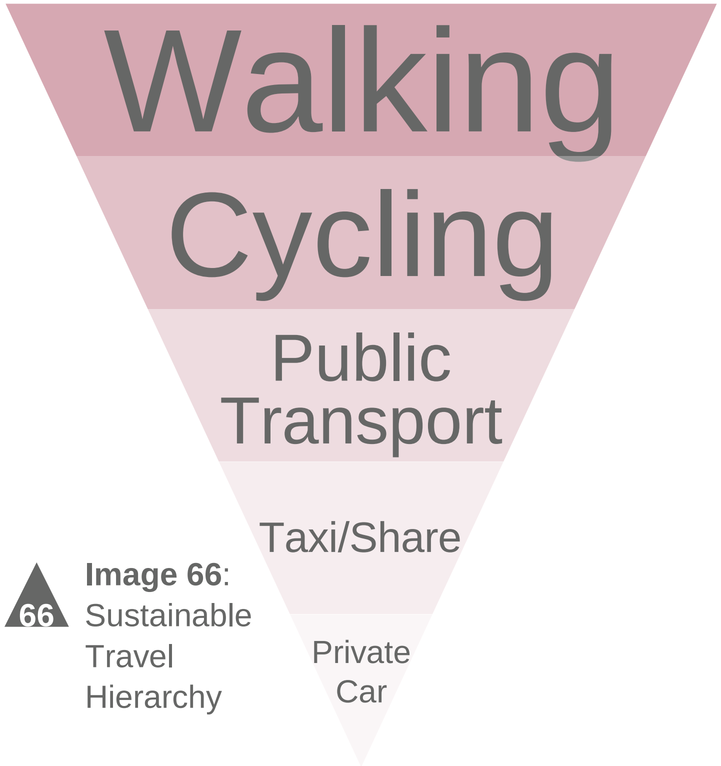


Image 66: Sustainable Travel Hierarchy

Image 67: Beryl Bikes, Hereford

Bike share schemes are publicly available bikes that can be hired by the hour or by the day. The Beryl bike scheme based in Hereford was launched in the summer of 2019 and now includes a network of 200 bikes, available from 65 bays. Discussion with the council regarding provision of bays in new development in Hereford would be encouraged.

Car clubs offer instant access to cars in and around a local area, without the need for individual car ownership. Annual membership ensures payment is only required when the car is used. Car clubs can provide a cheaper alternative to a second car, and are also suitable for those who do not frequently drive, yet still want access to a car when needed. Providing provision for a car club space in a new development is actively encouraged and can lead to an acceptable reduction in parking requirements. The council website has a link to the Park and Share scheme, which encourages people to car share when making trips into and out of Hereford city.

Definitions

- **Active Travel:** Moving in ways that don't use fossil fuels. Active travel improves health and wellbeing, whilst also helping to reduce a person's carbon footprint and reducing money spent on transportation.

Further Information

- Beryl Bikeshare, Hereford

Best Practice Recommendations

- New residential development to provide bike storage for all properties.

Cycle storage & provision

Cycle storage should be conveniently positioned and sensitively integrated into public spaces, amenity space, gardens or buildings. New development should provide either private or communal cycle storage for occupants, with a charging point becoming a important addition, as electric bikes become more popular. Cycle storage should be secure, to minimise theft and for personal security. Include lockers and ensure there is enough operating space so that bikes are not damaged when taking them from the stands. It should be positioned so that it is well-lit, visible and sheltered.

68 **Image 68**: greenroofshelters.co.uk

Electric vehicles and charging

It is important that all new developments of a certain size facilitate the transition to ultra-low emission vehicles, for example by including charge points.

The Road to Zero explains the Government's ambition to end the sale of new conventional petrol and diesel cars and vans by 2040.

Charge points are primarily categorised by their power, (measured in kW), which reflects the speed at which they can charge an **electric vehicle** (EV). Whilst standard charging (7kW or lower) adds 10-25 miles of range per hour and typically requires cars to be parked for a long time. Rapid charging (around 50kW) provides around 100 miles of range in half an hour, requiring only 25-40 minutes for 80% charge. Ultra-rapid is currently being developed, with most EV's on sale from 2020 onwards likely to accept 100kW charging, providing a range of 200 miles in half an hour.

Charge points take a variety of forms and can be placed at on-street or off-street locations. Private charging will require a socket to be mounted externally within the property's boundary. Public charge points are integrated into a free-standing column, or into streetlights, whereas rapid chargers are similar to a parking payment machine.

Where parking is being provided, there should be an allowance for EV charging. The type of charging will depend on whether parking is allocated or not. For example, EV charging must be considered for all in-curtilage parking, whereas unallocated will instead require an allowance for a payment system and the potential to install rapid charging points.

Definitions

- **Electric Vehicle (EV):** A vehicle powered only by electricity. The vehicle is charged by an external power source and incorporates regenerative braking which helps to extend its range.

Best Practice Recommendations

- Non-residential development to provide cycle user showers, changing facilities and secure cycle storage.
- Inclusion of charge points for all residential and visitor parking spaces, and 1 for every 5 cars in non residential developments.

Further Information

- Charging electric vehicles Energy Savings Trust

Building for a Healthy Life (BHL) is a national design code for creating places that are better for people and nature and replaces the previous Building for Life 12. The latest edition has been written in partnership with Homes England, NHS England and NHS Improvement.

BFL comprises of 12 considerations that are designed to be used as a way of structuring discussions about a proposed development at the very start of the design process. The considerations capture the areas of design and placemaking that need most attention but are often the most overlooked; helping people improve the design of new and growing neighbourhoods.. There are three chapters, each with 4 of the 12 consideration questions:

- Integrated neighbourhoods
    - Natural connections
    - Walking, cycling and public transport
    - Facilities and services
    - Homes for everyone
- Distinctive Places
    - Making the most of what's there
    - A memorable character
    - Well defined streets and spaces
    - Easy to find your way around
- Streets for All
    - Healthy streets
    - Cycle and car parking
    - Green and blue infrastructure
    - Back of pavement, front of home

With a proposed development reviewed and awarded a green, amber or red for each of the 12 topics, the more greens that are achieved, the better the development.

This tool encourages the wider external context to be considered, initiating thought beyond the buildings themselves. Other design considerations discussed in this SPD, such as the embodied carbon and operational carbon of buildings will need to considered independently.

69 **Image 69**:
Building for a Healthy Life Cover

Further Information

- Building for Life

Best Practice Recommendations

AC1 Prioritising pedestrians and cyclists over vehicles; delivering cycling, walking and passenger transport networks.

AC2 Large developments to strengthen existing public transport, cycleways and implement community transport initiatives.

AC3 Non-residential development to provide cycle user showers, changing facilities and secure cycle storage.

AC4 New residential development to provide bike storage for all properties.

AC5 Inclusion of charge points for all residential and visitor parking spaces, and 1 for every 5 cars in non residential.

Herefordshire Council

Construction

ARCHITYPE

Construction Overview

In this section

This section will detail:

1 / How to address waste in construction

2 / On-site testing required to deliver high performance

3 / Post Occupancy Evaluation and certification

Executive summary

> Circular principles are key to reducing construction waste, which is accounts for more than half the waste generated in the UK annually.

> Introducing a hierarchy of decisions that first prevents waste, then minimises excavation and demolition waste by reuse and recycle will drastically improve the environmental impact of a development and will ensure alignment with the emerging Herefordshire Minerals and Waste Local Plan (MWLP). Considering longer lifecycle building products will also minimise the lifecycle waste associated with a project.

> Reducing travel, and particularly car travel, will have a significant impact on the greenhouse gas emissions associated with developments.

> The average performance gap on UK buildings is 40%. Air testing during construction and post-completion - and including robust performance testing as part of plans from the outset - will help drive the kind of performance standards referenced in this document.

Introduction

This final chapter discusses the considerations at construction phase that must be implemented to address embodied carbon and operational energy use in the built environment. Whilst much of this does require forward planning at earlier design stages, it is during the construction stage that action happens.

The importance of embodied carbon assessments has been discussed in earlier sections. The management of waste generation on site is an important aspect for discussion, as careful consideration can lead to improved reuse and recycling opportunities. However earlier design decisions can have implications on the amount of waste generated both on site immediately and also during the lifetime of the building. Considering waste at all stages can help reduce the embodied carbon within a building and create efficient use of resources.

Ensuring buildings perform as anticipated at design stage and addressing the **performance gap** is vitally important during the construction phase. Whilst there is a responsibility for designers to ensure buildings are modelled realistically and assumptions reflect in-use performance of buildings, a large responsibility also rests with those constructing the building to eliminate the performance gap. Methods to facilitate this, including testing, monitoring and certification are discussed in this chapter.

The effect development has on physical resources and reduction, reuse and recycling of waste, particularly on development sites featured within Herefordshire Council's Core Strategy policies SS6, SS7, and SD1 along with the the Herefordshire Minerals and Waste Local Plan. Currently reliance is placed on certification and achieving building standards to ensure building performance targets are met. However, as certain Government targets are met and it becomes necessary to prove that buildings achieve these required targets it is intended that the **performance gap** will disappear.

Policies

- Policy SS6 Environmental quality & local distinctiveness
- Policy SS7 Addressing climate change
- Policy SD1 Sustainable design and energy efficiency
- Herefordshire Minerals and Waste Local Plan

Definitions

- **Performance Gap:** the difference in how a building was anticipated to perform at design stage and the in-use energy consumption.

Waste

As part of a 25-year Environmental Plan and a focus on resource efficiency, the Government have set out to eliminate all kinds of avoidable waste by 2050. To help deliver this goal, the National Resources and Waste Strategy was published in 2018, focusing on the concept of the **Circular Economy**.

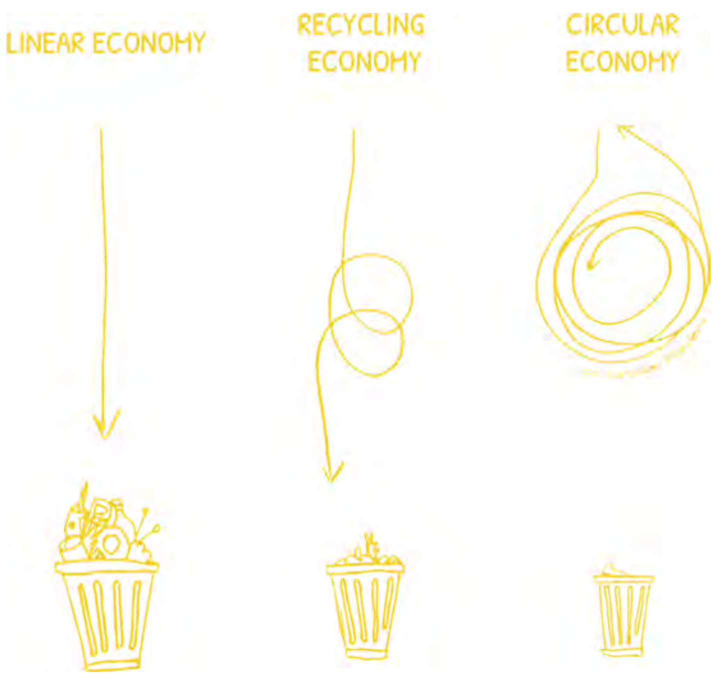


Image 70: Circular Economy (Image courtesy of Circular Flanders)

The construction sector accounted for 62% of the total waste generated in the UK in 2016 and while small improvements are being made, the construction industry needs to make some big strides in the near future. Efforts must be made to eliminate waste from the outset and to minimise use of resources.

In order to achieve this, it is important to understand the impact various elements of the construction process (including demolition, excavation and construction) have on waste generation. The following should be prioritised:

Managing demolition waste: A demolition strategy should be developed, setting out how materials will be segregated on site and how waste flows can be managed to maximise re-use and reclamation. Larger projects should also consider independent pre-demolition audits to aid in this process and demonstrate a commitment to minimise waste.

Managing excavation waste: An excavation strategy should be developed to highlight the nature of this waste, the reasons behind its removal and if it can be reused or recycled, ideally on site or in the locality (for example to raise levels to address flood risk). This can then inform key design decisions from the outset.

Definitions

- **Circular Economy:** refers to a regenerative economic system aimed at continual use of resources to eliminate waste. This contrasts the traditional linear economic system: 'take, make, dispose.'

Further Information

- UK Statistics on Waste
- Our Waste, Our Resources: A Strategy for England
- Circular Economy Statement Guidance, Draft for Consultation

Managing construction waste: Waste generated during construction can arise due to a number of reasons such as, inefficient design that leads to wastage, over ordering of materials, poor storage that results in damage and poor workmanship that results in duplication of work.

Segregating materials to allow them to be recycled and repurposed is important. It may also be possible to reuse materials on site and for this reason materials with this potential should be separated from those that will need to be recycled off-site. Developing a strategy to address construction waste will again assist with decision making from early in the process.

Managing lifecycle waste: Re-useable coffee cups are more robust, last longer and reduce the single use impact of disposable cups. In the same way, choosing building products with longer lifespans, a nd ones that are easily recycled or made of naturally occurring materials, will mean that when materials are replaced less waste will go to landfill and more can be recycled. The same considerationshould also be applied to the materials specified for the infrastructure and landscaping around buildings.

Whole life carbon assessments are a good start in assessing the carbon impact over the expected lifespan of a building and can often provide a direct reflection of the impact of waste too.

Waste hierarchy: As illustrated below, the priority is to prevent the creation of waste from the outset, followed by preparation of waste for reuse; to recycling, and then recovery. Disposal, in landfill for example, is regarded as the worst option.

Image 71: Waste hierarchy

Definitions

- **Whole Life Carbon:** (WL-CO2e) refers to the carbon dioxide equivalent (the measure by which greenhouse gases' impact on the climate is measured) emissions from EN:15978 building stages A, B and C, with D reported separately.

Best Practice Recommendations

- All developments shall calculate life-cycle carbon emissions (including embodied carbon emissions) with a nationally recognised methodology and demonstrate actions taken to minimise life-cycle carbon emissions
- A Site Waste Management Plan to be implemented

One Planet Living is a simple framework designed to help people live well with the resources of the planet we have. It comprises ten intuitive One Planet Living. Principles that can be used by anyone – personally and professionally – to imagine, plan, do, and communicate about deep sustainability. It is based on what science is currently telling us about what is needed to live within the Earth's means.

The One Planet Living Framework is not a prescribed standard, certification or accreditation system and consequently there is no pass or fail, but instead, its application required thought about a wide range of design considerations. It is a commitment to a journey rather than a tick-box certification.

This framework ensures a complete approach to development and for this reason is a recommended tool. A One Planet Action Plan would be developed for each site and will be dynamic, allowing modification and improvement. This will include a set of goals for each topic, outlining the strategies and actions for implementation. This is where this framework can work alongside other standards; with these standards set as goals within the One Planet topics.

72 **Image 72**: Bioregional One Planet Living Logo

73 **Image 73**: Bioregional One Planet Living 10 principles

Further Information

- One Planet Living

Testing during construction

- **Air testing:** It is a set requirement for all buildings to have an **airtest** upon completion as well as diagnostic testing during the construction process to suggest improvements, if required. An airtest at the end leaves minimal options for improvement without significant cost.

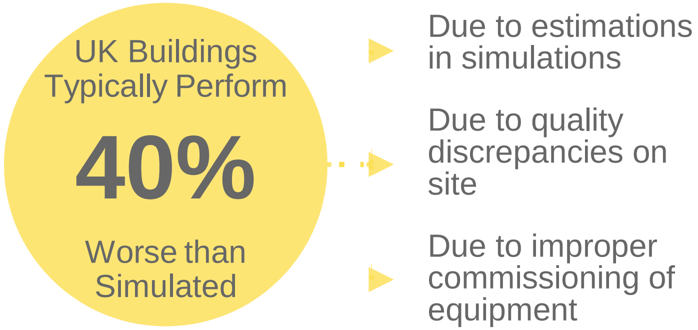
A draughty building doesn't only cost more money to heat, it is also uncomfortable to be in.

The required value for this airtest will depend on the standard the building is set to achieve. The airtest and measured airtightness will be essential in being able to use **MVHR** at this stage or in the future.

74 **Image 74**: Air test during construction

- **Performance testing:** Post completion performance testing is an effective way of ensuring quality in construction, and that targets have been achieved.

It is also possible to undertake performance tests (simulations) for a building in the early stages of design, which can be used to define how the building will perform against how it will work spatially/visually. This is a positive step to ensuring that required/set standards can be achieved.



75 **Image 75**: Performance Gap

Further Information

- [Veritherm](#)
- [UKGBC targets](#)
- [BSRIA Soft Landings Framework](#)

Definitions

- **Airtest:** tests the air leakage through uncontrolled ventilation, for example gaps in walls, between walls, windows, doors or the roof. This provides an indication of how draughty a building is.
- **MVHR:** Mechanical Ventilation with Heat Recovery. This is a key element of energy efficient / Passivhaus buildings with high levels of airtightness.

Best Practice Recommendations

- Carry out an air test on all new buildings and a minimum airtightness reading of 0.6 air changes/hr @ n50 should be achieved.

Handing the building over & monitoring performance

To ensure the handover of a building is smooth, and how the building is used and maintained is understood, a **soft landings** approach is recommended.

Post Occupancy Evaluation (**POE**) of this nature allows for clients/building users to engage with designers/contractors and ensure their building is performing as designed. It highlights any issues in the performance so that these can be addressed and resolved.

Post Occupancy Evaluation: It is important to understand if a building performs as it was designed to do. This often includes:

- Monitoring actual energy use (and consideration to sub metering of different uses such as energy used for heating, hot water, **small power**, lighting and energy generation from renewables.
- Monitoring internal air quality (temperature, **relative humidity**, carbon dioxide), this gives an important indication of user comfort and potential health concerns – for example high levels of carbon dioxide in a school will impact significantly on concentration of pupils.
- User comfort surveys – maybe more use for major projects where the developer could undertake user comfort surveys to assess how occupants find the buildings in terms of their environment but also useability. This can be used to feedback into future projects.

76 **Image 76**: Thermal imaging for POE

Best Practice Recommendations

- All developments shall put in place a recognised monitoring regime to allow the assessment of energy use, indoor air quality and overheating risk and ensure that the information recovered is provided to the owners and the planning authority. Monitoring running and user satisfaction should also be implemented on larger developments.
- All major developments shall implement a soft landings scheme from the outset.

Definitions

- **Soft Landings:** a set of procedures with the aim of passing a building smoothly from the build phase to the occupation phase, ensuring operational needs are fully considered as early as possible in a project
- **POE:** Post Occupancy Evaluation is the process of analysing how a building functions while in use.
- **Small Power:** refers to unregulated energy demand, e.g. socket and appliances energy demand.
- **Relative Humidity:** (RH) The relative amount of water vapour in the air. A healthy indoor space should be between 40% and 60% RH.

Certification

It is important that this is considered and actioned from the outset. There are various methods, services and products available to enable **POE.**

The certification of a development is linked to the chosen standards set out at start that the development intends to achieve. Whilst many standards have levels of accreditation it is important when utilising these to improve the environmental performance that there is an aspiration to achieve the highest rating.

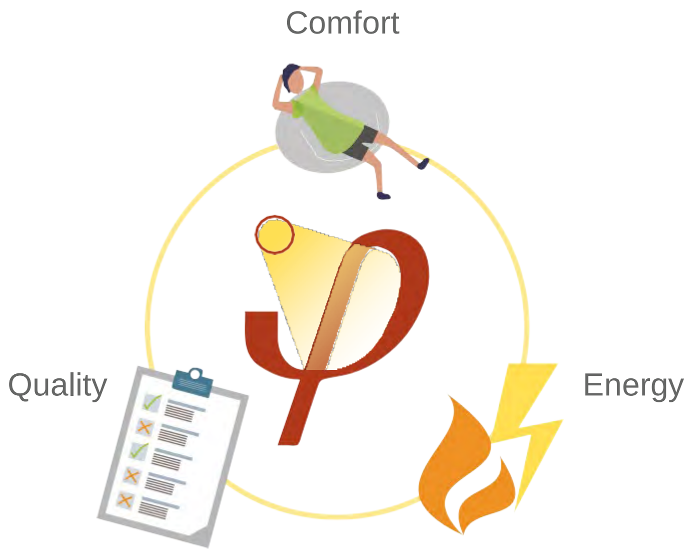


Image 77: Passivhaus Principles

Certifiying a building to the passivhaus standard assures design quality but is also provides quality assurance on site, it is especially good to hold builders to account and ensure a minimum quality is met.

The Passivhaus standard uses a third party to certify the design, construction and commissioning stages. This helps to ensure that buildings are delivered to perform as designed, and achieve the low energy targets.

- **Design quality:** Passivhaus buildings are validated using passivhaus software (PHPP), which creates a detailed energy model. Additionally, Passivhaus designers and certifiers are constantly on the look out for troublesome details - those that result in poor insulation, or make achieving airtightness difficult - in order to design them out of the project.
- **Construction quality:** Passivhaus certifiers act as a second set of eyes on site, ensuring what is designed is what is constructed, and that the quality of workmanship is up to standard.
- **Commissioning quality:** Passivhaus certifiers act as overseers to validate commissioning information for buildings, to ensure it operates as intended.

Best Practice Recommendations

CS1 All developments shall calculate life-cycle carbon emissions (including embodied carbon emissions) with a nationally recognised methodology and demonstrate actions taken to minimise life-cycle carbon emissions.

CS2 A Site Waste Management Plan to be implemented.

CS3 Carry out an air test on all new buildings and a minimum airtightness reading of 0.6 air changes/hr @ n50 should be achieved.

CS4 All developments shall put in place a recognised monitoring regime to allow the assessment of energy use, indoor air quality and overheating risk and ensure that the information recovered is provided to the owners and the planning authority. Monitoring running and user satisfaction should also be implemented on larger developments.

CS7 All major developments shall implement a soft landings scheme from the outset.

Herefordshire Council

Best Practice Summary

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Building Performance

PF1 Prioritise the refurbishment and retrofit of existing buildings where possible. Also, aim to re-use elements of existing buildings if at all possible, for example foundations (subject to structural engineer input), bricks or even floorboards for a new purpose.

PF2 A fabric first and building physics approach to be implemented during all design stages.

PF3 All new building to achieve the Passivhaus Plus Standard, incorporating renewable energy within the design.

PF4 Achieve an air permeability of below $3m^3/h.m^2$ @50pa in all new developments. However an airtightness of $<0.6m^3/h.m^2$ @50pa required for Passivhaus is encouraged. For an airtightness of below $3m^3/h.m^2$ @50pa, this will need to be in combination with a mechanical ventilation heat recovery system.

PF5 All new development to be designed and built to meet CIBSE TM59 overheating standards. Future climate scenario modelling to also be completed. The Good Homes Alliance overheating tool could be used for smaller developments.

PF6 Installation of MVHR in all buildings where possible.

PF7 Target an embodied carbon performance of <750 $kgCO^2e/m^2$ for non-domestic office buildings and <625 $kgCO^2e/m^2$ for domestic buildings, <540 $kgCO^2e/m^2$ for education buildings and <535 $kgCO^2e/m^2$ for retail by 2030 (minimum 40% reduction in embodied carbon compared to the current business as usual benchmarks) by using low carbon materials that are responsibly and ethically sourced.

PF8 Evaluate embodied carbon using the RICS Whole Life Carbon Assessment for the Built Environment professional statement 2017 methodology.

PF9 On projects where Whole Life Carbon assessments are not being undertaken, effort should be made to reduce embodied carbon and quantify the embodied carbon savings achieved.

PF10 Householder Extensions: Consider and implement the 9 householder environmental building considerations.

PF11 Householder Extensions: consider extending the environmental improvements to the existing property, and look to achieve the Passivhaus EnerPHit standard as a whole house approach.

PF12 Consider all 4 Aims when working with a historic building.

Energy Use

EU1 No onsite combustion of fossil fuel for new development.

EU2 All development shall assess the viability of on-site renewable generation and design a strategy to maximise storage.

EU3 Major development shall match total energy demand through a combination of renewable energy generation capacity, energy storage and smart controls.

EU4 Compliance of the evaluation of operational energy shall be demonstrated through performance methods such as the Passivhaus Planning Package (PHPP), CIBSE TM54 or Better Buildings Partnership Design for Performance (2019).

EU5 Offset remaining carbon emissions by contributing to renewable energy projects that will help facilitate decarbonising the national and/or local grid. Alternatively, offset through investment in a retrofit programme, requiring certification to Passivhaus EnerPHit or another agreed target.

External Environment

EN1 Achieve Biodiversity Net Gain across the development.

EN2 Incorporate living roofs as part of the whole sustainable water management strategy, minimising large expanses of flat roof.

EN3 Implement SuDS as the primary drainage solution through Green and Blue Infrastructure.

EN4 Development should not add to surface water run-off and should aim to reduce existing run-off rates and volumes.

EN5 New build residential water efficiency of 75 litres/person/day as a minimum.

EN6 New build non-residential equivalent to BREEAM 3 for water consumption as a minimum.

EN7 Development above householder level to be Air Quality Neutral or better.

Accessibility

AC1 Prioritising pedestrians and cyclists over vehicles; delivering cycling, walking and passenger transport networks.

AC2 Large developments to strengthen existing public transport, cycleways and implement community transport initiatives.

AC3 Non-residential development to provide cycle user showers, changing facilities and secure cycle storage.

AC4 New residential development to provide bike storage for all properties.

AC5 Inclusion of charge points for all residential and visitor parking spaces, and 1 for every 5 cars in non residential.

Construction

CS1 All developments shall calculate life-cycle carbon emissions (including embodied carbon emissions) with a nationally recognised methodology and demonstrate actions taken to minimise life-cycle carbon emissions.

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CS7 All major developments shall implement a soft landings scheme from the outset.

Appendix

Key Points

- To create a functional, diverse and low maintenance SuDS scheme and wetland system adjacent to the existing brook to protect it from stormwater discharge and pollution from the development.
- Existing landscape features were retained and new habitat for wildlife created through the SuDS design.
- Rainwater run-off is collected from the roofs and paved areas via a network of pipes and stored in a rainwater harvesting tank, where it is pumped into the building to flush toilets. This helps reduce the volume of water within the storm water management system, helping to reduce flood risk.
- The SuDS design for the storm water involves a series open swales that feed into a wetland system, with the lower part of this a reed bed. Each treatment stage is separated by gabion baskets, each filtering and cleaning the water before it eventually reaches the existing brook and natural drainage system.

Project Details

- **Project Name:** Kington Medical Practice
- **Landscape Architects:** DSA Environment & Design
- **Engineer:** Couch Consulting Engineers
- **Architects:** West Hart Partnership
- **Main Contractor:** Vinci Construction UK Ltd
- **Completed:** 2012

Image 78:
Swale

Image 79:
Entrance

- The shallow and curvilinear contoured swale design ensured these areas integrate with the overall landscape scheme and allow for easy maintenance.
- All SuDS were future-proofed and designed for a critical 100 year + climate change storm event.
- New planting was, in the main, native along with the grassland and wetlands as part of the storm management system. The wetlands were planted with marginal aquatics. Grassland beyond the wetlands is designed to require less management, creating a 'wet meadow' setting. Finally native shrubs and trees unify the scheme.
- An otter holt was built, along with hazel planted for dormice to further encourage wildlife and are special features of the scheme. Ultimately the biodiversity of the site increased greatly.
- A Landscape Management Plan was conditioned by Herefordshire Council for a minimum of 5 years. This has been successfully implemented and has ensured the scheme developed and continues to perform as intended, playing a vital role in the success of this scheme.
- The reduced need for underground pipes and engineered drainage solutions resulted in cost savings.

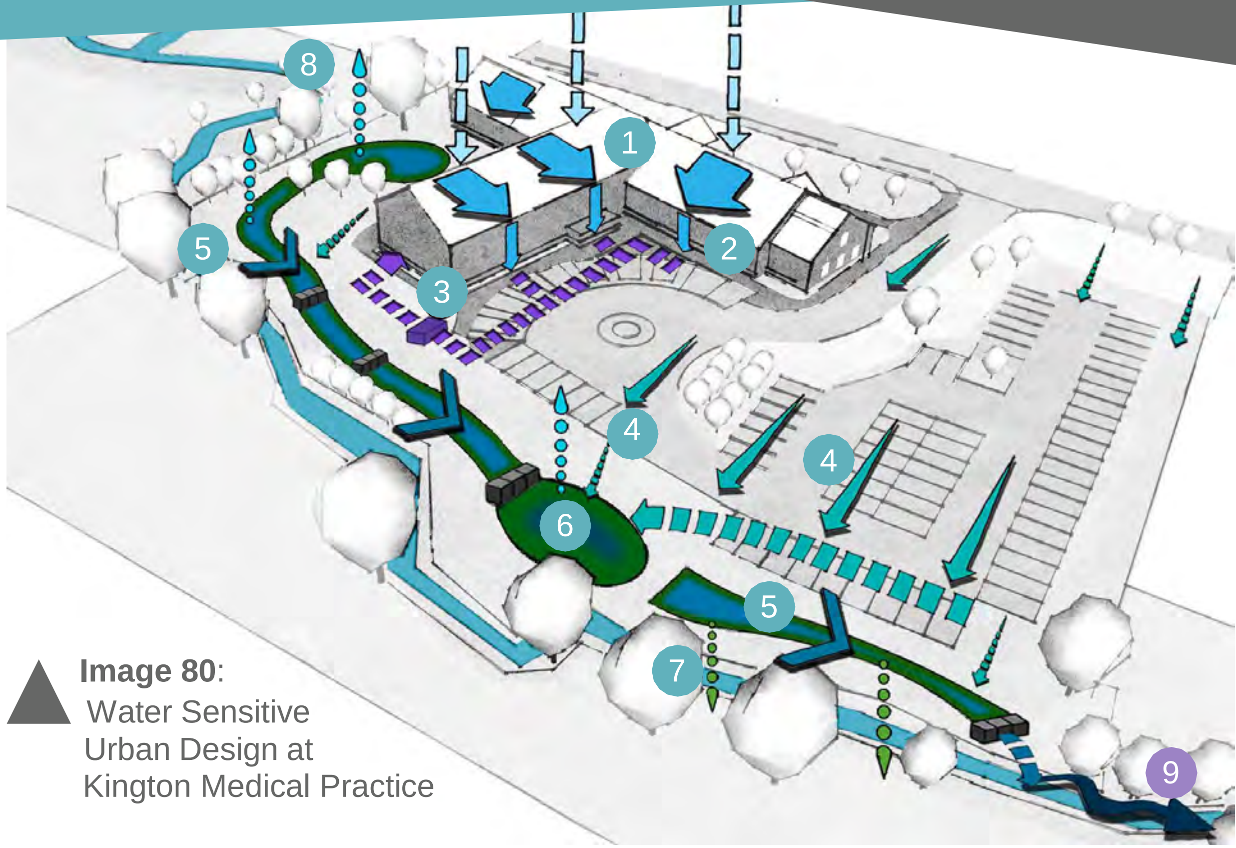

Image 80: Water Sensitive Urban Design at Kington Medical Practice

1. Rainwater collected on rooftop
2. Roof water conveyed via downpipes
3. Roof water harvested and reused as 'greywater' in the building
4. Stormwater collected from hard and soft surfaces and controlled through landscape design
5. Swales convey collected water
6. Water is held, using flow control, in attenuation basins
7. Water is encouraged to infiltrate into the natural ground where it recharges groundwater
8. Plants allow evapotranspiration of water back into the air
9. Controlled outfall into the surrounding drainage system

Project Details

- **Project Name:** Beacon View, Colwall
- **Architects:** Architype
- **Engineer:** Andrew Collinson
- **Mechanical & Electrical Consultant:** Alan Clarke
- **Landscape Architects:** Reckless Orchard Landscape Consultants
- **Contractor:** Mike Whitfield Construction
- **Completed:** 2021

Image 81: Entrance

Image 82: Green Roof

Key Points

- 3 detached Passivhaus homes that include a PV array, ASHP and MVHR unit
- Position of houses was to enable as much of the footprint of the existing house to be reused, retain an established mature oak tree and orientate the houses to maximise solar gains
- The houses are low in embodied carbon with timber frames, recycled newspaper insulation along with triple glazed windows and doors
- Bicycle storage is incorporated into the house layouts
- The scheme embraces a sustainable drainage strategy using permeable hard surfacing materials with an attenuation pond in the rear field

Image 83: Rear Elevation

Project Details

- **Project Name:** Wahroonga, Ledbury
- **Architect:** Janet Cotterell (CT & T architects, London & Passivhaus Homes)
- **Energy Consultants:** Nick Grant & Alan Clarke
- **Contractor:** Mike Whitfield Construction Ltd
- **Completed:** 2012

Image 84:
Front Elevation

Image 85:
Rear Elevation

Key Points

- A detached family home built to the Passivhaus standard
- The property has a highly insulated timber frame using sheepswool and recycled newspaper insulation.
- Certified Passivhaus windows and doors were used
- Natural daylight is emphasised with dual aspect daylighting in each room
- The specification includes: water saving and A+ rated appliances, micro-bore hot-water piping and low energy lighting throughout,
- 5sqm of solar thermal panels for hot water heating are included on the reclaimed Welsh slate South East facing roof

Image 86:
Interior View

Project Details

- **Project Name:** Hope View House, Malvern
- **Architects:** Warren Benbow
- **Energy Consultants:** Nick Grant & Alan Clarke
- **Engineer:** Allan Pearce
- **Contractor:** Covenhope Construction Ltd
- **Completed:** 2017

Image 87: Interior View, Passivhaus Trust

Image 88: Exterior View, Passivhaus Trust

Key Points

- Built on a steeply sloping site in an AONB, Hope View is designed to be a part of and sit within the landscape, nestling into the contours.
- There are three key components to the concept: trees, meadow, house. The upper part of the site has been planted by the clients with over 1200 deciduous trees, whilst the lower part of the site has been replanted as wildflower meadow and orchard.
- An attenuation pond and swales were designed within the landscape to deal with the surface water drainage.
- The property is Passivhaus, with an MVHR unit installed for ventilation and high levels of insulation.
- All living space faces south, benefiting from views and natural daylight with summer solar gains controlled by the inclusion of a continuous covered walkway, creating a large overhang in front of the windows.
- A PV array generates electricity, with a GSHP installed for heating (supplied underfloor) and hot water and. The soakaway drainage field from the sewage treatment plant passes through the GSHP drainage field to add extra “energy” into the ground.
- The stone on the south facing elevation was locally sourced.

Project Details

- **Project Name:** Grove Cottage, Hereford
- **Architects:** Simmonds Mills
- **Energy Consultant:** David Oliver
- **Mechanical & Electrical Consultants:** Alan Clarke, Peter Warm
- **Engineer:** Bob Johnson
- **Contractor:** Eco-DC
- **Completed:** 2009

Image 89: Front Elevation

Image 90: Rear Elevation

Key Points

- The first sustainably renovated property to be certified to the EnerPHit standard in the UK.
- Although improvement measures were applied to the whole property the approach was to ensure the front elevation would retain as much of the original character as possible to demonstrate how energy efficient measures can be applied without impacting on the original architecture. The rear elevation moves away from this idea, focussing on a design to benefit from solar gains and daylighting and include a new extension.
- Daylighting to all rooms displaces the need for electric lighting. Daylight is maximised through careful sizing and design of windows and internal colour scheme. Some windows have splayed reveals which increases light distribution and levels.
- The existing building is insulated externally with either a render or western red cedar cladding from a local woodland and processed by a local sawmill.
- Reclaimed and FSC certified timber was used, along with the reuse of roofing slates and inclusion of extensive living roofs to improve biodiversity.
- Water-efficient appliances and sanitaryware were installed along with a PV array.

Project Details

- **Project Name:** Twyford Barn, Twyford
- **Architects:** Architype
- **Engineer:** Roger Gell
- **Water & Energy Consultant:** Elemental Solutions
- **Contractor:** Mike Whitfield Construction Ltd
- **Completed:** 2006

Image 91:
Exterior View, ©Architype

Image 92:
Interior View,
©LeighSimpsonPhotographer

Key Points

- An existing set of barn buildings converted into a sustainable work place
- Locally sourced and healthy materials were used inside and out with local chestnut for interior timber along with natural paints and stains and Douglas Fir cladding externally with the original stone, reclaimed and revived
- The building is designed with water efficiency at the heart and includes an airflush toilet system
- A biomass boiler is installed for hot water and heating, due to the remote location and available space.
- The landscaping is designed to blend with the natural setting and extend local biodiversity.

Image 93:
Cladding Materials,
©LeighSimpsonPhotographer

Project Details

- **Project Name:** Portfield Street, Hereford
- **Architects:** Simmonds Mills Architects
- **Engineer:** BJSE
- **Contractor:** Alzeco Build
- **Completed:** 2021

Image 94: Rear Elevation

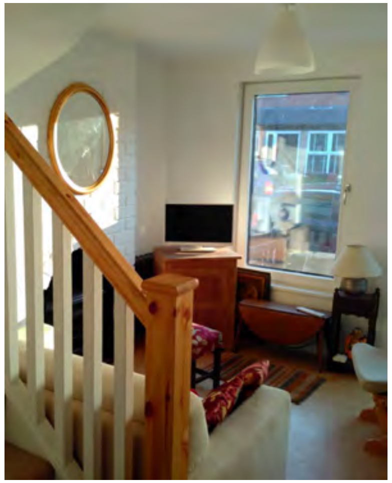

Image 95: Living Space

Image 96: Rear Elevation

Key Points

- Residential extension and renovation project to improve the energy efficiency of an existing end of terrace property
- During design and construction decisions were made to minimise waste, with existing materials reused where possible. Timber removed from the existing house was denailed, salvaged and stored for reuse
- Existing finishes were also retained where possible, old surfaces cleaned and repaired, cracked lime plaster ceilings repaired rather than replaced, wall lime plaster cleaned with internal wall insulation installed over
- The PHribbon, a programme that can be added to the PHPP software was used to complete a lifetime carbon analysis. Decisions were made to reduce embodied carbon including the use of SIPS panels which were 60% recycled feedstock from the food industry, galvanised ground screws instead of concrete foundations, internal wall insulation made from corn starch bound silicate boards, recycled newspaper insulation to the attic and a rainscreen cladding chosen that precluded the need for exterior roof and wall breather membranes

Project Details

- **Project Name:** Staunton-on-Wye Endowed Primary School
- **Architects:** Architype
- **Mechanical & Electrical Consultant:** Ernest Griffiths
- **Engineer:** Ramboll
- **Landscape Architect:** Hannah Genders Landscape and Planting Design
- **Contractor:** Thomas Vale Construction Plc
- **Completed:** 2010

Image 97: Exterior View, ©LeighSimpsonPhotographer

Image 98: Hall, ©LeighSimpsonPhotographer

Key Points

- The design reflects the eco-friendly ethos of the school community, with sustainability embedded within their curriculum
- A biomass boiler provides heating and hot water
- The building is constructed from a simple and robust palette of natural materials, including local stone, timber cladding, timber windows & doors and green roofs externally, and timber screens, natural linoleum, and organic paints and stains, internally.
- The design achieves good day lighting levels and cross ventilated air flow throughout the building whilst minimising heat gains. Overheating is controlled by the angle and location of the glazing and by the roof overhang on the South.
- The external fabric of the building is highly insulated with good air-tightness and minimal cold bridging to reduce heat losses and therefore minimise the heat input required to create a comfortable, low energy building.

Project Details

- **Project Name:** Hereford Archive & Records Centre, Rotherwas, Hereford (HARC)
- **Architects:** Architype
- **Mechanical & Electrical Consultants:** E3 Consulting Engineers
- **Conservation Physics & Energy Consultant:** Elemental Solutions
- **Engineer:** Eastwood & Partners Consulting Engineers
- **Landscape Architect:** Churchman Landscape Architects
- **Contractor:** Kier
- **Completed:** 2015

Key Points

- The UK's first archival storage to be built to the Passivhaus standard
- Solar gain is controlled using brise soleil and the highly insulated building fabric. Lighting loads are control by a combination of switching, daylight and absence control.

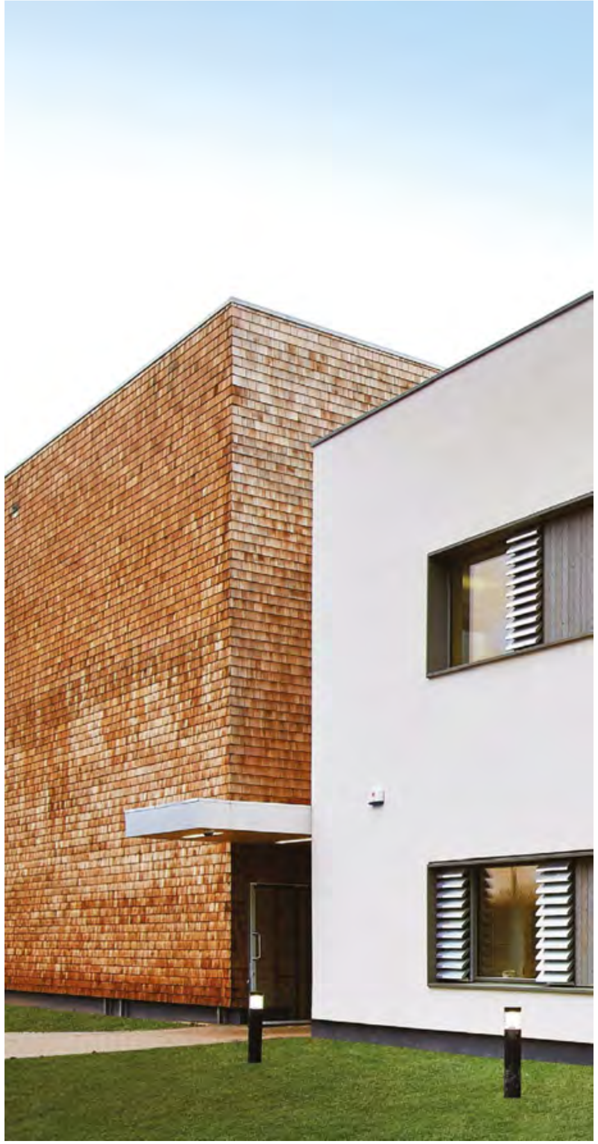

Image 99:
Entrance, ©KierConstruction

Image 100:
Atrium, ©KierConstruction

- The stringent fire safety demands of the building required the core to be concrete, with the remaining building timber frame. However, the fabric first approach, with high levels of insulation has led to an estimated 60-70% reduction in operational energy and carbon
- Summer ventilation is controlled by users who can open windows and insulated secure louvres. Cross ventilation into the atrium space via attenuated air paths is drawn by stack effect through actuator controlled high level openings. This also provides night purge cooling, supplemented if required by mechanical ventilation, to further drive down running costs.
- The landscape design includes areas such as wildflower meadows to increase biodiversity along with a ditch on two elevations that attenuate the site surface runoff whilst also providing a natural habitat
- Located to provide a civic presence to Holme Lacy Road, the site is sustainably accessible, by bus, bike and foot via the sustrans/connect2 bridge over the River Wye

Image 101:
Storage, ©KierConstruction

Image 102 :Internal Entrance, ©KierConstruction

Project Details

- **Project Name:** Garway Village Hall, Garway
- **Architects:** Simmonds.Mills Architects
- **Energy Consultant:** Alan Clarke, Infrastruct
- **Engineer:** BJSE
- **Contractor:** William Powell and Sons
- **Completed:** 2018

Image 103: Exterior View, ©William Powell

Key Points

- A Passivhaus certified community centre, providing manyfunctions for the village including a large multi-functional hall with full stage / green room etc; an outreach medical centre; a cafe/bar and part-time post-office
- The building is constructed using a glulam frame, with exposed timber and insulated using blown mineral fibreinsulation.
- A mix of timber cladding and render is used externally with a PV array on a galvanised steel roof, the later paying reference to the rural context and the old hall. APV array is installed on the south facing roof.
- To minimise surface run-off, porous surfaces, including inthe parking area, were specified.

Image 104: **Garway Hall, ©William Powell**

Project Details

- **Project Name:** Larch Corner Passivhaus, Warwickshire
- **Architects:** LEAP
- **Passivhaus Consultant:** Alan Clarke
- **Engineer:** Tribus, Airey and Coles
- **Contractor:** Mac Eye Projects
- **Completed:** 2018

Image 105:
Living Roof and PV Array, Passivhaus Trust

Further Information

- 2021 UK Passivhaus Awards
- 2020 ASBP Awards Finalist
- Desirable Homes Webinar

Building performance

- **Form Factor:** Improved from original planning submission design, which was overly complex. Reduced to a smaller form factor of 3.9 (although it is worth noting this reduction was limited by project constraints, and therefore is still high and not best practice).
- **Daylighting:** Optimal window size was calculated to improve thermal performance, while maintaining sufficient daylighting, leading to a reduction in window size from the original planning design.
- **Overheating:** Indoor and outdoor temperatures were measured over a 12 month period. The living room was over 25 degrees Celsius 10% of the time. PHPP suggests 9%, however good practice is less than 5%.
- **MVHR:** Includes Mechanical Ventilation with Heat Recovery (MVHR).
- **Superinsulation:** ~360mm thick wood-fibre insulation between timber I-beams and an additional 80mm insulation on top.
- **Airtightness:** 12 x more airtight than required by Passivhaus and 244 x more airtight than Building Regulations, with a record-breaking airtightness result of 0.047ach@50pa. Larch Corner is one of the UK's most airtight dwellings, with the equivalent leakage area fitting on a 1-penny coin.
- **Natural Materials:** In addition to the use of timber throughout the project, Larch Corner also used low VOC (volatile organic compound) finishes including wood wax.
- **RIBA 2030 Climate Challenge:** Embodied carbon at 383.1kgCO^2/m^2. Larch Corner exports energy, but operational energy is over the 2030 target at 43kwh/m^2/year. LEAP didn't remove the exported energy from operational energy.
- **Sustainability Standards:** Certified Passivhaus
- **Performance Gap:** Reduced to 0. The calculated heating demand was 14kwh/m^2/annum and the heating consumption in reality was = 14kwh/m^2/annum.

Image 106:
Entrance, Passivhaus Trust

Image 107:
Exposed CLT Interior, Passivhaus Trust

Energy Use

- **Heat Pumps:** Air Source Heat Pump
- **Renewable Energy:** 9.3 kWp photovoltaic array means the house generates more energy than required.

External Environment

- **Living Roof or Wall:** Green Roof

Accessibility

- **Accessible by All:** Wide corridors and level access from the parking area to the house (with the house all one level), so Larch Corner is accessible to all, including prams and wheelchairs. It is also future-proofed as can be adapted to different uses, Bed within storage wall. Electrical car charger is included, and was accounted for in the operational energy consumption calculation.

Construction

- **Lifecycle Carbon:** Cellulose/ sustainably sourced timber products are utilised throughout. The adoption of an all-timber construction over more traditional masonry has resulted in a reduction in embodied carbon of 40%.
- **Minimising Construction Waste:** Constructed using cross laminated timber (CLT) which is prefabricated. Whilst CLT is quick to erect, on a project of this scale, timber I-beams would have been preferable as they make more efficient use of resources.

Image 108:
Celebrating Air Test Result, Passivhaus Trust

Project Details

- **Project Name:** Goldsmith Street, Norfolk
- **Architects:** Mikhail Riches with Cathy Hawley
- **Passivhaus Consultant:** Warm
- **Engineer:** (Structural) Rossi Long Consulting, (M&E) Greengauge
- **Contractor:** RG Carter
- **Completed:** 2019

Image 109:
Street Presence, Passivhaus Plus

Further Information

- RIBA Stirling Prize 2019
- Mikhail Riches: Goldsmith Street
- Passivhaus Plus: Goldsmith Street

Building performance

- **Form Factor:** From between 2.66 to 2.85.
- **Orientation for Solar Gains:** All houses and flats face South, with a 15-degree roof pitch allowing winter sun to hit the homes' south-facing façades to provide passive heating. Brise-soleil above windows and doorways shade the south facing windows in summer.
- **Fabric First:** Walls are 600mm thick, superinsulated, to reduce heat loss. The subsequent larger depth window sills double up as interior seats.
- **Window Design:** Windows are modestly sized to reduce heat loss in winter and heat gain in summer. The facade includes larger surrounds to the windows to maintain the desired proportions.

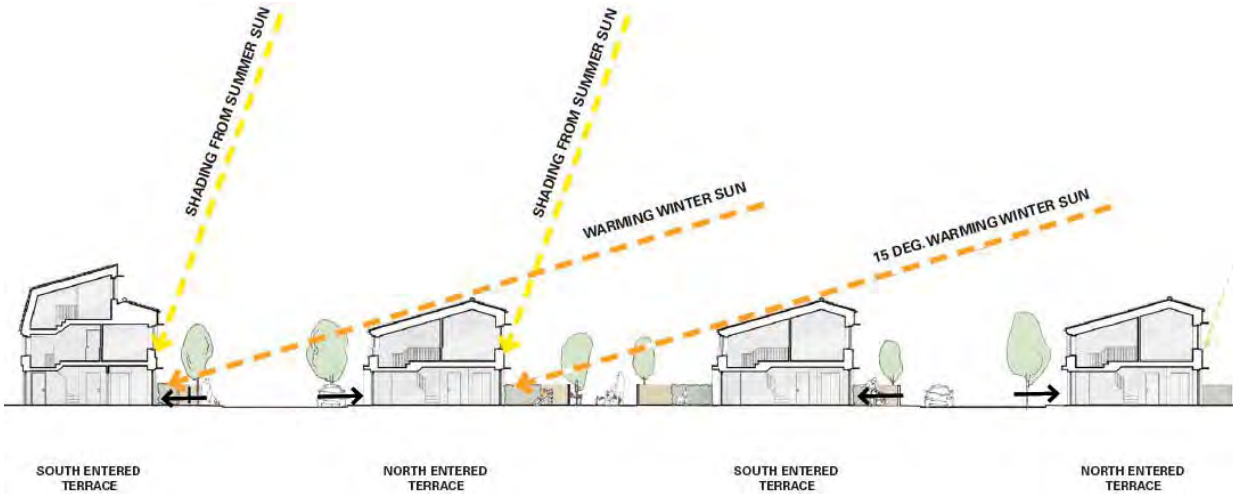

Image 110:
Roof/Shading Design, Passivhaus Plus

Image 111:
Central Landscaped Space, Passivhaus Plus

Image 112:
Secure 'Alleyway', Passivhaus Plus

Building performance

- **Airtightness / Air Tests:** Three air tests were carried out on each dwelling: the first when Cygnum completed their installation, the second after building services and windows were fitted, and the third on practical completion. The worst score was 0.63 ACH, the best 0.39 ACH.
- **Sustainability Standards:** On target to achieve full 'Passivhaus' Certification and understood to be the largest social housing scheme in the UK to achieve Passivhaus.

Energy Use

- **Renewable Energy:** There is scope for solar photovoltaic (PV) panels to be added to the south-facing pitches in the future, to bring the energy performance of the homes close to 'net zero carbon'.

External Environment

- **Landscaping:** Existing green links are to be reinforced with a landscape scheme which extends beyond the boundaries of the site to include local roads and a park. A wild flower meadow is included in he central landscaped space.

Accessibility

- **Accessible by All:** There is a wide pedestrianised 'alleyway' which only key holders (residents) can access, with benches and planting, as well as other outdoor play spaces and landscaped areas which are accessible without crossing busy streets.
- **Bicycle Parking:** Each has a front door on to the street, a staircase and a ground-floor lobby for prams or bikes. Car parking is provided on the street, but there is a 20mph speed limit, so pedestrians are prioritised.

Construction

- **Locally Sourced Materials:** Interlocking clay pantile, grey facing brick and buff facing brick from Crest Brick Slate & Tile Ltd. East Yorkshire, with highly insulated timber frame structure by Cygnum, Suffolk. These materials reference the local area architecturally and provide the qualities needed to reach the Passivhaus standard - In addition, they are sourced from UK suppliers which reduces embodied carbon associated with transporting materials from further afield.

Project Details

- **Project Name:** Bicester Eco
- Business Centre, Oxfordshire
- **Architects:** Architype
- **Passivhaus Consultant:** WARM
- **Engineer:** Price & Myers LLP
- **Contractor:** Kier Construction
- **Completed:** 2018

Image 113:
Exterior View, ©KierConstruction

Further Information

- Passivhaus Trust: Bicester Eco Business Centre

Building performance

- **Sustainability Standards:** The UK's first non-domestic building to achieve Passivhaus Plus standard. BREEAM excellent.
- **Natural Materials:** Timber used in the wall build up (larson-truss infill panels), fins and internal finishes. Insulated with Warmcell. Hygroscopic walls and non-toxic bio-based materials. Low in Volatile Organic Compounds (VOC's).
- **Form Factor:** This 3-storey rectangular form has an efficient form factor, and its simplicity made it easier to achieve continuous insulation, minimising thermal bridges.
- **Airtightness / Air Tests:** Air test result of 0.59ach. The airtightness layer is located on the inside of the thermal envelope. The main building entrance is designed with a double door lobby to help minimise excessive heat losses. Learning from their previous Passivhaus scheme, Keir designated an on-site airtightness champion. Frequent site meetings between contractors, designers and consultants helped both to plan and minimise service penetrations through the building fabric, and also to optimise construction sequencing to assure airtightness details.
- **Daylighting:** Triple height top-lit atrium space, allowing daylight into the depth of the plan, and reducing excessive use of artificial light and energy.
- **Overheating:** The shading system of vertical timber fins and horizontal brise soleil (to the south facade) allows the building to have generous amounts of glazing affording natural daylighting whilst controlling the risk of overheating. Exposed internal concrete provide thermal mass to help the building regulate its thermal environment.

Energy Use

- **Heating:** Heat is supplied from the local direct gas district heating system which is located across the road.
- **Sustainable Lighting:** Lighting is provided with solar post lights which will guide users along paths and signify the car park entrance.

Image 114:
Rooftop Solar Panels, ©Jack Hobhouse

Image 115:
Landscaping, ©Jack Hobhouse

Energy Use

- **Renewables:** Whole roof is covered in PV panels. The balcony areas create additional roof area to maximise solar PV panel coverage.

External Environment

- **Sustainable Drainage:** SUDS strategy promotes the sustainable re-use of water and the gradual soakaway of surface water. The use of a loose gravel helps soften the building edge, whilst also providing a valuable drip line for the building. Levels are designed to allow surface water to filtrate into the planted areas where possible.
- **Landscaping:** The planting scheme is intended to add to the biodiversity of the surrounding area, improve the visual appearance of the site and add to its character. A number of native plant species have been selected alongside ornamental varieties.
- **Biodiversity:** The planting will provide habit for insects and nectar for bees through the flowering species. Linking to the existing planting along Pippin Street also helps to extend the green corridor.
- **Reducing Water Consumption:** Allowing water to permeate into the planting beds and using a gravel mulch to retain the water in hot and dry periods negates the need for automatic irrigation and using piped water.

Accessibility

- **Accessible to All:** Responds to duties under the Equality Act 2010, the requirements of Building Regulations, Approved Document M (ADM) and relevant local planning policy. This is supplemented by reference to BS8300:2009 Design of Buildings and their approaches, to meet the needs of disabled people.
- **Accessible Circulation**: The proposal designs out the need for internal/external ramps, with gradients that offer safe access for all users of the building. Corridor widths meet requirements set out within the Building Regulations. The stair, lift car size and clear manoeuvring space is designed to comply with ADM. Opening pressures, 300mm clear to leading edge, ironmongery, vision panels & manifestation all enable easy use of the building by all users.

Image 116:
Interior View, ©KierConstruction

Image 117:
Bicycle Parking, ©Jack Hobhouse

Accessibility

- **Accessible Sanitary Facilities:** Consistent location on each floor ensures ease of access and orientation within the building. All areas of the building are within 40m horizontal travel of wheelchair accessible provision on the same floor, and wheelchair accessible WC layouts are handed on alternate floors to allow for choice of left or right handed transfer as suited to individual needs.
- **Accessible Fixtures:** Fire alarms emit visual and audible signals to warn occupants with hearing or visual impairments. Ironmongery selected to be suitable for operation with limited dexterity.
- **Disabled Parking spaces:** 2 of 21 parking spaces are disabled bays, located close to the building main entrance, with clear level access.
- **Electric Vehicle Charge Points:** Electric charging points within the car park will promote the use of green vehicles within the site.
- **Public Transport:** A new bus service connects Bicester Town Centre, train stations, residential areas and the Local Centre.The bus stop serving the Local Centre is situated immediately outside the Eco Business Centre. A Real Time Information system within the building, promotes bus usage and enables people to plan journeys more efficiently.
- **Bicycle Parking:** 22no. covered cycle parking spaces, including a minimum of 13no. to be dedicated for use by staff of the Eco Business Centre, and the remaining available for visitor and general public use. Showers, changing facilities, and lockers provided for cyclists.

Construction

- **Sustainable Construction:** Contractors issued an Environmental Policy Statement to reduce carbon emissions, prevent pollution, reduce waste, conserve water, enhance biodiversity, use benign materials and minimise travel. They also recieved positive audits by the Considerate Constructors scheme.
- **Net Zero Carbon:** Passivhaus Plus certified, and therefore produces as much energy as it consumes (net zero carbon in use).

Introduction

On 8th March 2019, Herefordshire Council unanimously passed a motion declaring a Climate Emergency. This signalled a commitment to ensuring that the council considers tackling climate change in its future work and decisions taken. With this resolution came a county-wide aspiration to be zero carbon by 2030. From a planning perspective, it is therefore imperative that the council needs to demonstrate explicitly how the policies relating to climate in the adopted Core Strategy, SS7 and SD1, are being fully taken into account in the decision making process.

Policy SS7 sets out how the Plan will seek to address the impact that new development in Herefordshire has on climate change. It outlines how development proposals will be required to include measures to mitigate their impact on climate change at both a strategic level and through its design requirements for new developments.

Policy SD1 and its supporting text set out how new development will have to incorporate sustainability measures, and give consideration to climate change impacts through design. Alongside other aspects of sustainable design, in terms of climate change impacts, development proposals should incorporate the following requirements:

- utilise physical sustainability measures that include, in particular, orientation of buildings, the provision of water conservation measures, storage for bicycles and waste including provision for recycling, and enabling renewable energy and energy conservation infrastructure;
- where possible, on-site renewable energy generation should also be incorporated;

The policy’s supporting paragraphs 5.3.31-5.3.33 elaborate on how this will be applied:

5.3.31 : All developments must demonstrate how they have been designed and how they have incorporated measures to make them resilient to climate change in respect of carbon reduction, water efficiency and flood risk. Carbon reduction should influence design from the outset by ensuring the fabric of the building is as energy efficient as possible, for example, attaining thermal efficiencies through construction that achieves low U values and fuel effciencies through the use of services such as effcient boilers. Good site planning can also aid greater energy effciency in new development, for example, by seeking to maximise solar gain.

5.3.32 : Revisions to the Building Regulations are introducing progressive increases in the energy efficiency requirements for new buildings. In terms of energy conservation, developments in sustainable locations that achieve accredited standards of energy conservation which cover a range of sustainability criteria will be supported, particularly where the level achieved materially exceeds the relevant Building Regulations and other relevant standards in place at the time.

5.3.33 : Large-scale developments should demonstrate how opportunities for on-site renewable energy generation and sustainable waste management have also been considered and addressed within the design of the scheme. Such details should include an appraisal of all suitable renewable energy technology. Other developments will also be encouraged to consider whether on-site renewable energy opportunities might be available. Alongside this, the council supports the provision of renewable and low carbon technologies within existing developments, subject to such proposals according with other policies of the Core Strategy.

This checklist has been prepared in order for applicants to demonstrate to decision makers that the policies have been complied with, in that sustainability measures have been incorporated in development proposals where possible. It should be submitted by the applicant as supporting evidence of compliance with the climate change mitigation criteria of policy SD1, supporting the objectives of policy SS7. In the event of non-compliance, sufficient justification would need to be provided as to why this is necessary. In the absence of this, the application will be refused on the grounds of being contrary to policy SD1.

All applications for all new build development (or at Reserved Matters stage if applicable) will need to submit information in the below table(s).

For clarification, the definitions of different development types are listed below:

- Minor scale housing development = 1-9 dwellings.
- Minor non-residental development = under 1000sqm.
- Major scale housing proposals = over 10+ dwellings.
- Large scale non-residential development = 1000sqm and above floor space.

Environmental Building Standards. Sustainability elements considered.	Tick where incorporated	Further details required
Building performance		
Site Context, topography and existing built and natural environment. Has the scheme considered the context of area from an energy perspective? Considered the shadowing from topography and existing buildings. Has there been analysis of prevailing winds, light quality, sun paths and locate climate, to create pleasant spaces between buildings?		
Has the scheme considered **optimising the massing of the building**, to ensure an efficient building design and placement. Has the scheme utilised the **form factor calculator** to assess the efficiency of development form?		
Orientation of scheme/solar gains. Has the scheme been located and orientated to maximise natural shading and solar gains? *Room design, position on site, window placement/design should be considered*.		
Has careful consideration been given to the **window design**, including placement, window frames and openings, proportion and specification to maximise solar gains/ daylight but minimise overheating?		
Has the scheme considered measures to **minimise overheating**, through use of thermal mass, shading mechanisms and window design? Has there been a review for the risk of overheating?		
Does the scheme include **mechanical ventilation with heat recovery**?		
Does the scheme include **natural ventilation** to all rooms?		
Has the scheme considered a **Fabric First approach** in its design and construction?		
Insulation. Does the development use **thermally efficient materials**?		
Has the development been designed to ensure **continuous insulation** can be installed externally, to minimise thermal loss? **& will it be detailed to minimise draughts**?		
Has the scheme considered **airtightness** in its design/construction? Has an airtightness target been set? If so what is this?		

Environmental Building Standards. Sustainability elements considered.	Tick where incorporated	Further details required
Will the scheme carry out an **air test** during and once the development is constructed?		
Has the development considered **using natural materials, finishes and fibres in its internal finishes and construction**?		
Has the scheme prioritised the **refurbishment and retrofit** of buildings where possible?		
Has consideration been given to the sustainability of building materials and their impact on the environment and **embodied carbon**?		
Has the embodied carbon in the scheme been assessed or will it be assessed, by using the **RICS whole life carbon assessment**?		
Does the scheme aim to meet the standards set out in the **RIBA 2030 climate change metrics** for buildings?		
Does the scheme aim to meet any other standards? If so, please detail.		
Will the scheme carry out a post occupancy evaluation and in use monitoring to assess the **buildings real life performance**?		
Energy Use		
Does the scheme include onsite combustion of fossil fuels, If so please explain why.		
Does the development include **efficient services -** does the scheme include energy efficient mechanical and electrical systems including LED lights, fittings and appliances?		
Renewable energy. Has the scheme included **solar PV or wind generation**?		
Heating. Are heat recovery systems included in the scheme? If so please explain.		
Renewable energy. Has the scheme included **solar thermal panels**?		
Renewable energy. Has the scheme included **heat pumps**? If so, which type? And does this meet all heating and hot water requirements?		

Environmental Building Standards. Sustainability elements considered.	Tick where incorporated	Further details required
Renewable energy. Has the scheme included **Biomass**?		
Has the scheme included **alternative low carbon heating systems such as hydrogen cells**?		
Does the scheme maximise **renewable energy through decentralised sources -** on site generation, community led initiatives and low and zero carbon technologies?		
What percentage of total site energy demand is produced from **on-site renewables**, in order to reduce dependence on carbon emitting sources?		
Has the scheme carried out **whole life cycle carbon and cost assessments**, assessing embodied carbon and operational carbon?		
What measures has the scheme used to **reduce the development's need for operational energy** above those mentioned in earlier sections?		
What other measures has the scheme used to improve the **energy efficiency** of the development that should be mentioned?		
External Environment		
Landscaping. Does the scheme consider landscaping to encourage new and enhance existing habitat/ biodiversity? i.e. wildflower meadows/wetlands/ bat boxes/marshes/local tree planting, establishing green corridors, integration of sustainable drainage systems.		
Has the scheme set out measures to achieve **Biodiversity Net Gain across the development**?		
Has provision been made to **minimise any impact on landscape** i.e. tree and hedgerow protection.		
Has **multifunctional green and blue infrastructure** been included in the scheme? If so, please explain.		
Does the scheme have a **living roof or wall**?		
Does the scheme include measures to reduce surface water runoff? Is **sustainable drainage** a part of the water management strategy?		

Environmental Building Standards. Sustainability elements considered.	Tick where incorporated	Further details required
Has the scheme included **rainwater harvesting** systems? i.e. water butts		
Does the scheme have provision for **greywater recycling**?		
Has the building been designed to include measures to **reduce water consumption**? i.e. low flush WC's		
Does the scheme have **provision for recycling / waste storage / composting**?		
Does the scheme include measures to **minimise light, water, noise, air pollution** during its use?		
Accessibility		
Does the scheme have provision for **secure bicycle parking/storage**?		
Does the scheme have provision for **EV charging onsite**? What percentage of parking spaces have EV charging?		
Does the scheme have access nearby to **public EV charge points**?		
Does the scheme have access nearby to **bicycle hire (i.e Beryl bikes)**?		
Does the scheme have access nearby to a **car share**?		
Does the scheme have access nearby to **public transport**?		
Does the scheme have access nearby to **community car share/ bike hire**?		
Is the scheme **accessible** by all?		
Construction		
How does the scheme intend to **minimise construction waste**?		
Will the scheme **reuse building materials (where possible) during the construction process**?		
Will **locally sourced materials** be used in the development?		
Does the scheme **calculate life cycle carbon emissions**?		
Will the scheme include a **site waste management plan, to minimise environmental impact from construction activities**?		

Planning Application No:	
Site/ Address of Proposal:	
Brief description of proposal:	
Type of application:	
Date:	

Introduction

The aim of the sustainability statement is for household developments to detail how they have considered sustainability throughout the development lifespan of their scheme, and how this intends to meet the highest standards of sustainable design and construction. A sustainability statement demonstrates how a scheme will address Core Strategy policies and guidance around sustainability, as set by the local authority.

The questions set out are for the applicant/agent to demonstrate where possible, how they will address specific topics set out in the chapters of the Environmental Building Standards SPD. The template is divided into five chapters, Building Performance, Energy Use, External Environment, Accessibility and Construction. There is a breakdown of questions for each of the sections, it is expected that the applicant/ agent will provide a response with the necessary amount of detail included. The applicant/agent can cross-reference any relevant studies/ plans and assessments to support their responses.

This template is expected to be updated and amended following following the Local Plan revision; the updated version is expected to set out local performance targets.

Please can the applicant/ agent provide their responses in the boxes below.

A	**Building Performance:** Has the scheme considered the orientation to maximise solar gains and natural shading? Does the scheme use thermally efficient materials and is it appropriately insulated? Does the scheme address airtightness and ventilation, both natural and mechanical? Has consideration been given to the sustainability of building materials and their impact on the environment and embodied carbon?
Where appropriate please provide responses to questions here.	
B	**Energy Use:** Does the scheme include onsite renewable energy generation? Does the scheme include efficient services, fixtures and fittings? Is there a low carbon heating system included in the scheme?
Where appropriate please provide responses to questions here.	
C	**External Environment:** Does the scheme include landscaping to enhance habitat and biodiversity of the site? Does the scheme have green roofs/walls? Does the scheme included sustainable drainage to reduce water run off? Does it include rainwater or greywater recycling systems? Has provision been made for household recycling/ waste storage/ composting?
Where appropriate please provide responses to questions here.	
D	**Accessibility:** Does the scheme provide cycle storage and EV charging points?
Where appropriate please provide responses to questions here.	
E	**Construction:** Will the scheme include measures to minimise construction waste in the build process? Does the scheme include measures to reduce light, water, noise or air pollution? Have features been included to monitor the building's efficiency once complete?
Where appropriate please provide responses to questions here.	