Broxtowe Borough Council & Nottingham City Council:

Reduction of Carbon in New Development

Supplementary Planning Document

June 2025

Nottingham City Council

Broxtowe Borough Council

CN28 Carbon Neutral Nottingham 2028

Climate Change & Green Futures

Produced in collaboration with Bioregional and Edgars.

Contents

chapter one
Introduction

1 Broxtowe Borough Council (BBC) and Nottingham City Council (NCC) are seeking to reduce energy demand, improve the energy efficiency and the use of renewable energy in new developments in their areas. To support existing Local Plan policy for BBC and NCC a *Reduction of Carbon in New Development Supplementary Planning Document* (SPD) has been created to provide more detailed guidance on how development can lower carbon emissions.

2 Nottingham City Council declared a climate and ecological emergency in 2019 and Broxtowe Borough Council declared a climate emergency also in 2019. Both Councils have since prepared strategies which set carbon reduction priorities within the Council areas. NCC along with partners set an ambition to be the first carbon neutral city in the UK by 2028, and this goal is known as Carbon Neutral Nottingham 2028, or CN28. Broxtowe Borough have prepared a Climate Change and Green Futures Strategy which sets carbon reduction priorities within the Council.

3 Under the Greater Nottingham Aligned Core Strategies Part 1 Local Plan, **all development proposals will be expected to mitigate against and adapt to climate change and comply with national and contribute to local targets on reducing carbon emissions and energy use**, unless it can be demonstrated that compliance with the policy is not viable or feasible.

4 This SPD provides guidance on how new development will be expected to address:

- Energy & carbon: reducing carbon emissions through:
    1. Passive design, passive cooling, and incorporation of green and blue infrastructure
    2. Improving the energy efficiency of buildings
    3. Utilising low carbon heat sources and technologies and incorporating renewable energy

- Sustainable construction: the prudent use of materials through:
    1. The reuse and recycling of materials
    2. Sustainable material selection
    3. Embodied carbon
    4. Building reuse and retrofit

1.1 Purpose of this SPD

5 Supplementary Planning Documents (SPDs) provide more detailed advice and guidance on the implementation of policies within adopted Local Plans.

6 This SPD will provide further guidance relating to the existing Greater Nottingham Aligned Core Strategies Part 1 Local Plan, covering Broxtowe Borough and Nottingham City, Nottingham City Council Land and Planning Policy Part 2 Local Plan covering Nottingham City and, Broxtowe Part 2 Local Plan covering Broxtowe Borough.

1.2 Scope and Status of this SPD

7 This document has been prepared as a Supplementary Planning Document (SPD) under Regulation 14 of the Town & Country Planning (Local Planning) (England) Regulations 2012 (as amended).

8 This SPD provides detailed guidance, it cannot introduce new Local Plan policies. Once adopted by Broxtowe Borough Council and Nottingham City Council, this SPD will be taken into account by the Councils as a material consideration when determining planning applications. As such it is expected that developers will take account of the guidance when preparing their proposals.

9 The local validation requirements are listed in Table 1 below. To demonstrate compliance with relevant Local Plan policies applicants are required to submit a **Sustainability and Energy Statement, and a Site Waste Management Strategy (SWMS)**. This SPD provides further guidance on what information should be included in a Sustainability and Energy Statement. It is acknowledged that the level of detail provided will vary dependent on the type and size of development proposed.

Table 1: Local validation requirements

	Major	Minor
Sustainability and Energy Statement	✓	✓
Site Waste Management Strategy (SWMS)	✓	

10 Where there are thresholds in Local Plan policy requirements, for example for major applications, then this is expressed clearly within the SPD.

11 Once adopted, this SPD will replace Nottingham City Council Informal Planning Guidance: The reduction of carbon in new development (June 2022) and supplement Nottingham City Council Design Quality Framework for developments within Nottingham City area. In respect of Broxtowe, there are no SPDs or informal guidance documents which will be replaced.

12 This document is guidance that is being prepared as a supplementary planning document (SPD) under Regulation 14 of the Town & Country Planning (Local Planning) (England) Regulations 2012 (as amended).

1.3 Structure of this SPD

13 This SPD is divided into the following chapters and sub-sections:

Chapter 2: Energy and Carbon

- Sub Section 2.1 Introduction
- Sub Section 2.2 Energy hierarchy
- Sub Section 2.3 Passive design
- Sub Section 2.4 Green and blue infrastructure
- Sub Section 2.5 Fabric first approaches
- Sub Section 2.6 Low carbon heating and efficient supply
- Sub Section 2.7 Renewable energy
- Sub Section 2.8 Site-wide approaches
- Sub Section 2.9 Drainage and flooding
- Sub Section 2.10 Links to useful external resources

Chapter 3: Sustainable Construction

- Sub Section 3.1 Introduction
- Sub Section 3.2 Reuse and recycling of materials, including keeping existing buildings in use via retrofit
- Sub Section 3.3 Sustainable material selection
- Sub Section 3.4 Embodied carbon and life cycle analysis
- Sub Section 3.5 Links to useful external resources

Glossary of key terms and Appendices including a Sustainability Checklist and Case Studies - to assist applicants in demonstrating how proposals comply with planning policies and guidance.

14 Each topic-based chapter provides a summary of relevant national and local planning policy, before outlining how applicants can integrate sustainable principles or measures into the proposed development and provides examples of what new development needs to achieve to meet policy but also how developments can go further and aspire towards best or exemplary practice.

Text shown in this colour text box will demonstrate how an application can comply with Local Plan policies. This correlates with the checklist in Appendix A. The checklist should be used in the preparation of planning applications and to demonstrate where in the applications' documents this information is contained.

Text shown in this colour text box refers to information relating to the Nottingham City Council area only.

Text shown in this colour text box will demonstrate how developments can aspire towards best practice.

Text shown in this colour text box will demonstrate how developments can aspire towards exemplary practice.

15 At the end of each chapter a list of external resources that are thought to be useful in the preparation of compliant proposals is provided.

1.4 Policy Context

National Policy

16 The Climate Change Act 2008 (2050 Target Amendment) contains a statutory target of securing a reduction in carbon dioxide levels of 100% below 1990 levels by 2050. Furthermore, this legislation requires the Government to set legally binding carbon budgets for each five-year period to 2050. The sixth carbon budget sets the target of reducing emissions by 78% compared to 1990 levels.

17 Section 182 of the Planning Act 2008 introduced a duty on local planning authorities to include policies that make a contribution to both climate change mitigation and adaptation in their plans. This sets a clear legal framework for the role of planning and local planning policy in responding to climate change.

18 The National Planning Policy Framework (December 2024) (NPPF) sets out the Government's planning policies for England and enshrines the overarching presumption in favour of sustainable development, which includes making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution and mitigating and adapting to climate change.

19 The NPPF makes it clear that planning must address climate change. New development should be planned for in ways that minimise vulnerability and improve resilience, help the reduction of greenhouse gas emissions and support renewable and low carbon energy and associated infrastructure.

20 Planning Practice Guidance (PPG) also provides clarity on the interpretation of the NPPF. The PPG supports integrated solutions for adaptation and mitigation measures that support sustainable development.

21 The National Design Guide 2021 outlines that well-designed places and buildings conserve natural resources including land, water, energy and materials.

SPD relationship to Broxtowe Borough Council's and Nottingham City Council's existing policy

22 This SPD covers development in both Nottingham City Council and Broxtowe Borough Council areas. Local planning policy is aligned for both districts under the Greater Nottingham Aligned Core Strategies Part 1 Local Plan (ACS) which includes the overarching policy '**Policy 1 Climate Change**'. Individually for developments in Nottingham City, additional policies under the Nottingham City Land and Planning Policies (NCL&PP) apply, whilst developments in Broxtowe Borough must also comply with the Broxtowe Part 2 Local Plan.

23 For the purpose of this SPD, local planning policy concerning the adaptation and mitigation to climate change, reduction of carbon and sustainable construction has been identified as illustrated in Table 2. Please note that within the scope of this SPD no additional Local Plan policies were identified in Broxtowe Borough's Part 2 Local Plan.

24 Table 2 summarises the policies identified in the Greater Nottingham Aligned Core Strategies Part 1 Local Plan (ACS), and Nottingham City Land and Planning Policies (NCL&PP) where further guidance can be added to the adopted Local Plan Policies to address the implementation of the policies.

Table 2: Local Plan Policies

		ACS P1 Policy 1	ACS P1 Policy 10	ACS P1 Policy 16	NCL&PP CC1	NCL&PP CC2	NCL&PP DE1
Councils	Nottingham City	✓	✓	✓	✓	✓	✓
	Broxtowe Borough	✓	✓	✓			
Topics	Energy Hierarchy	✓			✓		✓
	Sustainable design (orientation, overheating, cooling)	✓	✓		✓		
	Passive design	✓	✓		✓		
	Fabric First Approach	✓	✓		✓		✓
	Low carbon heating and efficient supply	✓			✓		✓
	Renewable energy technologies	✓			✓	✓	✓
	Heat and power networks and site wide approaches	✓				✓	
	Sustainable construction: re-use and recycling of materials				✓		✓
	Sustainable materials selection	✓					
	Embodied carbon	✓			✓		
	Building Re-use and retrofit	✓			✓		
	Urban Heat Island: blue and green infrastructure	✓	✓	✓	✓		

Local Plan policies to be supplemented with additional guidance

25 The Greater Nottingham Aligned Core Strategy Part 1 Local Plan for Broxtowe Borough and Nottingham City includes a number of policies which relate to climate change and to which this SPD can provide further guidance. The relevant planning policies are summarised below and within each chapter.

Policy 1: Climate Change: this is the overarching policy which states that all development will be expected to mitigate against and adapt to climate change and comply with national and contribute to local targets on reducing carbon emissions and energy use. The policy also requires that all development makes use of sustainable materials and minimises waste.

Policy 10: Design and Enhancing Local Identity: The policy requires that development is adaptable to meet the changing needs of occupiers and the effects of climate change.

Policy 16: Green Infrastructure, Parks and Open Space: The policy outlines that green and blue infrastructure provided through development should tackle and adapt to climate change.

26 Nottingham City Land and Planning Policies applies to development in Nottingham City only and includes several policies which build on the foundations of the Aligned Core Strategy. These policies are:

CC1: Sustainable Design and Construction: this policy encourages both residential and non-residential buildings to be zero carbon. The policy outlines that development is expected to utilise sustainable design principles including passive design, utilisation of green and blue infrastructure and the use of recycled materials. The policy also supports improvements on buildings regulations where fabric efficiency and low carbon energy generation can be employed.

CC2 Decentralised Energy and Heat Networks: this policy encourages connection to existing decentralised energy and heat networks and supports the use of low carbon and renewable energy in development proposals.

DE1 Building Design and Use: this policy supports applications which accord with the principles of sustainability including the use of renewable resources, recycled materials and ensuring the efficient use of buildings.

27 As noted previously, there are no policies within the Broxtowe Borough Part 2 Local Plan in addition to the ACS policies noted above.

28 Throughout the chapters in this SPD, the relevant Local Plan policies are identified and expanded upon to guide the reader in demonstrating compliance with the policy criteria.

29 This SPD should be read alongside other relevant SPDs and guidance for each local authority area: Nottingham City Council and Broxtowe Borough Council

chapter two
Energy & Carbon

2.1 Introduction

National Carbon Commitments

30 The Climate Change Act 2008 (as amended) sets the national target for net zero carbon emissions by 2050 with legally binding carbon budgets every five years (the most recently set of which limits national emissions to 965MtCO_2e in the period 2032-2037).

31 The reduction of carbon emissions from buildings is a key strand to the Climate Change Committee's (CCC) strategy in driving emission reductions. To meet these targets, it is necessary to improve energy efficiency in existing buildings, switch to low carbon heating in existing and new buildings, implement stringent energy efficiency standards for new buildings and ensure that buildings are designed for a changing climate.

32 The UK Government's Heat and Buildings Strategy (2021) aimed to set out the transition to low carbon buildings, starting with ensuring high efficiency levels and updating guidance throughout the next decade. The guidance included:

- Future Homes Standard which will introduce a 75-80% reduction in carbon emissions (beyond current standards) from new homes achieved by high building fabric standards and low carbon heating from 2025;
- Future Building Standard applies the guidance to non-residential buildings;
- Consultation on halting any new gas connections to homes from 2025, in favour of low-carbon heat strategies;
- The Heat and Buildings Strategy also sets out how energy performance standards should be achieved using the Building Regulations Part L update (now in force).

33 Whilst these consultations and strategies are important steps in ensuring the UK's homes and buildings are fit for the future, at the time of writing this SPD the implementation date of the Future Homes Standard and Future Buildings Standard is not yet established and as such it is essential at a local level that new homes and buildings are built to reduce carbon emissions.

34 The urgency of achieving net zero emissions by 2050 demands a fundamental shift in how the UK builds its future. While existing efforts towards energy efficiency and responsible construction practices are commendable, a "business as usual" approach simply won't suffice.

35 The current rate of emissions reduction in the built environment is insufficient, and existing practices often fall short of the transformative changes required to meet mandated national climate targets and ambitious local targets. This Supplementary Planning Document (SPD) **outlines how new developments within Nottingham and Broxtowe can reduce their carbon impact and emissions**, to ensure they play a role in achieving net zero and fostering a more sustainable future for the region and the wider UK.

Local Context & Relevance

36 In Nottingham City, carbon emissions from buildings represent 25%[1] of the total carbon emissions of the city and in Broxtowe Borough they represent 34%[2]. It is essential that new buildings do not add to the carbon deficit of the Councils, as carbon reductions are required across all sectors, including buildings, to meet the net zero targets of the Councils.

37 Nottingham City have pledged to become the first carbon neutral city in the UK by 2028 through their Carbon Neutral Charter and Carbon Neutral Nottingham Action Plan 2020-2028. The action plan outlines that carbon reductions will be targeted through heating buildings through low carbon and renewable heating, encouraging energy efficiency improvements and adoption of technology and minimising emissions through the construction of new homes and buildings. The production of this SPD is a central part of the Carbon Neutral Action Plan for the built environment.

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1 Carbon Neutral Nottingham Action Plan
2 BEIS data 2021

38 Broxtowe Borough Council are targeting carbon neutrality on their own operations by 2027. BBC's Climate Change and Green Futures Strategy 2023-2027 and Carbon Management Action Plan outline that the Council will prepare guidance for new buildings to improve energy efficiency and the generation of renewable energy (this guidance).

39 It should also be noted at the time of preparing this SPD, both districts are preparing the Greater Nottingham Strategic Plan which supports both Councils' journey towards net zero carbon.

40 Improvements to building standards, energy efficiency and employing low or zero carbon technologies are key ways to reduce carbon emissions from new and existing buildings and are the focus of this chapter.

Policy requirements

41 Table 3 provides a summary of Local Plan policy, outlining the requirements of policy for developments in Nottingham City (NCC) and Broxtowe Borough (BBC).

42 The overarching policy for all developments in NCC and BBC is **Policy 1** of the Aligned Core Strategy. Policy 1 requires that all developments mitigate against and adapt to climate change, to comply with national and local carbon emissions targets. To reduce carbon emissions, it is expected that all development will follow the energy hierarchy (see image below) in:

- Using less energy through energy efficient buildings, including thermal insulation, passive ventilation and cooling.
- Utilising energy efficient supplies.
- Maximising the use of renewable and low carbon technologies.

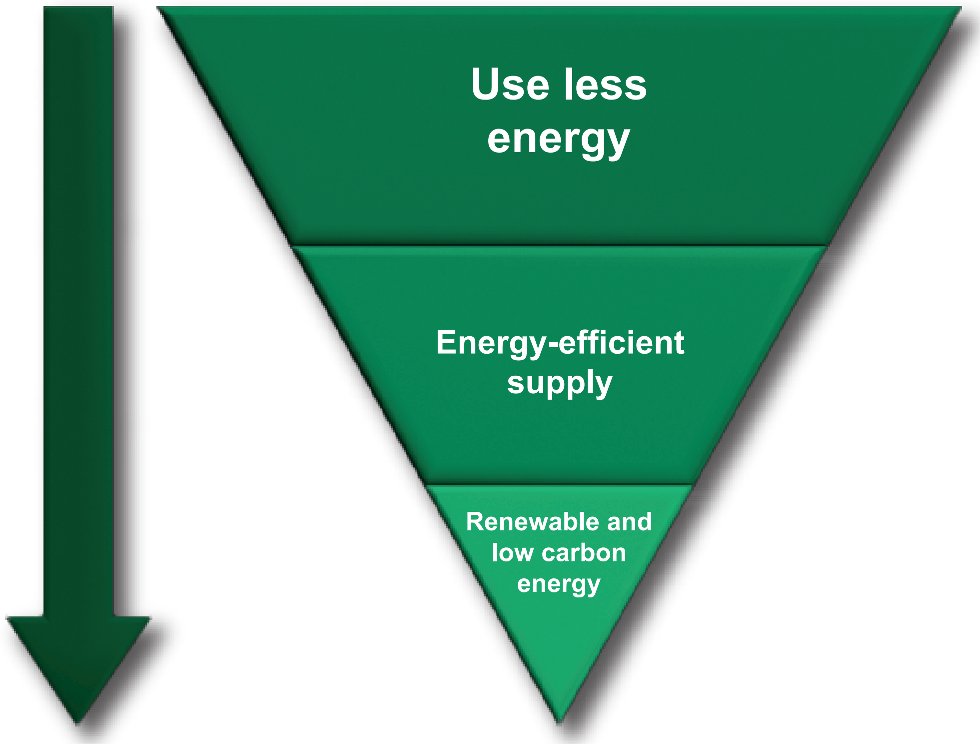

Figure 1: Energy Hierarchy

43 To comply with national, and contribute to local targets to reach net zero, Policy 1 indicates that buildings need to be designed and constructed to minimise carbon. As is demonstrated through this chapter, buildings being designed and built to meet current building regulations (2021) are not fit for a net zero future. Therefore 'business as usual' does not align with Nottingham City's carbon target, nor national targets to reach net zero by 2050.

44 This chapter is organised to guide readers through the stages of the energy hierarchy to demonstrate what measures can be taken at each step to reduce carbon emissions in the design of new buildings. The SPD introduces established and emerging standards for new buildings to illustrate what measures are compatible with the UK's net zero targets and seeks to encourage applicants to incorporate measures or apply standards in new development and the refurbishment of existing buildings.

45 A checklist is provided in Appendix A to assist applicants with checking the content of their Sustainability and Energy Statement.

BM Solar City, Nottingham City Centre

Table 3: Local Plan policies requirements

Policy:	Nottingham City Council	Broxtowe Borough Council	Relevant Requirements

ACS Policy 1 Climate Change	✓	✓	• Reducing carbon emissions to comply with local and national targets.
			• Compliance through the energy hierarchy:
			  • Using less energy through energy-efficient building design
			  • Implementation of decentralised renewable and low-carbon energy technology
			• Adaptation to future changes in climate

ACS Policy 10 Design and Enhancing Local Identity	✓	✓	• Development should be adaptable and meet the challenges and effects of climate change
ACS Policy 16 Green Infrastructure, Parks and Open Space	✓	✓	• Existing and proposed green infrastructure should help tackle climate change and be adaptable to effects of climate change.

Policy:	Nottingham City Council	Broxtowe Borough Council	Relevant Requirements
NCCLPP CC1 **Sustainable Design and Construction**	✓		• Energy efficiency over and above current Building Regulations will be supported • Low carbon energy generation will be supported • Sustainable design features (greywater recycling, green roofs and recycled materials) are expected • Sustainable design for solar gain and to minimise overheating is expected • Major non-residential developments to achieve BREEAM 'very good' and encourage 'excellent'
NCCLPP CC2 Decentralised Energy and Heat Networks	✓		• Consideration to connection to existing decentralised heat and power networks • Development of low-carbon and renewable energy resources
NCCLPP DE1 Building Design and Use	✓		• Sustainable design leading to efficiency in use • Renewable resources and energy generation

2.2 Energy hierarchy

Towards net zero carbon

46 To avoid the worst of the impacts of the climate crisis, globally we must halve carbon emissions by 2030 and achieve net zero by 2050. The built environment is directly responsible for 25% of the UK's carbon emissions. The UKGBC's Whole Life Carbon Roadmap highlights the trajectory for the built environment industry to work towards net zero.

47 LETI defines net zero operational carbon as where a new building achieves a level of energy performance in-use in line with our national climate change targets, does not burn fossil fuels, and is 100% powered by renewable energy.

48 Net zero carbon means whole life carbon, which is formed of two key components:

- **Operational Carbon:** a new building with net zero operational carbon does not burn fossil fuels, is 100% powered by renewable energy, and achieves a level of energy performance in-use in line with our national climate change targets. Operational net zero carbon can be achieved through designing development to accord with the energy hierarchy.
- **Embodied Carbon:** Best Practice targets for embodied carbon are met, and the building is made from re-used materials and can be disassembled at its end of life in accordance with the circular economy principles. Embodied carbon is considered in Chapter 3 of this SPD.

49 LETI, along with other industry leaders such as the World Green Building Council and Architecture 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 (including existing buildings) must operate at net zero carbon by 2050. Current building regulations alone will not enable the UK to meet these targets, and both operational and embodied carbon emissions must be addressed in building design, construction and operation.

50 Achieving net zero carbon emissions must be the responsibility of all design team members, including architects, building technicians and engineers throughout the design process, and through the appointed contractors, manufacturers and sub consultants during construction. Irrespective of the on-site specification of a building, applicants are encouraged to procure electricity from providers using renewable energy sources as a route towards nationwide net zero carbon.

Energy hierarchy

51 Applicants should follow the energy hierarchy in preparation of their Sustainability and Energy Statement. The energy hierarchy is a sequence of steps that should be used to demonstrate how energy consumption has been minimised using the most effective and long-lasting measures first before resorting to less effective or short-term measures. This is measured using modelling of the building's energy use and carbon emissions at each step, and reductions are based on regulated energy use. The steps of the energy hierarchy, often referred to as the ***Be Lean, Be Clean and Be Green stages***, are as follows (as shown in Figure1):

1. Reduce energy demand and use energy efficiently (Be Lean)

Including energy efficient building fabric and building services, thereby reducing energy demand.

2. Supply energy efficiently (Be Clean)

Including connection to existing heat and energy networks in the vicinity; providing a single point of connection and space / capability for future connection to local planned networks; and creation of site-wide networks and communal energy strategies with centralised generation of energy.

3. Renewable energy (Be Green)

Including: on-site generation of renewable energy; on-site storage of renewable energy and/or heat generated, thereby reducing the amount of electricity and/or gas that must be bought from the grid; and procurement of electricity from suppliers who have certified renewable sources for generation of energy.

The Centre for Sustainable Chemistry, University of Nottingham

52 Applicants are expected to demonstrate a meaningful percentage reduction over Building Regulations Part L baseline. Best practice and exemplary practice are provided in the blue and orange boxes below.

53 Applicants are encouraged to use the Energy Use Intensity (EUI) metric to set targets for energy consumption demonstrating how energy demand has been reduced through design. This metric shows a real commitment to reducing the energy consumption of buildings' users. Energy Use Intensity is the total annual energy consumption of a building, including regulated energy (heating, hot water, cooling, ventilation, and lighting) and unregulated energy (plug loads and equipment e.g. kitchen white goods, ICT/AV equipment), and excluding electric vehicle charging.

54 As EUI is measured in kWh/m²/year, it can be estimated at design stage and is displayed on energy bills so building users will be able to easily verify how the building is performing. It relies only on how the building performs, rather than considering the carbon factor of the grid. LETI argues that it should be the metric used across planning and design decisions because of this. Please also refer to LETI's Climate Emergency Design Guide for further guidance on energy efficiency measures and reducing carbon emissions.

Policy Compliance

To comply with ACS Policy 1 and national & local carbon reduction targets, have you demonstrated that through the application of the energy hierarchy the development achieves a reduction of carbon emissions against current building regulations?

The following best practice box indicates the % reduction to aim for.

On-site energy and carbon improvements

Best practice

Benchmarks for on-site energy and carbon improvements vs Part L 2021

- 63% regulated carbon reduction on TER (Future Homes Standard)

Energy benchmarks and calculation methods

Exemplary

- Calculate 'Energy Use Intensity' (EUI) using CIBSE TM54 or Passivhaus PHPP
- Aim to hit LETI/RIBA targets:
    - Residential – energy use intensity of 35kWh/m²/yr and reduce space heating to 15 kWh/m²/yr
    - Commercial – energy use intensity of 55kWh/m²/yr and reduce space heating demand to 15kWh/m²/yr.
    - Schools - energy use intensity of 65kWh/m²/yr and reduce space heating demand to 15kWh/m²/yr

2.3 Passive design

Passive solar design: shading; window size/G-value

55 Step 1 of the energy hierarchy involves applicants considering the implementation of passive design measures to reduce heat demand before specifying active heating systems. Passive measures include improving the building envelope, minimising infiltration of outdoor air, using a simple building form and optimising solar gain.

56 Passive solar design is working with the sun's energy for the heating and cooling of dwellings and non-residential spaces by utilising exposure to the sun in winter and protection from the sun in summer. This includes glazing on south facades with external shading devices installed as an obstacle to the angle of the summer sun while allowing low-angle winter sun to pass. The aim is to get the best balance by reducing the need for space heating in winter, while avoiding the need for active cooling and fans in the summer so that that the winter efficiency gains are not cancelled out.

57 Applicants should demonstrate that the balance between achieving sufficient internal daylight levels and mitigating overheating has been achieved by glazing size and location. The optimum wall-to-(external) window ratio is approximately 20% for South, East and West orientations and 20-40% for North facing glazing.

58 The g-value of glass is used to describe how much solar heat energy can pass through and is shown on a scale from 1 to 0. For housing values of 0.6-0.5 are recommended, for offices 0.4-0.3 and for schools 0.5-0.4. Reducing the g-value to mitigate overheating is not recommended and must be balanced as larger areas of glazing have greater heat loss than an insulated wall resulting in reduced energy efficiency of the building. The applicant is encouraged to demonstrate the proposed g-value.

59 Demonstration of daylight and sunlight levels can be achieved using the BRE Right to Light Guidance and showing that the recommendations will be achieved in all dwellings and occupied spaces.

60 Internal shading can include the installation of blinds at a base build level for commercial spaces and dwellings (especially high-rise dwellings exposed to long periods of sunlight, without shading from buildings or trees). Applicants should confirm where internal shading is required and how this will be indicated to future tenants.

61 Passivhaus is a best practice standard that incorporates passive measures into building design and provides a verification process and implementable pathway to achieving good passive design.

62 Applicants should consider implementing a recognised quality standard such as Passivhaus, NEF/GHA Assured Performance Process, or Home Quality Mark which ensures the finished building performs against the design intentions with regards to energy use, carbon emissions, indoor air quality and overheating risk. Applications using such quality assurance schemes will be looked on favourably. Applicants could also consider undertaking a BREEAM assessment for non-residential new build or refurbishment applications, please see section 3.2 of this SPD for further information and specific requirements for Nottingham City Council.

Best practice for solar gain and glazing ratio

- No main window orientation that faces North.
- No unnecessarily complex building shapes that result in a high form factor (see paragraph 65).
- Simple building shapes should be prioritised.
- Glazing ratio should not exceed 25 – 30% to manage overheating risk and heating demand.

Building form and orientation

63 The orientation of a building can impact its thermal performance due to the amount of sunlight entering the building. The space heating demand of a building can increase purely based on the orientation of the building, where a flat with the majority of glazing on a north-facing facade requires significantly more space heating over an annual period than a flat with the majority of glazing facing south, due to reduced levels of sunlight. Therefore, building orientation can also impact the thermal comfort of occupants, overheating risk, and internal light levels.

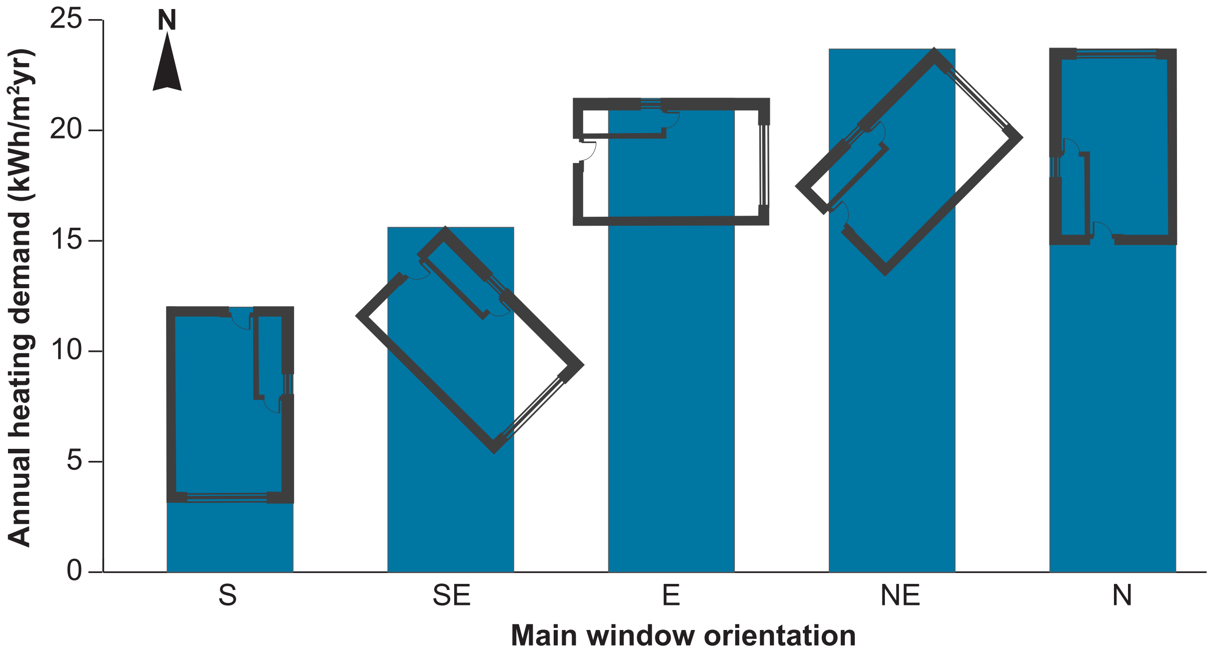

Figure 2: LETI orientation and heat demand study

64 The figure above (LETI Climate Emergency Design Guide) shows how a home's energy use for heating gets worse the further the window is oriented away from south. Please note the blue bars represent energy use for space heating, not sunlight coverage.

65 A building's form factor is the ratio of internal floor area to external surface area; therefore, a detached house would have a higher form factor than a mid-floor flat in an apartment block. The higher the form factor the less efficient the dwelling would be due to exposure to outdoor conditions affecting the energy efficiency of the dwelling, requiring higher levels of energy consumption and increased fabric efficiency to meet required thermal performance. Simpler, more compact shapes achieve a better (lower) form factor than unnecessarily complex shapes.

66 Buildings with simpler shapes (and adjoining walls with neighbouring homes) are inherently more thermally efficient than standalone buildings or ones with complex shapes. Applications should aim for efficient building design, lowering the form factor to reduce the overall energy needs of the building.

Type	Form Factor	Efficiency
Bungalow	3.0	Least efficient
Detached house	2.5	
Semi-Detached house	2.1	
Mid-Terrace house	1.7	
End mid-floor apartment	0.8	Most efficient

Figure 3: LETI form factor

Natural ventilation

67 Applicants should demonstrate a natural ventilation strategy has been followed where appropriate to the application. Windows should be openable to allow for purge ventilation, with noise and air pollution concerns considered during ventilation strategy design. Dual aspect homes should be prioritised, and single aspect homes should be avoided.

68 Ventilation design should also consider the unwanted accumulation of moisture in order to prevent damp and mould, especially in kitchen and bathroom spaces where extract ventilation should be adequately sized and appropriately located. The proposed natural ventilation strategies can be demonstrated to the Council as part of an overheating analysis.

Policy compliance

To comply with ACS Policy 1, have you demonstrated that the proposed development's form, orientation and solar gain have been optimised for energy efficiency and to reduce the risk of overheating?

Best practice for building form and orientation

- Orientation should be considered within the specific context of the development. The link between solar gain and orientation should be treated holistically.
- A building with a south-facing main window orientation will reduce heating demand but should be balanced with measures to mitigate overheating risk during summer.
- Form factor should be reduced as best as possible for the typology of the building.

Exemplary practice for building form and orientation

- Orientation should be considered within the specific context of the development. Main window orientation facing south is considered exemplary as long as this is balanced with measures to mitigate overheating.
- Form factor is dependent on the building type, but exemplary practice is considered to be <3, with Passivhaus buildings aiming to achieve 3 or less.
- Complete either a CIBSE TM52 (non-residential) or TM59 (residential) overheating assessment using TM49 weather files; and
- Demonstrate that a recognised quality regime will be used to ensure the as-built performance indoor air quality and overheating risk meets the as-designed performance (e.g. Home Quality Mark).

2.4 Green and Blue Infrastructure

69 The Urban Heat Island Effect (UHIE) occurs due to the removal of natural vegetation surfaces and their replacement with hard surfaces: pavements, roads and buildings. The subsequent increase in thermal mass and darker-coloured surfaces results in significant heat absorption and retention, leading to higher temperatures in urban areas than less dense, more vegetated areas – the difference can be up to 7° in some cases.

Woodland near Beauvale Priory, Eastwood

70 Applicants should demonstrate how they have incorporated measures to combat UHIE (whether by reducing UHIE in existing urban fabric, or by avoiding the creation of UHIE).

71 Mitigation measures to combat UHIE consist of:

- Increased abundance of foliage and vegetation which is native and would be climate resilient.
- Increasing canopy cover and shading from trees
- Sustainable forms of urban drainage
- More bodies of open water for enhanced evaporative cooling
- Use of more reflective materials on hard surfaces

72 The role of materials in minimising the UHIE can be significant, as roofs and pavements account for ~60% of urban surfaces and absorb in excess of 80% of the solar radiation received.

73 'Cool materials' can reduce this effect due to increased albedo, meaning that the surface can better reflect sunlight and emit heat from the building. Cool materials will therefore reduce overheating risks within the building and the wider urban area. For example:

- White and reflective roofs are up to 4 times more effective than dark roofs.
- It is helpful to avoid dark, low reflectance surfaces adjacent to glazing.

74 New development in high-density urban areas has an opportunity to significantly reduce the level of heat absorbed and retained on-site, and importantly ensure it does not worsen existing urban heat island areas. Reducing the urban heat island effect should be addressed alongside biodiversity and ecology policy requirements, due to the role that increased vegetation can play.

75 Natural England's Green Infrastructure Framework provides useful information and resources for planners, developers and communities. It includes the Green Infrastructure Planning & Design Guide which gives specific design guidance for Green Infrastructure and carbon reduction / climate change.

Green roofs to mitigate heat gain

76 Green roofs containing vegetation, and sometimes water features, provide multiple benefits to a development. Water runoff reduction, evaporative cooling, increased biodiversity and reduced solar gain on the building surface are all key features.

77 Similarly to a rooftop garden, green roofs can reduce heat islands through the provision of shade, removing heat from surrounding air and reducing roof surface temperatures. Compared to standard roofs, green roofs can be over 4°C cooler at the surface, whilst modelling simulations have shown indoor temperature reductions from green roofs of up to 3°C.

78 Green roofs can be combined with solar panels to make ‘biosolar roofs’. Although green roofs may reduce roof space for solar panels, this may be outweighed by efficiency gains of the panels due to the green roofs’ mitigation of extreme temperatures. Panel efficiency is highest at a set operating temperature, and thus increases when paired with green roofs, as the panels are less likely to exceed this temperature. Panels should be placed at least 75cm above vegetation.

79 Blue roofs can also be used to temporarily store and gradually release rainwater. Blue roofs are a key part of Sustainable Drainage Systems (SuDS) and are often used in urban areas where space is limited.

Example of a biosolar roof

80 It is anticipated that as policy requirements become more stringent for operational energy, overheating and biodiversity, a crucial balance in new development will need to be struck between:

- Installing sufficient on-site rooftop solar PV for a net zero energy/carbon balance
- Mitigating overheating risk with reflective appropriate materials and design
- Integrating green and blue roofs with other requirements

Trees for shading

81 Increased abundance of trees is a measure to address both climate adaptation and biodiversity, resulting in co-benefits. Shading from trees provides enhanced thermal comfort at street level and helps reduce health impacts of increased temperatures, which are exacerbated in urban areas. This is supplemented by the evapotranspiration ability of trees, providing a cooling effect.

82 Studies have found street air temperature with higher tree cover density to be 1.3°C lower than streets with lower densities. This benefit is even greater during summer months, where average air temperature under street trees can be up to 3.3°C cooler than open pavement streets.

83 Where trees are planted, it is vital that the underlying soil is appropriately assessed to determine that the quality and volume of soil is sufficient for predicted tree growth. Without soil assessments, trees are at risk of inhibited growth, impeding pavement surfaces and could die prematurely.

Policy compliance

To accord with ACS Policy 16, have you incorporated green and blue infrastructure into the proposed development?

Best practice: Green and blue infrastructure

- Appropriate material selection is made to mitigate urban heat island impacts
- Design is innovative to enable green and blue roofs and solar PV
- Trees and green spaces are integrated into the development to increase biodiversity, reduce overheating and promote outdoor recreation.

2.5 Fabric first approaches

84 A fabric first approach involves maximising the building fabric performance during design, before considering building services that will be required. This enables carbon emissions to be reduced as well as ongoing maintenance and ensures operational energy efficiency. 'Fabric first' could involve improving the thermal mass, insulation, airtightness, incorporating both natural and mechanical ventilation with heat recovery whilst considering solar gain, glazing ratios, and shading devices. A fabric first approach reduces energy demand through effective building fabric design before looking at heating/cooling systems and renewable energy. Applicants should demonstrate how the fabric first approach has been followed.

85 Energy modelling should be carried out using adopted modelling software: SAP for residential models; and SBEM for non-residential. For residential, the total Part L Fabric Energy Efficiency Standard (FEES) should be calculated and reported. However, the use of more accurate energy modelling methodologies such as TM54 or PHPP will be looked on favourably.

86 Irrespective of the method of energy modelling undertaken, applicants should demonstrate appropriate insulation (u-values of all elements) and airtightness levels have been met. The proposed values should be demonstrated against those of the Building Regulations notional building, showing where improvements have been made. Good practice would be to demonstrate a carbon emission saving of ≥15% from fabric improvements compared to Part L 2021 Target Emission Rate for the building (non-residential).

87 Building Regulations Part L 2021 mandate the maximum u-values for building components for dwellings (Volume 1), including existing and new dwellings, and Buildings Other Than Dwellings (Volume 2). The guidance within Part L 2021 is a useful starting point to consider the properties of buildings' components, insulation, and thermal bridging. The table below demonstrates the Part L building performance requirements as well as LETI best practice guidance for different building types.

Table 4: Building fabric performance standards

Element	Part L 2021 standard for new builds	FHS December 2023 Option 1	LETI guidance outlining exemplary practice
Floor U-value ($W/m^2.K$)	0.13	0.13	0.08-0.10 housing, 0.10 -0.12 offices, 0.09-0.12 schools
External wall ($W/m^2.K$)	0.18	0.18	0.13-0.15 housing & schools, 0.12-0.15 offices
Roof ($W/m^2.K$)	0.11	0.11	0.10-0.12
Window ($W/m^2.K$)	1.2	1.2	0.8 small scale housing (triple), 1.0 medium & large scale housing (triple), 1.0 triple – 1.2 double offices, 1.0 triple schools
Door	1.0	1.0	1.0 housing, 1.2 offices, 1.2 schools
Air permeability at 50 Pa	$5.0m^3/ (h.m^2)$	$4\ m^3/m^2.h$ @ 50Pa	<1 ($m^3/h.\ m^2$@50Pa)
Heating appliance	Gas boiler	Notional ASHP equivalent to ErP A++	Recommend heat pump and MVHR, offices connection to community wide ambient loop
Heat emitter type	Low temperature heating	Low temperature heating	Low temperature heating
Ventilation system type	Natural (with extract fans)	d-MEV	MVHR and openable windows
PV	40% ground floor area	High efficiency solar PV panels covering equivalent of 40% of ground floor area	Small scale housing – Maximise renewables so that 100% of annual energy requirement is generated on-site. Medium – large scale housing and schools maximise renewables so that 70% of the roof is covered. Offices maximise renewables to generate the annual energy requirement for at least two floors of the development on-site
Wastewater heat recovery	Yes	Yes	Recommended
y-value ($W/m^2.K$)	0.05	-	0.04

88 At the time of writing, the consultation on the Future Homes Standard (FHS) (December 2023) is in circulation and provides two options for the future of the standard. Option 1 is presented in the table above, which includes an airtightness value of 4 m³/m².h @ 50Pa as opposed to 5 m³/m².h @ 50Pa for Option 2. Option 2 does not include the provision of PV or WWHR and includes natural ventilation with intermittent extract fans as opposed to d-MEV in Option 1.[3]

89 The building 'fabric' comprises of the materials that constitute the walls, floors, roofs, windows and doors. The more insulation contained within these elements, the better their thermal performance. However, the building fabric also includes the building's overall airtightness, as well as the impact of thermal bridges where the insulation layer is not continuous. Therefore, insulation continuity must be achieved across elements of the building to ensure gaps do not lead to heat loss and potentially condensation and mould.

90 Thermal bridging occurs when areas of a building have significantly higher heat transfer than adjacent/surrounding areas (e.g. due to the conductivity of materials or reduced levels of insulation). Building fabric should be designed and installed to minimise thermal bridging.

Policy compliance

Have you demonstrated the fabric performance standards (U values) of superstructure components including external walls, floors, roofs, windows and doors?

It is expected that proposed developments seek to improve energy efficiency through fabric improvements to comply with ACS Policy 1.

Policy compliance

For Nottingham City, developments that can demonstrate a <20kWh/m²/year space heat demand through Part L FEE will be supported under policy CC1.

Best practice fabric energy efficiency

- Demonstrate a 10% reduction on the Building Regulations Part L TFEE (residential)
- Demonstrate a Part L FEE of ≤20kWh/m²/year (residential only)
- Demonstrate a carbon emission saving of ≥15% from fabric improvements compared to Part L 2021 Target Emission Rate for the building (non-residential)

3 https://www.gov.uk/government/consultations/the-future-homes-and-buildings-standards-2023-consultation/the-future-homes-and-buildings-standards-2023-consultation

Exemplary practice fabric energy efficiency

- Calculate space heat demand using TM54 or PHPP
- Aim to hit targets using those calculations, such as:
  - 15kWh/m²/year space heat demand (LETI target, all building types)
  - Other kWh/m²/year space heat demand targets by building type, to be developed via the industry-led UK Net Zero Carbon Buildings Standard.

Thermal mass

91 Materials that absorb heat when surrounding temperatures are higher and then give this heat back when the surroundings are cooler, are said to have higher levels of thermal mass. This enables the material to store heat.

92 Concrete, bricks, tiles, and stone have high thermal mass. Using these materials in the right amount in the right location can help maintain comfortable year-round indoor temperatures, absorbing the sun's heat and releasing it in the evenings when air temperature falls. Controlling and stabilising internal environments this way can reduce usage of heating and cooling systems; however, the materials must be exposed within the space to efficiently function. Applicants are encouraged to demonstrate how thermal mass has been considered within their proposals.

Air tightness

93 Air permeability tests should be carried out on all new dwellings and non-domestic buildings, this helps to identify and reduce unwanted heat loss that occurs through air infiltration into a building.

94 The Building Regulations Part F 2021 defines highly airtight dwellings as those with either:

- A designed air permeability of <5 m³/hr/m²@50Pa
- An as-built air permeability of <3 m³/hr/m²@50Pa

95 Passivhaus certification requires air tightness of <1 m³/hr/m²@50Pa. Applicants should provide the targeted design air permeability within their Sustainability and Energy Statement.

96 The following benchmarks are mostly applicable to residential buildings however other building types should be able to achieve this.

Basic expected limit	Best practice	Exemplary practice
<5 m³/hr/m²@50Pa	<3 m³/hr/m²@50Pa	<1 m³/hr/m²@50Pa

Best Practice

Have you targeted a lower air permeability less than 3 m³/hr/m²@50Pa?

Guidance on retrofitting

97 In an average home or building, fabric improvements or the installation of low or zero carbon technology are unlikely to require planning permission. However, planning permission may be required where the proposed measures affect the external appearance of a building. Applicants are urged to check what permitted development rights are available to them, and if unsure contact the Council before implementing these measures or applying for planning permission.

98 ACS Policy 1 applies to both retrofit applications and new building proposals in Nottingham and Broxtowe in the same way. Where planning permission is required, applicants should demonstrate how retrofit proposals are targeting zero carbon in their Sustainability and Energy Statement.

99 Retrofit can be broken down into the level of intervention, including very low cost or free quick wins; low cost and technically easy measures, high cost and technically difficult measures and deep retrofit requiring technical expertise. Therefore, the measures can range between:

- energy and water saving measures during operation including reducing wasted energy, and water leaks.
- building fabric interventions including glazing replacement, installation of secondary glazing, improved levels of insulation (cavity wall/ceiling insulation/raft roof/loft/floor), chimney improvements and increased levels of draughtproofing.
- building services upgrades such as replacement heating systems, radiator replacements, heat pumps, underfloor heating, installation of solar thermal or a PV array, mechanical ventilation with heat recovery and wastewater heat recovery systems.

100 Please also see the Passivhaus Trust's retrofit guidance and Retrofit Primer (2022) for detailed guidance on retrofit strategies.

101 Retrofit interventions have the opportunity to not only improve energy efficiency, potentially lowering the cost of energy bills, but also to improve the thermal comfort of occupants and thus support the health and wellbeing of building users.

Historic Buildings and Contexts

102 Some measures noted in the above two sections require further consideration when dealing with historic buildings (designated and non-designated heritage assets, including locally listed buildings) and buildings in a Conservation Area. However, the sensitive retrofitting of energy efficiency measures and the appropriate use of micro-renewables will be encouraged, providing the special characteristics of the heritage assets are conserved in a manner appropriate

for their significance. Applicants may find it useful to refer to guidance from Historic England on Retrofit and Energy Efficiency in Historic Buildings (updated Historic England, 2024).

103 In line with new buildings, building fabric upgrades and improved energy efficiency should be addressed prior to low carbon energy sources or renewable energy.

104 Full planning permission or listed building consent may be required from the local planning authority for these works to take place.

2.6 Low carbon heating & efficient supply

105 To ensure we maintain alignment with the trajectory zero carbon buildings is based on, the future of heat delivery within all new buildings **must be fossil-fuel free**. The Committee on Climate Change has also expressed this view regarding the role that new buildings will need to play in order to be compatible with the UK's legislated net zero carbon targets.

106 Therefore, we strongly encourage all new development proposals to be fossil fuel free and to not use gas boilers, as this would constitute insufficient mitigation of climate change.

107 Supplying fossil fuel free energy is key to minimising carbon emissions. For new builds, heat pumps are the most efficient means of heating a building without reliance on fossil fuels. Heat pumps come in a variety of forms and can provide both space heating and domestic hot water, serving individual buildings or acting as communal heating systems. To ensure energy efficiency is maximised, and to minimise energy demand, the choice of system must be informed by the building and site's context and use.

108 Air source heat pumps (ASHP) use refrigerant fluid to absorb heat from the outside air, and as the refrigerant liquid boils, the gas is then compressed and condenses onto heat exchanger coils. ASHPs typically have an efficiency of 250-400% (dependent on system set up, size and application), but can be up to 500% for the most efficient available on the market at the time of writing this SPD. This is far higher than an efficient gas boiler (typically 80-90% efficient). Heat pumps also rely on electricity and therefore provide flexibility for the future, should systems need to be changed out, and also fit into decarbonisation strategies as the national grid continues to decarbonise.

109 Water source heat pumps (WSHP) and ground source heat pumps (GSHP) operate in a similar way, taking heat from surrounding land and bodies of water. The efficiency of the available systems is less variable than those for the currently available ASHP.

110 Please note, direct electric space heating strategies are preferably avoided, due to potential for higher energy bill costs to occupants (especially for hot water), and lower efficiencies of these systems, in addition to reduced flexibility for future adaptation of systems without deep retrofit which is costly and disruptive to occupants.

District Heat Networks

111 Step 2 of the energy hierarchy is the connection to existing and proposed future heat networks. Connecting to heat networks and the creation of networks within buildings on-site should be reviewed before the options for renewable energy technologies are considered. Examining heat networks first helps design smarter heating systems, optimise efficiency, and allows for future integration of renewable sources, making sustainability efforts more strategic and cost-effective.

112 District heat networks enable development of a sustainable and flexible supply of energy on a city-wide or regional scale, using local waste heat efficiently and opening up opportunities for reducing primary energy demand. In urban areas with high heat demand, sharing heat demands and strategies can increase energy efficiency and balance demand with mixed-use developments. Heat networks can offer a solution to decarbonisation as they are technology agnostic and can be replaced with lower carbon technologies in the future.

Nottingham District Heat Network (DHN)

For developments within Nottingham City Council, connection to the DHN will be expected where feasible and viable in terms of the development's location and forecast annual heat consumption.

There is the potential for a major expansion of the network through the [Heat Network Zoning Pilot Programme]() and planning permission for the Eastcroft Incinerator to have a third line, this would increase capacity for future developments to connect.

Policy compliance

To accord with Nottingham City policy CC2, have you explored the possibility of connecting to an existing or proposed District Heat Network as shown on the Nottingham City Polices Map?

Please cite the reasons if this is not feasible or viable.

Domestic Hot Water (DHW)

113 Applicants should demonstrate how domestic hot water will be generated and distributed around buildings. Following the energy hierarchy, communal systems should be considered as part of the Be Clean stage, for example where a communal energy centre with heat pumps is proposed, this system could also supply domestic hot water via a low temperature water distribution loop, with hot water boosted at the dwelling/building. Heat sharing loops like this also provide opportunities to recycle heat that is ejected from any part of the building that has active cooling.

114 Where other options are not feasible, applicants may propose direct electric hot water heaters in commercial buildings where the hot water demand may be very low (for example, in an office where it may be required for a single hand washing basin tap).

115 In accordance with the UK Health and Safety Executive, domestic hot water must be heated to and stored at a temperature of >60 degrees (amongst other storage and control measures) in order to prevent risk of exposure to Legionnaire's disease in residential and non-residential buildings. Where hot water is not stored, this requirement does not apply.

Thermal storage

116 Thermal storage of heating or cooling can be integrated into a communal system or individual system within a building. In winter the electricity grid is more likely to be constrained at periods when homes are heated and hot water demand is high, for example early in the morning. Thermal storage disassociates when heat is produced from when this heat is required. The thermal store can therefore be charged at a period when the grid is unconstrained or low carbon, then used to provide heating and hot water during peak grid times without putting extra load on the grid.

117 Thermal storage can also be utilised alongside renewable energy generation on-site in periods where renewable energy generation is higher than the energy use. The surplus energy can be transferred into thermal storage, e.g. hot water for later use.

Heat recovery (MVHR, WWHR)

118 Mechanical ventilation with heat recovery (MVHR) uses a heat exchanger to recover heat from 'used' or extract air to pre-heat 'fresh' air to be supplied to the dwelling. MVHR is more heat-efficient than natural ventilation and should be considered where noise, air pollution or security concerns may prevent occupants from opening windows. MVHR should be used in buildings where the proposed air-tightness triggers a need for mechanical ventilation and should be considered from early stages of design. Applicants should demonstrate that where mechanical ventilation is proposed it is adequate for the building. LETI recommends a 90% ventilation heat recovery may be needed in order to achieve the domestic hot water and space heating performance recommended in its Climate Emergency Design Guide.

119 Waste water heat recovery systems (WWHR) work by extracting the heat from the water a shower or bath sends down the drain and using this heat to warm the incoming mains water, reducing the energy required to heat the water up. Installation could reduce the energy required per shower use by up to 55%. WWHR is recognised to be an effective way to reduce energy demand for domestic hot water and applicants should consider this option, especially in buildings predicted to have high hot water demands.

Policy compliance

To accord with ACS Policy 1 (and Policy CC2 for Nottingham City Council), have you demonstrated that an efficient low or zero carbon energy system for the delivery of heat and/or power has been selected for the proposed development?

Best practice low carbon heating

- All new buildings to have a zero or low carbon heat supply e.g. no fossil fuel boilers
- Developments to consider connection to existing DHNs where feasible and viable
- Developments to be designed to follow the energy hierarchy of be lean, be clean, be green

2.7 Renewable energy

120 Step 3 of the energy hierarchy is incorporating low carbon and renewable energy technologies. Within the Sustainability and Energy Statement the Council expect that applicants undertake a feasibility assessment of renewable energy technologies to demonstrate which technologies are suitable for the type, form, use and context of the proposed development.

121 It is now widely accepted that heat pumps (including ASHPs, GSHPs, WSHPs) are renewable, due to the fact that they produce more units of heat than they consume in electricity to run. As the grid continues to decarbonise, the carbon of the electricity used by the heat pumps will also reduce.

Incorporating solar photovoltaics (PVs)

122 Applications should maximise opportunities for incorporating photovoltaic panels (PV) including horizontal and vertical arrays. Applicants should provide details of the proposed array including the area (m^2) of the PV array, the number of panels, the panel wattage and efficiency, estimated energy generation per annum (kWh per annum), and an estimation of the carbon emissions that could be offset with the introduction of this technology. The optimum installation would be East-West facing at a 0-30 degree angle of inclination. The density of solar panel area to fit in the available roof area should be maximised, in order to capture maximum solar energy.

123 Bio-solar roofs are where PV panels are installed on top of green roofs. Applicants are encouraged to explore bio-solar roofs as they incorporate both biodiversity benefits of a green roof with the generation of renewable energy. See paragraph 78.

Solar thermal

124 A solar thermal collector gathers energy from sunlight (similar to PV panels), however rather than generating electricity it generates heat. This heat is used to contribute to meeting domestic hot water demand but can also contribute a small amount to space heat via central heating.

Biomass heat

125 Creating heat from direct combustion of biomass may be appropriate in some locations, usually where there are local sources of agricultural, forestry or industrial biomass waste suitable for burning, where preference should be given to fuels that are a by-product of local processes. The carbon impact of transporting the biomass fuel must be considered when specifying this technology, as must the localised impact on air quality from transport and combustion. Applicants proposing such systems must demonstrate that the impacts are acceptable.

126 Following selection of the low/zero carbon technology, applicants should provide details of the proposed systems including the proposed set-up and efficiencies.

Grid capacity constraints

127 It is important to discuss with the District Network Operator the capacity of the local electricity grid as this may have constraints on exports. The need to export energy generated on-site can be solved with local energy storage. This could include battery storage for electrical energy, or in the case of surplus heat energy, thermal stores could be used. Using energy storage can allow consumers to meet peak demand with stored energy or could reduce operational energy costs during times of the day when energy costs peak.

128 The Councils encourage new buildings to be supplied via a three-phase power supply unless this is not viable. A three-phase system makes it more straightforward to install heat pumps, photovoltaic panels and electric car-charging systems, as the electrical demand is spread across the three-phases. Installing a three-phase supply allows homes to be future-proofed and supports future adaptability of buildings.

Historic Environment

129 There must be careful consideration of the impact on the historic environment when using renewables and when making other energy and carbon efficiency improvements. Historic England has provided specific advice in relation to Adapting Historic Buildings for Energy and Carbon Efficiency (Historic England Advice Note 18) and Commercial Renewable Energy Development and the Historic Environment (Historic England Advice Note 15).

2.8 Site-wide approaches

130 Applicants are encouraged to consider energy-sharing strategies to further reduce operational energy demand and carbon emissions. These include local grids; heat recycling; energy clubs via smart meters and Time of Use tariffs.

131 A site-wide strategy could incorporate forms of energy storage such as electrical batteries or heat batteries. Also as previously noted, heat-sharing loops across larger sites or neighbourhoods can present opportunities for heat recycling from waste heat sources in or near the site.

132 Applicants are also encouraged to consider demand side response, which is the flexibility of the energy system to reduce or increase energy consumption during a period of time to respond to energy price changes or energy availability on the grid. Buildings or sites that can modify their energy use in real time through the use of demand response (including storage systems) will be able to reduce occupants' energy bills and LETI argues that in the future it would be expected that these systems are incorporated in every new building.

133 Houshold energy storage should also be considered where feasible.

Policy compliance

To comply with ACS Policy 1, have you explored site wide approaches to centralised systems, energy generation, sharing and storage?

Please cite the reasons if this is not feasible or viable.

To accord with ACS Policy 1 (and Policy CC2 for Nottingham City Council), have you undertaken a feasibility assessment of renewable energy technologies and incorporated renewable energy generation into the scheme through on-site measures?

Best practice solar photovoltaics

- In the first instance, on-site renewable energy generation should be equal to total energy use to achieve a zero-carbon development without any off-site measures or offsetting.
- All buildings should have sufficient roof space for PV generation to achieve a zero-carbon balance only through on-site measures.
- If exceptional circumstances are demonstrated for buildings of 3 storeys or above, standard performance percentages should still be achieved as a minimum.

2.9 Drainage and flooding

134 A key impact of climate change will be an increase in the frequency and severity of flood events. Overwhelmed drainage systems will pose an increasing problem. It should be considered that all development, both existing and new, will be at risk of flooding in the future. ACS Policy 1 requires development to take into account the impact of periods of intense rain and storms and to incorporate measures to reduce surface water runoff whilst managing surface water drainage in a sustainable manner.

135 Therefore, all developments should not increase flood risk on-site or cumulatively elsewhere and should seek betterment over the minimum requirements wherever possible. Developments should work with the natural landscape and its features to reduce the risk of flooding (not only on-site but also beyond the site).

136 Sustainable Drainage Systems (SuDS) should be utilised, considered at every scale and designed in from the beginning of a project. If they are not used, it must be demonstrated why they are not viable or technically feasible.

137 Permeable surfaces should be used on paths, drives and car parks, so that when it rains, the ground absorbs the water and the sewerage system does not become overburdened. This is particularly important on sloping land where impermeable surfaces can exacerbate river or surface water flooding downslope.

Policy compliance

To comply with ACS Policy 1, have you incorporated measures to minimise surface water run-off e.g. minimising paved areas and impermeable surfaces and have you incorporated sustainable drainage into your development proposal?

You must demonstrate if such measures are not viable or technically feasible.

2.10 Links to useful external resources

138 Further guidance, resources:

- NEF/GHA Assured Performance Process https://kb.goodhomes.org.uk/tool/assured-performance-process/
- Home Quality Mark https://bregroup.com/products/home-quality-mark/
- BREEAM assessments and certification https://bregroup.com/products/breeam/
- BSRIA Soft Landings process https://www.bsria.com/uk/consultancy/project-improvement/soft-landings/
- Building Regulations Approved Document Part L: Conservation of fuel and power (2021)
- LETI Climate Emergency Design Guide
- LETI One-pager on Net Zero Carbon
- LETI Climate Emergency Retrofit Guide
- RIBA 2030 Climate Challenge
- Greater London Authority Energy Assessment Guidance
- Greater London Authority (GLA) Carbon Offset Funds Guidance (July 2022)
- UKGBC Net Zero Carbon Buildings: A Framework Definition (April 2019)
- UKGBC Unlocking the Delivery of Net Zero Carbon Buildings (November 2020)
- UKGBC Whole Life Carbon Roadmap: A Pathway to Net Zero (November 2021)
- Historic England guidance on retrofit (energy efficiency and renewable energy)
- CIBSE TM54 method for accurately modelling operational energy performance
- PHPP (Passivhaus energy modelling method) Technical Guidance Passivhaus Rules of Thumb other Passivhaus resources

chapter three
Sustainable Construction

3.1 Introduction

139 It is estimated that the built environment is directly responsible for 25% of UK carbon emissions, and of that 25% approximately a quarter is embodied emissions of buildings and other infrastructure. The built environment sector must urgently address its responsibility in countering the climate emergency and collaboratively work to accelerate decarbonisation in the design, construction and operation of our homes and buildings.

140 The Climate Change Act 2008 (as amended) sets the national target for net zero carbon emissions by 2050. The 2050 target covers all sources of emissions including from the extraction, processing and transportation of materials, and any carbon released through waste at the end of those materials' life.

141 As buildings become more energy efficient and the carbon emissions from their operation reduces, embodied carbon emissions represent a greater proportion of the overall carbon from a development, as much as 50% of total emissions over a building's lifetime.

142 The value of embodied carbon within existing buildings is also recognised through statutory bodies such as Historic England, who acknowledge that the reuse of existing buildings can radically reduce the overall carbon emissions compared with a new building. Additionally, retrofitting to address energy efficiency should also make use of sustainable materials and construction methods to limit embodied carbon.

143 Furthermore, Historic England's 'Heritage Counts' identifies the role of existing buildings to ensure sustainable materials and construction are pursued, rather than a sole focus on new builds. The UK will not be able to achieve the 2050 net zero target without appropriate policies and guidance in place for existing buildings, which primarily must include retention over demolition of existing buildings due to the high amount of embodied carbon that would result from a building replacement.

144 At the heart of the NPPF is a presumption in favour of sustainable development, which should be seen as the golden thread running through both plan-making and decision-taking. The NPPF through Chapter 14 states that the planning system should support the transition to a low carbon future through encouragement of the reuse of existing resources, including the conversion of existing buildings, and through Chapter 17 supports the use of secondary or recycled materials.

145 The Committee on Climate Change (CCC) recommends the substitution of high-embodied carbon materials with low-embodied carbon materials, in addition to the use of recycled materials, and for the introduction of a mandatory whole-life carbon standard for buildings and infrastructure.

146 Recent industry-led Part Z proposals have the intention of amending Building Regulations to introduce new requirements on whole-life carbon reporting and minimum standards by 2027. Whilst not yet national policy, this demonstrates the direction of travel in respect of quantifying and managing embodied carbon in the near future.

Local Context & Relevance

147 Alongside the urgent need to reduce the operational carbon emissions of buildings through their everyday use, the sustainability of the materials and techniques used in the construction, their use through their lifetimes and the end-of-life phases of buildings are also vitally important to reducing carbon emissions now and in the future.

148 Nottingham City have pledged to become the first carbon neutral city in the UK by 2028. The Carbon Neutral Nottingham Action Plan 2020-2028 outlined that waste reduction was also a key part of achieving net zero by 2028.

149 Broxtowe Borough Council's Climate Change and Green Futures Strategy 2023-2027 outlines that the Council promotes a circular economy approach to waste and seeks to reduce waste and increase recycling.

150 In respect of construction and demolition waste, this has historically made up more than half of the waste produced within Nottinghamshire and Nottingham, but this is estimated to have fallen in recent years to around 1 million tonnes per year[4]. Reduction in construction waste remains an important part of the Nottinghamshire and Nottingham Waste Strategy, and both Councils acknowledge that it is crucial to ensure that unnecessary emissions from waste practices are minimised and materials being demolished are re-used and recycled where possible to reduce carbon emissions against their targets.

151 Nottinghamshire Waste Core Strategy Part 1, policy WCS2 requires that all new development is designed, constructed and implemented to minimise the creation of waste, maximise the use of recycled waste and assist in the recovery of waste arising from the development.

Policy requirements

152 Table 5 provides a summary of Local Plan policy, outlining the requirements of policy to developments in Nottingham City (NCC) and Broxtowe Borough (BBC).

153 The overarching policy for all developments in NCC and BBC is again Policy 1 of the Aligned Core Strategy. **Policy 1** requires that all developments (including refurbishment to existing buildings where this requires planning permission):

- Employ sustainable design principles.
- Make efficient use of resources including materials and water
- Minimise waste
- Through its construction, reduce the carbon footprint

154 There should also be consideration of heritage assets and the historic environment, in accordance with the Planning (Listed Buildings and Conservation Areas) Act 1990 and section 16 of the NPPF.

155 This chapter is organised to guide readers through sustainable construction approaches, including the sustainable selection of materials, the reuse and recycling of materials, the retention and retrofit of existing buildings and the relationship between the construction process and embodied carbon.

156 A checklist is provided in Appendix A to assist applicants with checking the content of their Sustainability and Energy Statement and Site Waste Management Strategy,

4 Local estimate derived from Construction, Demolition and Excavation Waste Arisings, Use and Disposal for England 2008, Waste Resources Action Programme (WRAP)

Table 5: Local Plan policy requirements

Policy:	Nottingham City Council	Broxtowe Borough Council	Relevant Requirement. Further detail provided in chapter text.
ACS Policy 1 Climate Change	✓	✓	• Efficient use of resources and materials • Minimise waste • Minimise water use • Reduction of developments’ carbon footprint through construction
NCCLPP CC1 Sustainable Design and Construction	✓		• Use of recycled materials
NCCLPP DE1 Building Design and Use	✓		• Minimise the creation of waste • Maximise the use of recycled materials • Support the recovery of waste arising from developments

3.2 Reuse and recycling of materials, including keeping existing buildings in use via retrofit

157 The minimisation of waste is an integral criterion of the high-quality sustainable design that is expected of all new development. To inform decision-making on waste and re-use of materials, the waste hierarchy is a useful tool, set out below in order of preference. Applicants should demonstrate that they have used materials in line with the waste hierarchy, as follows:

1. Reduce - minimise the use of virgin raw materials and associated generation of waste.
2. Re-use (on-site first) – re-use materials wherever suitable on-site and prepare materials for future re-use.
3. Recycle (on-site first) – although recycling uses additional energy, it is preferable to other forms of disposal as it enables the content of the material to be re-used.
4. Recover – where re-using or recycling materials is not possible, energy can be recovered from materials through processes such as incineration, anaerobic digestion, gasification, and pyrolysis.
5. Dispose – as a last resort, where no opportunities for the above stages remain, materials are to be disposed of in landfill resulting in the end of a material's lifecycle.

Figure 4: The Waste Hierarchy

158 All opportunities should be maximised to mitigate materials usage and wastage, followed by re-use and recycling of materials wherever possible. If the site contains existing structures, the waste hierarchy implies that designs should firstly seek to retain these to reduce waste generation and the need for new materials.

Policy compliance

To comply with ACS Policy 1, have you demonstrated the implementation of the waste hierarchy?

Pre-demolition and pre-redevelopment audits

159 Any proposals for demolition of existing structures should, to be considered acceptable, include a strong justification explaining why it was not possible to retain and reuse/refurbish the existing structures and narrative on what steps were taken to explore scope for retention/refurbishment and avoidance of the need for demolition and disposal. Materials should only be passed off to other management/landfill as a last resort where it is clear that there is not suitable purpose for the material on-site or on an alternative site.

160 One generally expected first key step in this process would be site materials audits: pre-demolition or pre-redevelopment. Pre-demolition or pre-redevelopment audits are an assessment of your site to understand what materials already exist there and identifying the potential for these materials to possibly be reused. Where your site contains existing buildings or structures, these audits are strongly encouraged as a means to evidence that you have made efforts to fulfil the first two steps of the waste hierarchy rather than resorting immediately to demolition and disposal.

161 A pre-redevelopment audit should:

- Assess whether existing buildings and structures on-site can be fully or partially retained and refurbished as part of the proposals.
- Include a description of existing buildings and structures, their age, key materials, and photos of internal and external aspects.
- Clearly demonstrate how the proposed approach has been based on the embodied carbon and resource decisions of the existing site, and robust justification for decisions (demonstrating that they are not based on a purely economic basis).
- Provide justification if full demolition or partial demolition is required.
- See BRE Code for Practice: Pre-redevelopment audits (July 2017)

162 Once the decision for partial or full demolition has been made, a pre-demolition audit can be used to provide detail on the materials on-site in existing buildings and structures (including façade, foundations, etc). If carried out at an early design stage, this audit can help identify where materials can be re-used on-site and can help towards achieving targets for re-use and recycling both on and off-site (such as targets set in order to achieve credits towards a BREEAM certification).

Circular economy and potential for recycling/reuse on-site

163 A circular economy is one where materials are retained in use at their highest value for as long as possible and are then reused or recycled, leaving a minimum of residual waste. For example, at the design and construction stage of a new building, this may include constructing in a way that enables it to eventually be disassembled and its components directly reused economically, instead of having to be demolished into mixed fragments that cannot (physically, technically, or financially) be separated into useful resources.

164 For a site involving existing buildings, it would involve making every effort to:

i. Preferably keep the existing building in use in the redesign
ii. Next, pursue partial retention of functioning parts in situ or in their original form,
iii. If that is not possible then reusing their materials in another form.

165 Direct reuse in a 'high value' form is preferable to 'downcycling'. For example, if an existing building has marble slabs, these are a 'higher value form', whereas crushing them for aggregate infill would count as 'downcycling'.

166 To appropriately follow circular economy principles, the re-use of materials from any necessary demolition on-site must be entirely maximised. The recovery and re-use of such materials mitigates the need for new materials to be produced, whilst reducing material build-up in landfill. The following materials in particular should be salvaged as far as possible:

- Bricks
- Wood
- Asphalt
- Metals
- Glass
- Plastics

167 The UK Green Building Council guidance on the circular economy of construction sets out some useful principles to be addressed throughout various phases:

1. **Maximise re-use:**
   a) Re-use the existing asset
   b) Recover materials and products on-site or from another site
   c) Share materials for onward re-use
2. **Design buildings for optimisation**
   a) Longevity
   b) Flexibility
   c) Adaptability
   d) Assembly, disassembly, and recoverability

3. **Use standardisation**
    a) Standardised, modular elements in buildings are created with less waste and are easier to re-use
4. **Products as a service**
    a) Create payment systems where materials are treated as a service
5. **Minimise impact and waste**
    a) Use low impact materials
    b) Use recycled content or secondary materials
    c) Design out waste
    d) Reduce construction impacts

Sustainable waste management in construction and operation

168 A site waste management strategy is required for major development and for BREEAM assessments. Collectively, the strategy should ensure that negative impacts to the environment from construction and the use of materials within the site are avoided as far as possible in accordance with local planning policies.

169 Waste management throughout the construction phase is likely to have a larger impact than during the operation of the development, however operational waste management for occupiers should remain a primary consideration in the design of developments in ensuring dwellings and buildings have optimum space for the storage of waste and recycling.

Policy compliance

To comply with ACS Policy 1, if the proposed development involves an existing building, have you demonstrated that a pre-development audit has taken place?

Nottingham City Council BREEAM requirements

Nottingham City Council local policy CC1 states that non-domestic developments of >1,000m^2 of floorspace must achieve BREEAM ‘Very Good’ with an aspiration for ‘Excellent’. For projects to achieve a BREEAM rating of ‘Very Good’ there are a number of minimum credits which must be achieved. These include:

- Sub-metering of major energy consuming systems
- Achievement of 1 credit for the water efficiency of sanitary fittings
- Specification of a water meter on the mains water supply to each building; this includes instances where water is supplied via a borehole or other private source
- All timber and timber-based products used on the project are legally harvested.

Best practice reuse and recycling of materials

- Developments to follow the waste hierarchy for design and construction decisions
- Prioritise retention of existing buildings
- All proposals should provide pre-redevelopment and pre-demolition audits to inform the reuse, recycling, and repurposing strategy for the site.
- Major proposals should submit a circular economy statement, site waste management plan, construction environmental management plan and evidence that a waste recovery rate of ≥70% is achieved
- Prioritise direct reuse of materials in their high value form
- Set minimum construction and excavation waste targets for the site

Exemplary Practice Reuse and recycling of materials

Greater London Authority Circular Economy Guidance contains 5 key targets to demonstrate the extent to which circular economy has been pursued. In London, only major projects referable to the Mayor are required to respond to these targets, but the guidance has also been applied to proposals below that threshold. The targets are as follows:

- **Demolition waste:** Minimum of 95% diverted from landfill for reuse, recycling or recovery.
- **Excavation waste:** Minimum of 95% diverted from landfill for reuse.
- **Construction waste:** Minimum of 95% diverted from landfill for reuse, recycling or recovery.
- **Municipal waste:** Minimum 65% recycling rate by 2030.
- **Recycled content of materials:** Minimum 20% of the building material elements to be comprised of recycled or reused content.

Development should set targets to limit material wastage. According to WRAP guidance, best practice targets should be:

Waste generation (tonnes per 100k of construction value)

- **Residential new build: 6**
- **Other new build: 5**
- **Residential refurbishment: 4**
- **Other refurbishment: 3**

Waste recovery (%)

- **Construction: 70-80%**
- **Refurbishment/strip-out: 70-80%**
- **Demolition: 80-90%**
- **Excavation (non-hazardous): 100%.**

3.3 Sustainable material selection

170 Embedding sustainable materials into design decisions should take place as early as possible within the design process. Generally, sustainable products such as timber should be prioritised over traditional building materials such as metals and cement, which emit large amounts of greenhouse gases throughout their extraction, manufacturing, and processing.

171 There are a wide range of environmental impacts associated with material production, use and waste including, but not exclusively: greenhouse gas emissions, air pollution, habitat loss and deforestation, minerals extraction and water wastage, and pollution. When selecting construction materials, developers should consider how they will reduce environmental impacts and limit carbon emissions.

172 Where an organisation does not have a company-wide procurement plan, a sustainable procurement plan can be created and implemented for refurbishment and new development projects. This can be applied to all involved in specification and procurement during the project and provide a framework for responsible and local sourcing of products and materials.

Local sourcing

173 Local sourcing of materials and also the re-use of existing materials, can provide multiple benefits from social to environmental and economic. There is the opportunity for the UK to grow its material reuse focus and for this to take prominence in construction practices. Supporting local businesses increases both the circularity of materials but also reduces associated impacts from sourcing materials out of the local area.

174 The operational ability, adaptability to future conditions, durability and longevity of a material are all important elements to consider alongside sourcing locally. For example, if comparing a stronger Scandinavian timber against a weaker UK timber, the negative impact of additional travel distance of the Scandinavian timber may be outweighed by requiring less of the material to form a building foundation, or a greater durability allowing the building to delay the need for replacement. If one material can be re-used following the lifespan of the existing building, then that is also an additional benefit over a locally sourced material that may not be re-usable.

175 Applicants are strongly encouraged to check and consider the Environmental Product Declarations of materials to make informed decisions on construction materials during both design and construction.

Responsible sourcing

176 Responsible sourcing involves the procurement of materials which can be third party verified with an auditable certification that the raw material has been legally harvested and traded, considering the supply chain impacts that have occurred before the material is used on-site.

177 In the UK, it is not always easy to locally source all building materials, and this has led to the argument that responsible sourcing should be prioritised over locally sourcing materials in certain cases, where there are recognised certifications for products.

178 Although the sustainable selection of a material should always be the primary decision, the sustainable sourcing frameworks and certifications noted in this chapter can be of great use to reduce the carbon impact if more unsustainable materials are selected.

179 100% of timber and timber-based products used for building materials, but also all timber used on-site during construction (e.g. hoarding, pallets) should be sourced from sustainably managed sources and be legally sourced and harvested. This includes Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification (PEFC) certified timber. This should also include timber-based products, such as timber composite decking.

180 Certification schemes are also available for major materials, such as the CARES Sustainable Constructional Steel Scheme and Aluminium Stewardship Initiative, which can demonstrate sustainable sourcing and processing.

181 Environmental Management Systems (EMS) assess key processes for extracting raw materials such as ISO14001. EMS certifications partially comply with BREEAM criteria, based on the extent to which they cover the supply chain processes involved.

182 Environmental Product Declarations (EPD) disclose the embodied carbon (and other environmental impact factors) associated with the specific conditions in which an individual product is produced. Not all products on the market have EPDs, but many products claiming ‘green’ credentials do have these to evidence their claims. You can use embodied carbon data from EPDs in combination with generic embodied carbon data for other products or materials. EPDs should be third-party verified and conform to RICS guidance.

Cement replacement proportions

183 The production of concrete with Ground Granulated Blast-furnace Slag (GGBS) over cement can result in 1/5th of the energy used and 1/15th of CO_2 emissions. Targets for reducing embodied carbon in the building’s structure can be achieved by cement replacement such as GGBS, low carbon concrete mix design, low carbon materials and using recycled / repurposed materials.

Recycled content of total construction material

184 A straightforward way to determine sustainable material selection is to achieve a certain percentage of recycled content. Best practice should achieve at least 25% and aim for 50%. Applicants are strongly encouraged to demonstrate their ambition for recycled content in line with this best practice.

Global Warming Potential (GWP) of materials

185 The Global Warming Potential (GWP) of materials is an important consideration, particularly with operational materials such as insulation and refrigerants. GWP was developed to allow the different global warming impacts of different gases to be compared. The GWP of insulation in particular should be carefully considered, as benefits from insulation properties relating to energy efficiency could be outweighed by high embodied carbon impacts due to high GWP in some cases.

186 The majority of closed-cell spray foams and rigid foam products have high GWPs, particularly when compared to cellulose, sheep's wool and straw-based materials (which can have negative GWP as some of these natural materials also sequester carbon as they are growing).

Reducing material waste through efficient procurement

187 The construction industry is the leading contributor to the UK's total waste, with construction, demolition, and excavation accounting for 62% in 2018, according to DEFRA. This represents the significant impact the industry has and reveals the need for materials circularity to be improved.

188 Construction waste involves the waste that arises during the construction of a development and surplus materials due to inaccurate estimations or over-ordering and potentially poor storage of materials.

189 Wastage rates from construction materials can be reduced where suppliers offer buyback schemes, which means that any excess materials or wastage can be taken back by the supplier. The supplier is then able to resell the product or efficiently recycle it, instead of the developer sending the material for waste disposal in landfill. This means that the resource is not lost, which can also result in financial savings for the developer if there are excess materials that would otherwise cost more due to disposal fees.

190 Material efficiency plays an important role in reducing material wastage, as material mismanagement (e.g. purchasing more materials than required) will inevitably cause increased construction waste. An effective materials efficiency strategy must appropriately consider the impact of each material and ensure that exact amounts are specified, whilst specifying efficient designs to reduce the amount of material required in the first instance.

Policy compliance

To comply with ACS Policy 1, have you demonstrated consideration to sustainable material selection including: locally sourced materials, sustainable certifications and/or materials with low embodied carbon including recycled content?

Best practice Sustainable material selection

- Demonstrates how the balance between local and responsible material sourcing has been addressed
- Obtains certification for products where available for example, the Aluminium Stewardship Initiative
- Ensures recycled content is at least 25% and aims for 50%

3.4 Embodied carbon and life cycle analysis

191 Embodied carbon means the carbon that was emitted in the production and transport of building materials, and their assembly on-site. It can also include the emissions associated with maintaining and eventually disposing of a building too. If the latter are included, this is termed 'whole-life embodied carbon'.

192 These emissions arise largely from fossil fuel energy use to extract and process raw materials such as minerals and metals, then transport them. There can also be emissions from chemical processes to produce building elements (such the carbon dioxide in concrete production) or from the breakdown of the material at the end of its lifespan.

193 Embodied carbon makes up a very large share of the total carbon emissions caused by the creation and use of a building across a typical 'design lifetime' of a building, usually 60 years (see UKGBC). Many commonly used building materials like ordinary cement, steel, aluminium, and zinc have inherently high embodied carbon because of how they are produced. Vice versa, plant-based materials like timber can have less than zero embodied carbon because the tree absorbed carbon dioxide from the atmosphere, and this is locked up in the material for as long as it is in use.

194 Applicants should demonstrate that embodied carbon during the construction phase has been considered and reduced where possible. This information should be contained within the Energy and Sustainability Statement and only applies to full or outline applications.

Scope of embodied carbon

195 Embodied carbon means emissions associated with the materials and construction process of a development, measured in $kgCO_2e$. For example, carbon emissions associated with the energy use or manufacturing process of extracting and producing a product, transporting it to the site, assembling it into a building, both when the new building is created and when it is refurbished or maintained. Embodied carbon is usually measured against Gross Internal Area (GIA) (kilogrammes of carbon per m^2), as defined under NRM 2 produced by RICS.

196 In the RICS Code of Measuring Practice, the GIA is the area of a building measured to the internal face of the perimeter walls at each floor level.

197 The industry standard method to account for a building's embodied carbon is the RICS Whole Life Carbon Assessment for the Built Environment. This is based on the relevant British Standard BS/EN 15978. The RICS method defines the various different parts of the building that should be assessed, and divides a building's life into several stages or 'modules':

- **A1 – A5:** All stages up to completion of the building. This is also known as 'upfront carbon'.
- **B1 – B5:** The building's in-use lifespan. (Sometimes also includes B6 and B7, which relate to operational energy use and operational water use respectively).
- **C1 – C4:** End of life of the building and disposal of its waste materials.

198 LETI Embodied Carbon Primer (January 2020) sets out to provide supplementary guidance to their Climate Emergency Design Guide, and provide voluntary recommended embodied carbon reduction targets, broken down into three building types, which LETI states will contribute to whole life net zero carbon design, when combined with achievement of energy use intensity (EUI) targets and supplied with 100% renewable energy.

199 RIBA 2030 Climate Challenge – sets voluntary targets for embodied carbon, operational energy, and water consumption. Version 2 of their targets has been updated so that embodied carbon targets align with LETI, GLA and UKGBC guidance.

200 UKGBC – According to the UKGBC, 20% of built environment carbon emissions are due to embodied carbon from the construction and refurbishment of buildings. The UKGBC recommended that minimum standards or embodied carbon limits are set by 2025 for large buildings (>1000m^2) in mature sectors (where benchmark level data exists) and that by 2027, these minimum standards for embodied carbon are applied to all sectors.

Heavy embodied carbon impacts

201 The largest contributor to embodied energy is through stages A1-A5. Carbon emitted through these stages occurs 'today' and therefore will certainly affect the local and national carbon budgets as previously noted in relation to the Climate Change Act and Paris Agreement.

202 Heavy embodied carbon impacts tend to arise from:

- Concrete and cement production
- Steel production
- Metal extraction and refinement (e.g. aluminium and copper)
- Plastic and glass production
- Transportation with long distances between source and site

203 Material selection is of the utmost importance to reduce embodied carbon and should be considered at the earliest possible stage to ensure supply chain availability and integration into building design. Resources such as the Materials Pyramid can be particularly useful to understand the embodied carbon impact of particular materials and ensure sustainable material selection. All proposals should consider the use of such resources to appropriately account for embodied carbon, even if a full embodied carbon assessment is not required.

Policy compliance embodied carbon

To comply with ACS Policy 1, have you demonstrated in the Energy and Sustainability Statement that embodied carbon in the construction phase has been considered and reduced where possible?

Best practice embodied carbon

- Embodied carbon of construction is considered and reduced where possible throughout the design and construction.
- This is demonstrated through the completion of an embodied carbon assessment for RICS stages A1 – A5 (or similar methodology).
- The project sets embodied carbon targets to be achieved upon completion.

Exemplary Practice embodied carbon

- Aim for LETI or RIBA Climate Challenge embodied carbon targets
- Proposals to follow guidance in the LETI Embodied Carbon Primer.

3.5 Links to useful external resources

- LETI Climate Emergency Design Guide focuses on the need to consider low-embodied carbon choices for key materials: concrete, timber/wood, bricks, structural steel, aluminium and glass. For example, the production of concrete with Ground Granulated Blast-furnace Slag over cement can result in 1/5th of the energy used and 1/15th of CO_2 emissions
- Certification schemes are also available for major materials, such as the CARES Sustainable Constructional Steel Scheme and Aluminium Stewardship Initiative, which can demonstrate sustainable sourcing and processing.
- BES6001 Framework Standard for Responsible Sourcing includes organisational management, supply chain management and sustainable development requirements. It focuses on individual products, not organisations/companies.
- Independently certified Environmental Management Systems (EMS) which assess key processes for extracting raw materials such as ISO14001 EMS certifications partially comply with BREEAM criteria, based on the extent to which they cover the supply chain processes involved. BREEAM Guidance Note 18 provides detailed information on which EMS have been recognised by BREEAM and given a responsible sourcing weighting level by the BRE.
- RIBA 2030 Climate Challenge – sets voluntary targets for embodied carbon, operational energy, and water consumption.
- RICS Whole Life Carbon Assessment for the Built Environment – the industry standard method to account for a building's embodied carbon.

Glossary

Glossary

Air Permeability or Airtightness: A measure of how much (or how little) air leakage a building experiences, due to its fabric. Measured in air changes per hour at a pressure of 50 pascals, sometimes abbreviated to 'ACH@50PA'. Air permeability is one of the notional building specification elements defined by Building Regulations Part L.

Air Source Heat Pump (ASHP): A form of low-carbon heat delivery in which an electrical pump utilises a reverse-refrigeration cycle to absorb free energy from outdoor air and emit it at a higher temperature indoors. Considered partially or fully renewable as the ASHP uses electricity to run but delivers more heat energy than it consumes in electrical energy. Can be fully renewable and zero carbon if run entirely on renewable electricity.

Building Emissions Rate (BER): A metric used in Building Regulations Part L to express the predicted carbon emissions rate of a non-residential building associated with its regulated energy uses. See also TER.

Building Regulations: National legal requirements for minimum quality standards in buildings. Different 'parts' of Building Regulations cover various topics including energy conservation, and access and use of buildings by people, including disabled people. The section relating to energy and carbon is 'Part L'.

Building Regulations Approved Document Part L: Conservation of fuel and power; this is the part of Building Regulations that sets minimum standards for energy-related carbon emissions and efficiency of buildings.

Building Research Establishment (Group) (BRE): A building science research entity which, among many other roles, hosts and updates the calculation methods 'SAP' and 'SBEM' that are used to measure compliance with Building Regulations Part L. Formerly a civil service body; now owned by a charitable trust.

Building Research Establishment Environmental Assessment Methodology (BREEAM): A voluntary sustainability certification for buildings, covering topics including energy, materials, waste, water, health, ecology, pollution, transport, and management. Offers several levels of achievement from 'pass' to 'outstanding'. Mainly used in non-residential but is also available for residential.

Chartered Institute of Building Services Engineers (CIBSE): Professional association body for Building Services Engineers.

Circular Economy: A model of production and consumption that involves leading, sharing, reusing, repairing, refurbishing, and recycling products and material for as long as possible. In this way, the life cycle of products is extended.

Coefficient of Performance (COP): A ratio used to indicate the performance a heating, ventilation or air conditioning system offers.

Combined Heat and Power (CHP): A highly efficient process that captures and utilises the heat that is a by-product of the electricity generation process.

Direct Electric Heating: Systems in which heat is generated directly within a material by passing an electric current through; e.g. convector heaters or electrical underfloor heating. The source of electricity can be renewable or non-renewable.

Decentralised Mechanical Extract Ventilation (d-MEV): A decentralised Mechanical Extract Ventilation (d-MEV) system is a low energy, continuous mechanical extract ventilation system designed to replace conventional bathroom fans and draw moisture laden air out of the wet rooms (bathrooms and utility).

Dwelling Emissions Rate (DER): A metric used in Building Regulations Part L to express the predicted carbon emissions rate of a dwelling, associated with its regulated energy uses. See also TER.

Embodied Carbon: Carbon that was emitted in the production, transport and assembly of materials that make up a building or product.

Environmental Product Declarations (EPDs): Declarations attached to a product expressing the calculated environmental impacts associated with its production (and sometimes also its use and end of life) using life-cycle analysis. Usually includes embodied carbon and may include other information such as impact on ozone or ocean acidification.

Fossil Fuels: Non-renewable, carbon-based, carbon-emitting fuel sources.

Fuel Poverty: Households that cannot meet their energy needs at a reasonable cost.

Future Homes Standard (FHS): Central government proposed changes to Parts L and F of the national Building Regulations.

Glazing Ratio: The proportional relationship between a building's opaque and glazed surfaces; i.e. a wall-to-window or roof-to-window comparison. Sometimes expressed as a ratio of glazed area to total *floor* area (for example in SAP, the notional dwelling has a *maximum* limit to the 'opening area' as a percentage of 'total *floor* area', while in SBEM the reference building has a *minimum* 'opening area' as a percentage of 'exposed *wall* area' and 'exposed *roof* area' which varies by building usage).

Global Warming Potential (GWP): A metric used to measure the impact of greenhouse gas emissions on climate change. In the construction industry, the use of materials with high GWP can significantly contribute to environmental harm.

Gross Internal Area (GIA): A measure of total floor space in a building.

Ground Source Heat Pump (GSHP): A form of low-carbon heat delivery in which a pump captures the latent heat from the ground and uses it to heat a building or the hot water used in that building. Considered partially renewable as the heat captured is 'ambient' environmental heat from the ground, and the heat pump delivers more heat energy than it uses in electrical energy. Can be fully renewable and zero carbon if run entirely on renewably generated electricity.

G-value: Amount of sunlight energy transmitted through (a window's or door's) glass.

Home Quality Mark (HQM): A voluntary quality certification system for dwellings, which includes some environmental criteria as well as criteria relating to the resident's experience of using the home. This system is devised and run by the BRE (see BRE in this glossary).

Low Energy Transformation Initiative (LETI): A voluntary network of over 1,000 energy-related built environment professionals working to improve practices in relation to design for energy efficiency and carbon reduction to make the built environment compatible with the UK's net zero carbon future. It has devised and released publications relating to net zero carbon buildings including definitions, targets and design guidance including for new and existing buildings, operational and embodied carbon.

Low Impact Materials: Materials that have a lower environmental impact. This can include natural, reclaimed or reused materials and those sourced from local suppliers. Materials that don't require intensive manufacturing or refinement as well as those that do not need to be transported vast distances are often considered low impact.

Mechanical Ventilation and Heat Recovery (MVHR): A ventilation system which recovers heat from outgoing air, to warm up the fresh incoming air.

National Calculation Methodology (NCM): The methodology approved by the Secretary of State for calculating the energy performance of buildings.

Part L: See 'Building Regulations Approved Document Part L'.

Passivhaus: A standard and certification for buildings that achieve an exemplary level of energy efficiency. Certified by the Passivhaus Trust. Several levels of certifications are available; the lowest level relates to only energy efficiency, while the higher levels also require renewable energy generation.

Passivhaus Planning Package (PHPP): A modelling methodology used to very accurately calculate/predict the total energy use of a building. This method is used as part of the process for undergoing Passivhaus certification (see above), but can also be used as a design tool in its own right without any involvement in the certification scheme.

Photovoltaics (PV): A form of renewable, non-carbon-based electricity production which utilises sunlight as an energy source.

Publicly Available Specification 2035 (PAS 2035): A best practice standardised process for retrofitting dwellings for energy efficiency in the UK. It allows retrofits to be Trustmark certified, providing security and reducing risks for building owners.

Renewables: Renewable resources; usually energy.

Royal Institute of British Architects (RIBA): Professional association body for the architectural profession. Among its many and wide-ranging activities it has published a set of aspirational targets for buildings to aim for in energy efficiency, embodied carbon and water efficiency to ensure they are fit for the UK's net zero carbon future and also reduce the demands they place on the UK's water resources.

Royal Institute of Chartered Surveyors (RICS): Professional association body for the chartered surveyor profession. Among its many and wide-ranging activities it has published a methodology to account for the embodied carbon of buildings across their lifespan (the Whole Life Carbon Assessment) in a way that complies with the relevant British Standard, BS15978.

Simplified Building Energy Model (SBEM): The calculation method used to set and comply with energy- and carbon-related targets within Building Regulations Part L for non-domestic buildings.

Standard Assessment Procedure (SAP): The calculation method used to set and comply with energy- and carbon-related targets within Building Regulations Part L for domestic buildings.

Supplementary Planning Document (SPD): A document (like this one) that provides additional guidance on how to comply with policies set by a Local Plan.

Target Emissions Rate (TER): A metric used in Building Regulations Part L (for both dwellings and non-domestic buildings) to express a limit which must not be exceeded by the predicted carbon emissions associated with the building's regulated energy uses. The TER is set by applying a certain minimum standard of fabric and services to an imaginary building of the same size, shape and use as the proposed building. This minimum standard of fabric and services is laid out in Approved Document Part L, and is updated every few years. Expressed in kg of carbon dioxide per square metre of floor space ($kgCO_2/m^2$).

Target Fabric Energy Efficiency (TFEE): A metric used in Building Regulations Part L to express a limit on a dwelling's demand for heating and cooling, determined only by the *fabric* of the dwelling, irrespective of the type or efficiency of the various building services such as heating system. Expressed in kWh/m^2 floor space / year.

Water Source Heat Pump (WSHP): A form of low-carbon heat delivery system in which a pump captures the thermal energy from a water source and uses it to heat a building or for hot water use within the building. Considered partially renewable as the heat captured is 'ambient' environmental heat, and the heat pump uses less electrical energy than it delivers in heat energy. Can be fully renewable and zero carbon if the heat pump is run on entirely renewably generated electricity.

TM54: Provides building designers and owners with clear guidance on evaluating operational energy use more comprehensively during the design stage. It facilitates better accounting for factors such as operating hours and occupancy, tailored to the building's intended use.

Waste Water Heat Recovery (WWHR): A form of secondary heat delivery in which heat from wastewater (e.g. used shower or bath water) is captured for reuse in the building, for example to pre-heat water entering a boiler/water tank in order to reduce demand on primary methods of heating water to a set temperature.

Whole life carbon: The carbon emissions resulting from the materials, construction and the use of a building over its entire life, including its demolition and disposal.

U-values: The rate of thermal transmittance measured in Building Regulations.

Zero Carbon: Net Zero Carbon: When the amount of carbon emitted by a building is zero, through efficiencies and use of zero-carbon resources. This typically refers to operational carbon (including regulated and unregulated emissions). **Operational:** Energy use and carbon emissions caused by the operation of a building. Operational carbon is almost entirely due to energy use, but can have other smaller causes, such as leaked refrigerant gases from air conditioning. **Regulated Emissions:** The share of those operational carbon emissions that are from an energy use that is regulated by Building Regulations, for example heating and hot water systems, or fixed lighting circuits. **Unregulated Emissions:** The share of those operational carbon emissions that are from an energy use that is not regulated by Building Regulations, for example plug-in electrical appliances.

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Appendix A – Sustainability Checklist

Chapter	Checklist question	Applicable to Nottingham City Council	Applicable to Broxtowe Borough Council
Energy Hierarchy Stage 1: Be lean			
2: Energy and Carbon	Have you demonstrated that through the application of the energy hierarchy the development achieves a reduction of carbon emissions against current building regulations?	✓	✓
2: Energy and Carbon	Have you demonstrated the fabric performance standards (U values) of superstructure components including external walls, floors, roofs, windows and doors?	✓	✓
2: Energy and Carbon	Can you demonstrate that new dwellings achieve <20kWh/m^2/year through Part L FEE?	✓	
Energy Hierarchy Stage 2: Be clean			
2: Energy and Carbon	Have you demonstrated that an efficient system for the delivery of heat and/or power has been selected for the proposed development?	✓	✓
2: Energy and Carbon	Have you explored the possibility of connecting to an existing or proposed District Heat Network as shown on the Nottingham City Polices Map? Please cite the reasons if this is not feasible or viable.	✓	

Chapter	Checklist question	Applicable to Nottingham City Council	Applicable to Broxtowe Borough Council
2: Energy and Carbon	Have you explored site wide approaches to centralised systems, energy generation, sharing and storage? Please cite the reasons if this is not feasible or viable.	✓	✓
Energy Hierarchy Stage 3: Be green			
2: Energy and Carbon	Have you undertaken a feasibility assessment of renewable energy technologies and incorporated renewable energy generation into the scheme through on-site measures?	✓	✓
Adaptation and mitigation to climate change			
2: Energy and Carbon	Have you demonstrated that the proposed development's form, orientation, solar gain have been optimised for energy efficiency and to reduce the risk of overheating?	✓	✓
2: Energy and Carbon	Have you incorporated green and blue infrastructure into the proposed development?	✓	✓
2: Energy and Carbon	Have you demonstrated that the development would achieve water consumption of 105 litres per person per day, subject to viability?	✓	✓

Chapter	Checklist question	Applicable to Nottingham City Council	Applicable to Broxtowe Borough Council
2: Energy and Carbon	To comply with ACS Policy 1, have you incorporated measures to minimise surface water run-off e.g. minimising paved areas and impermeable surfaces and have you incorporated sustainable drainage into your development proposal? You must demonstrate if such measures are not viable or technically feasible.	✓	✓
Sustainable Construction			
3: Sustainable Construction	Have you demonstrated the implementation of the waste hierarchy?	✓	✓
3: Sustainable Construction	If the proposed development involves an existing building, have you demonstrated a pre-development audit has taken place?	✓	✓
3: Sustainable Construction	Have you demonstrated consideration to sustainable material selection including: locally sourced materials, sustainable certifications and/or materials with low embodied carbon including recycled content?	✓	✓
3: Sustainable Construction	Have you demonstrated that embodied carbon in the construction phase has been considered and reduced where possible?	✓	✓
3: Sustainable Construction	For major non-residential development have you demonstrated that the development achieves (at the minimum) BREEAM 'very good'?	✓	

Appendix B - Case Studies

Prospect Place, Lenton, Nottingham

Prospect Place in Lenton, Nottingham will see the construction of 36 new affordable homes. The homes will be gas free and powered by Air Source Heat Pumps and PV solar panels. The building fabric of the homes will be highly insulated and energy efficient. The scheme will offer two, three and four bedroom homes to support housing need in the area, ten homes will be sold for shared ownership and the remaining 26 will be let as affordable rent by Nottingham City Council. The scheme is being built on a brownfield site, utilising land positively for affordable housing needs of Lenton and the wider community.

University of Nottingham, Jubilee campus buildings

The Jubilee Campus at the University of Nottingham is built on a former brownfield site and has embedded sustainability into its design and delivery. The campus has won many awards including the Millennium Marque Award for Environmental Excellence and the British Construction Industry Building Project of the Year. The buildings on the campus use natural materials such as cedar redwood cladding and recycled newspaper insultation. The lakes on the campus provide storm water attenuation and cooling for the buildings.

The building roofs are covered by low-growing alpine plants and use photovoltaic cells integrated into the atrium roofs. Several of the campus buildings make use of Lake Source Heat Pumps: these work similarly to GSHPs but extract heat from a body of water. The GSK Carbon Neutral Lab on the Jubilee campus includes the University's largest array of PV panels covering more than 45% of the roof area. Across all University of Nottingham sites there are approximately 6500m² of PV panels, contributing over 46% of on-site generation in 2019.

Hobart & Pitcairn, The Meadows, Nottingham

This ten year phased development has seen 166 homes built in the Meadows area of Nottingham. In 2012, work completed on the first phase of development in the Meadows, Green Street, 38 townhouses. The homes include high levels of insulation, whole-house heat recovery, high levels of air tightness and maximum use of natural light. Energy is also generated on-site through their roof mounted solar PV. Phase II of Green Street comprises of 21 homes, including seven custom build plots, allowing buyers at the time to fully customise the internal layout of their homes, a unique approach for housing in the East Midlands.

The third phase of development in the Meadows, Hobart & Pitcairn, was a partnership project between Blueprint, Asra Housing Group & William Davis completed in 2015. The site has delivered 35 homes for market sale, and 38 affordable properties through Asra, all designed to AECB Silver Standard, a fabric first approach based on Passivhaus principles. Hobart & Pitcairn homes meet both the Code for Sustainable Homes level 4 and AECB Silver Standard, a fabric first approach which seeks to reduce C02 emissions by up to 70%.

The Centre for Sustainable Chemistry, Nottingham University

Collaboratively delivered by Nottingham University and GSK, the Centre for Sustainable Chemistry at Nottingham University's Innovation Park is an award-winning carbon neutral laboratory. The building also achieves BREEAM outstanding and LEED Platinum certifications.

The building delivers carbon neutral development through a biofuel combined heat and power system, 230kWh solar array and mechanical heat recovery and ventilation. These systems along with the building's passive design will result in offsetting all carbon emissions resulting from the construction of the building over a 25-year period. Beyond this point this building would be carbon negative in operation, in generating more energy than it uses, which powers nearby buildings on the campus.

The choice of materials was considered from the scheme's inception through a carbon model which required low embodied carbon materials and sustainable procurement and has led to its LEED & BREEAM certifications. An example of a sustainable material choice was the use of PEFC and FSC certified timber, transported by ship to lower carbon emissions, which is used for the superstructure of the building.

Sneinton, Nottingham

Nottingham City Homes undertook a net-zero pilot project, retrofitting 10 dwellings in 2017. Existing homes were retrofitted with prefabricated external insulation, insulated roofs with integrated PV panels, battery storage, and high performance double glazing. The properties also benefitted from being connected to a communal GSHP.

With the increased level of insultation, the space heating demand for these dwellings reached less than 40kWh/m²/year and overall has reduced carbon emissions by approximately 70%.

Image source: Transforming social housing in Nottingham (energiesprong.uk)

Fen Road and Ditton Fields

Cambridge's first Passivhaus social housing project delivered 18 net zero homes. The key to achieving this is a combination of energy efficiency (airtight building envelope, low U-values) and low carbon technologies (air source heat pumps, solar panels). Sustainability is a focus with responsible materials and low-flow fixtures. The development offers resident comfort with EV charging, private gardens, and improved biodiversity. This successful project has led Cambridge to adopt Passivhaus standards for all new Council housing.

Image source: https://kb.goodhomes.org.uk/case-study/fen-road-and-ditton-fields/

Prologis Apex Park, Daventry

Located on Prologis Apex Park, near Daventry the new 435,000 sq. ft unit is the UK logistics hub for a large American multinational. The building utilises rainwater harvesting and EV charging points and a 1.4MW rooftop solar system that has also been installed. This results in the building returning more energy to the grid than it consumes on an annual basis. The new unit is BREEAM rated 'Outstanding' – placing it in the top 1% of UK non-domestic buildings. Additionally, the unit is the first to achieve an EPC rating of A+ meeting the UKGBC definition of net zero carbon for both embodied and operational carbon. It is predicted the unit will generate more energy than it uses, avoiding 105tCO_2e per year, feeding unused energy back into the grid.

Image source: https://www.eastmidlandsbusinesslink.co.uk/mag/property/first-uk-logistics-building-to-go-beyond-net-zero-built-in-daventry/

Seaward Way - Minehead

Somerset West & Taunton Council's visionary project in Minehead is building a sustainable community. This development offers 54 brand new, affordable rent homes designed to be net zero carbon in operation. Solar panels are key, generating 100% of predicted energy needs. Air source heat pumps and high insulation minimize energy use, while the University of Bath monitors performance to ensure success. Sustainability is a priority, with 30% of building materials reused and low-carbon options chosen. Living comfort is important. All homes have EV charging points, and residents enjoy private gardens (houses) or balconies/terraces (apartments). A communal space with a play area, landscaping, and a pond fosters community spirit. Excellent connectivity includes a nearby bus stop and amenities within walking distance, with a cycleway.

Image source: https://kb.goodhomes.org.uk/case-study/seaward-way/

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