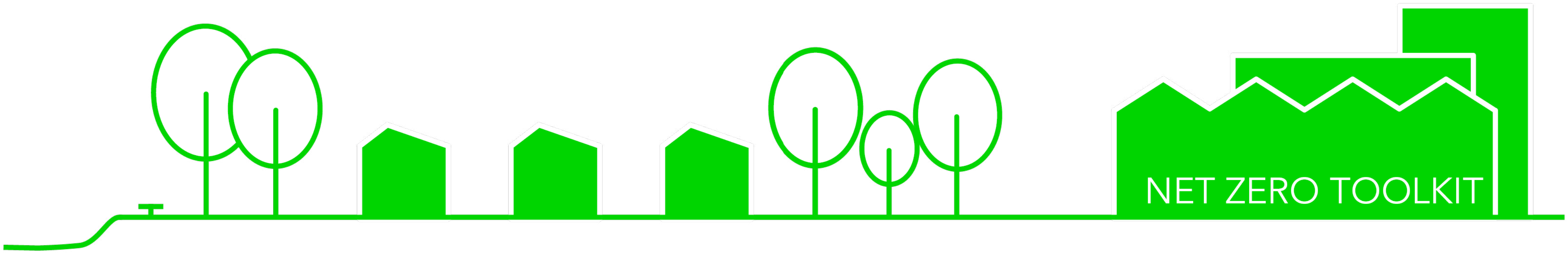
Folkestone & Hythe District Council

Homes England



NEW BUILDINGS

September 2023 | Rev F

Levitt Bernstein People.Design

Introba

Etude

Foreword and Acknowledgments

Foreword from F&HDC to be added

The Folkestone & Hythe District Council Net Zero Toolkit for New Buildings has been developed in close collaboration with the District Council, Otterpool Park LLP, Homes England and Kent County Council.

We are very grateful to the following individuals for their time, leadership, contributions and comments.

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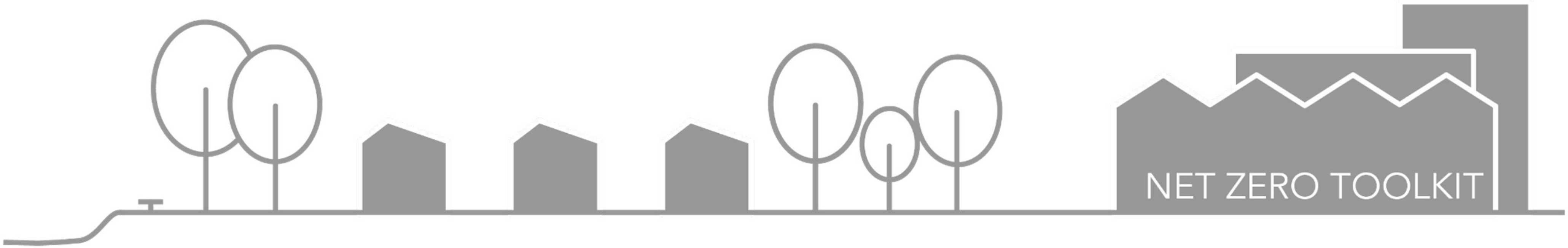
The Folkestone & Hythe District Council Net Zero Toolkit

The Folkestone & Hythe District Council Net Zero Toolkit comprises of four parts, each consisting of a separate document.



This document

Part 1

Decarbonising buildings – Strategic objectives

This part is 6 pages long and aimed at Councillors, officers and other key stakeholders involved in the formation and adoption of the Net Zero Toolkit.

It lays the foundations for the Toolkit documents by explaining legal climate change requirements and policy context. It also explain the "whys" for being ambitious with Net Zero Carbon new buildings.

Part 2

New buildings

This part is 60 pages long and aimed at developers (small and large), architects, consultants, planning officers.

Its main aim is to communicate how new developments that are consistent with climate change objectives can be designed and constructed. It covers both domestic and non-domestic developments and includes useful 'one pagers'.

Part 3

Retrofit

This part is 40 pages long and aimed at F&H District Council as it focuses mainly on the Council's own stock.

It seeks to communicate the importance of retrofit, explain which key improvements need to be made in a simple way

It also signposts useful guidance on retrofit.

Part 4

Planning policy recommendations

This part is 20 pages long and aimed at F&H District Council's Planning department.

It provides clear policy recommendations for the Council to consider for the next Local Plan update.

Contents page

1 CONTEXT

This chapter discusses Net Zero carbon buildings as well as Folkestone and Hythe's carbon budget. It contextualises the electrical revolution and the role of Net Zero buildings in a larger context. It also outlines the additional energy measures that should be considered on projects in order to create a comprehensive, sustainable approach.

Context | Why Net Zero carbon new buildings?

We only have so much carbon left to emit

Climate science shows a direct correlation between the amount of carbon in the atmosphere and global temperature rises. If we are to limit these to 1.5-2°C, as strongly recommended by the Intergovernmental Panel on Climate Change (IPCC), we only have a limited amount of carbon left to emit before we get to that point. In the UK, we are predicted to overshoot our carbon budget by 2027 – which is why reducing carbon emissions is an urgent matter.

Buildings are one of the easiest things to make zero carbon

The technology, materials and know-how is there to construct zero carbon buildings today.

Zero carbon buildings are cheaper to run

On average, zero carbon homes use 1/3 of the energy of a standard new build home. This means large energy bill savings for occupants, even more so where buildings generate renewable energy.

Our energy system needs us to use energy efficiently

As our energy system transitions away from fossil fuels it's important we use energy efficiently so it can adapt and decarbonise faster.

We need to generate our energy from clean, renewable sources

The amount of renewable energy we need to generate in the UK needs to quadruple by 2050 according to the National Grid. Buildings offer the ideal location for solar panels, where they deliver benefits to occupants and do not compete with other land uses.

There are few arguments for not going zero carbon!

The biggest ones are costs and shortage of skilled labour.

Cost uplifts are minimal, have already fallen and will continue to fall as more people adopt these practices. Skills shortages can be overcome through training and learning project by project.

Folkestone & Hythe's carbon budget = 3.1 $MtCO_2$ (from 2020)

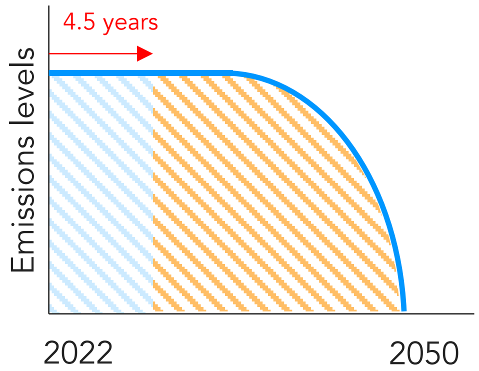
Current emissions rate = 0.47 $MtCO_2$/yr

Years left of budget at current emissions rate: **4.5 years**

Annual emissions

UK's carbon budget

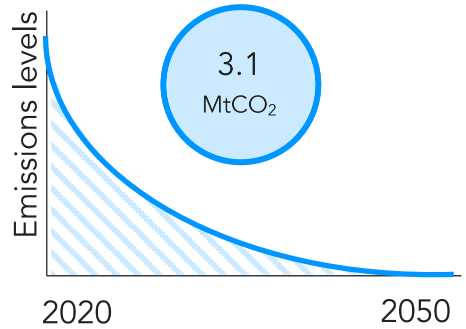
Carbon overspend



Trajectory type A

This trajectory continues at current emissions rates until the 2030s at which point it drops off steeply.

It is zero carbon by 2050 but the carbon budget is far exceeded.



Trajectory type B

This trajectory sees a 13.3% reduction in emissions year on year. Cumulative emissions stays within the carbon budget.

Other trajectories are possible – but it's imperative that we do not overspend on carbon, otherwise we will not be on a Paris compliant trajectory.

Context | The low carbon electricity revolution?

Towards a decarbonised and smarter electricity system

The carbon content of electricity has fallen over the last few years. It is now three times less than ten years ago and already lower than natural gas on a per kWh basis. It is forecasted to continue to reduce even further over the next 20-30 years. This explains the current energy revolution and why the electrification of transport and heat is the best strategy to move away from fossil fuels. It is also considered unlikely by the Climate Change Committee that hydrogen will play a significant role in heating our homes.

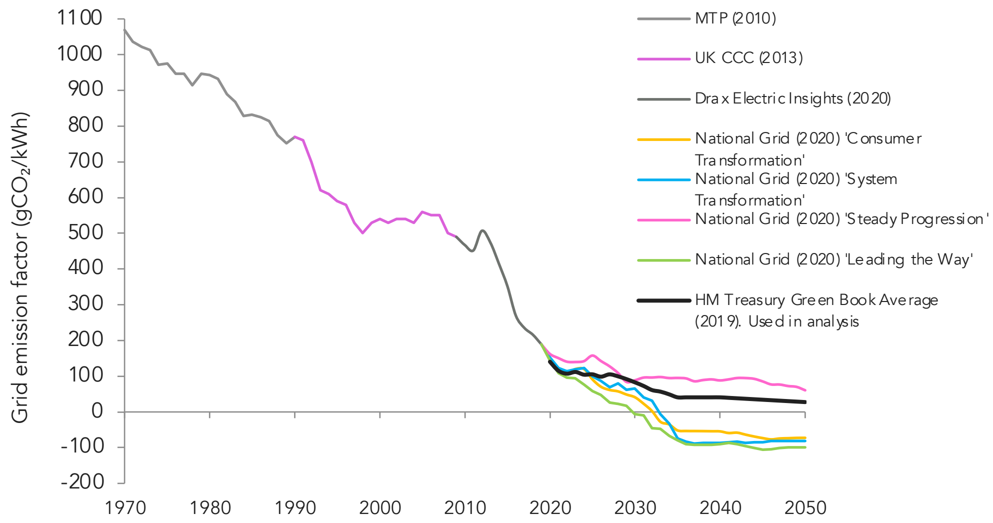
In order for this electricity revolution to be successful and as cost effective as possible it is very important to reduce energy use so that energy demand is not more than renewable and nuclear energy generation by 2050. If electricity demand is more flexible, it can also be matched to times of high renewable energy generation. Electric vehicle charging from homes will also create additional demand for electricity*.

The impact on buildings

The electrification of heat (e.g. the replacement of gas boilers by heat pumps) is widely considered as one of the main priorities of decarbonisation. New gas or oil boilers should not be installed in buildings anymore, in new or existing homes.

Energy storage (e.g. hot water tank) and management (e.g. smart controls) as well as smart meters for Time of Use (ToU) variable electricity tariffs are all likely to become increasingly important.

In summary, electrification and digitalisation provide the backbone of decarbonisation for buildings.



Long-term variations in emission factor of grid electricity show the rapid historical reduction in emission factors *© Etude based on data from Market Transformation Programme, UK Committee on Climate Change, Drax, National Grid and HM Treasury.*

Note: *The National Grid Future Emissions Scenarios (FES) show that if the power sector removes CO_2 from the atmosphere by the growth of biomass and captures it when it is used in power stations, it could be carbon negative. This would rely on the use of Bioenergy with Carbon Capture and Storage (BECCS). Carbon Capture and Storage is a process in different steps: CO_2 produced is captured, transported away and isolated from the atmosphere in long-term storage in geological formations or for use in industrial processes). When more carbon is removed from the atmosphere and stored by a process than is emitted into the atmosphere, emissions are negative. BECCS features prominently in three of the four scenarios modelled in FES.*

Context | Beyond energy – wider sustainability

Sustainable design goes beyond energy and carbon. It's important we design and build developments that operate within planetary boundaries, to create healthy, happy environments for people, and support the wider natural environment on which we all depend.

To truly address climate change we need to think holistically

The environment in which we live is inextricably interlinked.

Climate change is changing our weather patterns, increasing extremes in weather that the built environment needs to respond to. Increased risk of overheating, unpredictable rainfall, increased flooding, stronger winds.

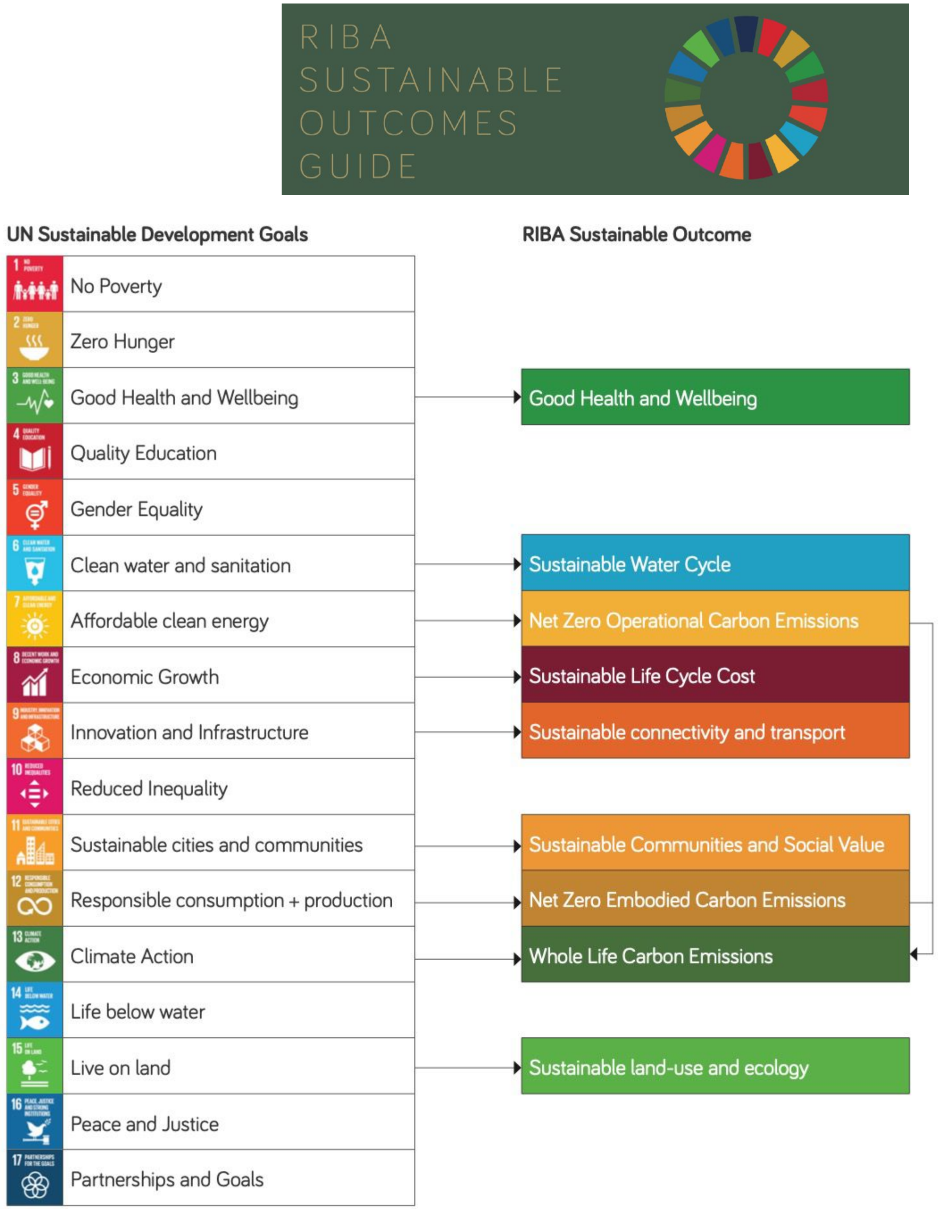
The environment around us plays a big part in mitigating these risks: trees and plants help keep us cool, green space absorbs and retains rainfall and carbon and provides habitat for wildlife.

How our environment is designed can also facilitate healthier and more sustainable lifestyles: encouraging active travel, reducing car use and water use, providing space for communities to come together.

The RIBA's Sustainable Outcomes

The United Nations Sustainable Development Goals (SDGs) are a collection of 17 interlinked global goals designed to "be a blueprint to achieve a better and more sustainable future for all". The 17 goals go beyond energy and span the triad of sustainable development: environmental, social and economic sustainability.

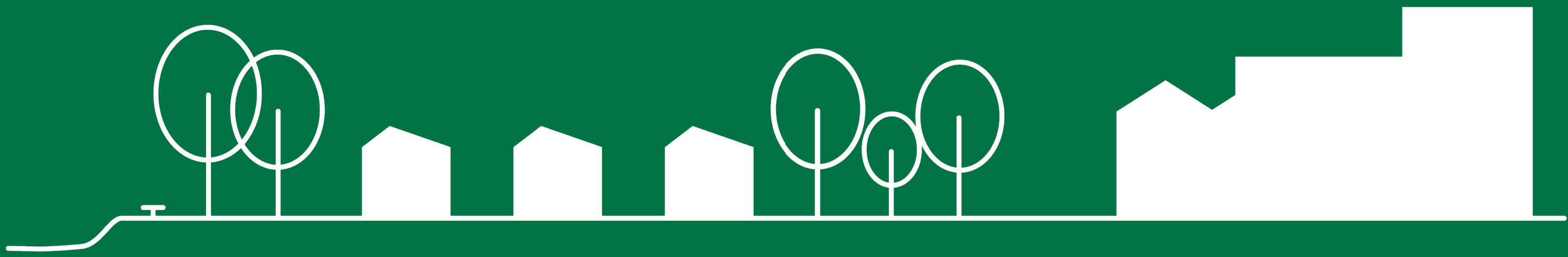
The Royal Institute of British Architects (the RIBA) has analysed the UN's SDGs for where and how the design of the built environment can positively contribute towards the achievement of these goals. The diagram on the right summarises the results of this work, which are distilled into the RIBA's nine sustainable outcomes.



The RIBA Sustainable Outcomes Guide translates the United Nation's Sustainable Development Goals into 9 key outcomes the built environment should aim to achieve.

2 CORE PRINCIPLES

This chapter outlines the fundamental principles for designing and constructing Net Zero projects, including energy efficiency of the building, low-carbon heating, and on-site renewable energy generation. It also discusses embodied carbon, as well as broader sustainable performance metrics and suggested assessment tools for beyond energy.



Core principles | Net zero carbon buildings summary

Net Zero carbon buildings in operation are defined by four core principles that are inter-related. The impact of each one the others should be considered when measuring Net Zero performance. The principles are:

1 - Energy efficiency

Buildings use energy for heating, cooling, hot water, ventilation, lighting, catering, and other electronic equipment. The efficient use of energy reduces running costs and carbon emissions. It also reduces a building's impact on the wider energy network, which is also an important consideration for future renewable generation capacity.

2 - Low carbon heating

Low carbon sources of heating and cooling are an essential feature of Net Zero carbon buildings. All new buildings should be built with low carbon heating/cooling from the moment they start operating and must not connect to the gas network.

3 - Renewable energy generation

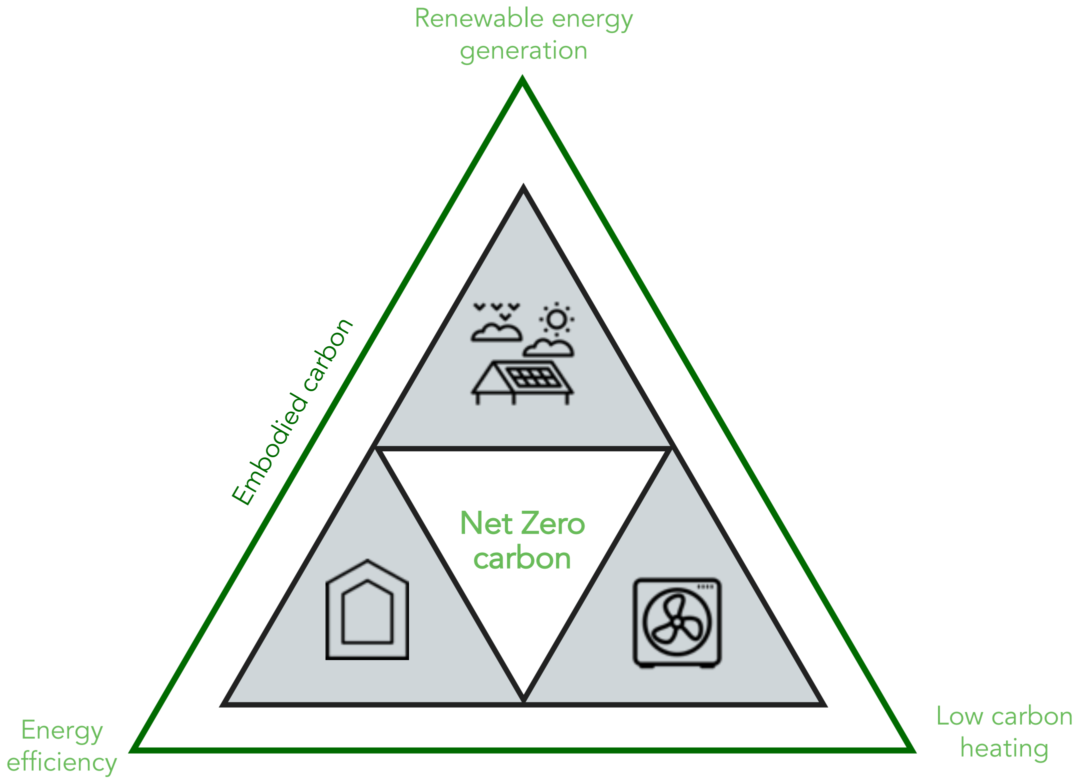
In new buildings, renewable energy generation should be at least equal to the energy use of the building on an annual basis for it to qualify as Net Zero carbon in operation. This is straightforward to achieve on site for most new buildings through the use of solar photovoltaic (PV) panels.

4 - Embodied carbon

Operational carbon is only part of the story. Net Zero buildings should also minimise embodied carbon in the materials.

Beyond energy

Buildings impact on the environment in more ways than just energy and carbon. A Net Zero building should fully consider how it will consume other resources and change the place in which it is located, both positively and negatively as well as now and into the future.



The four core principles of a Net Zero building

Evaluating performance

Two techniques underpin the principles of a Net Zero building:

- Accurate **modelling** offers a way of testing the impact of decisions, stress testing buildings and understanding how systems will impact on real life performance. Modelling to level required for Net Zero means that each core principle needs to be fully considered and based on realistic conditions.
- Detailed **monitoring** helps us understand if the targets are achieved in-use and confirm the accuracy of the model that was created. This is important for developers as well as planning authorities to understand what is or isn't working.

Combining modelling and monitoring enables improvements to a building's performance whilst it is being used.

Core principles | Energy efficiency

Why is energy efficiency important?

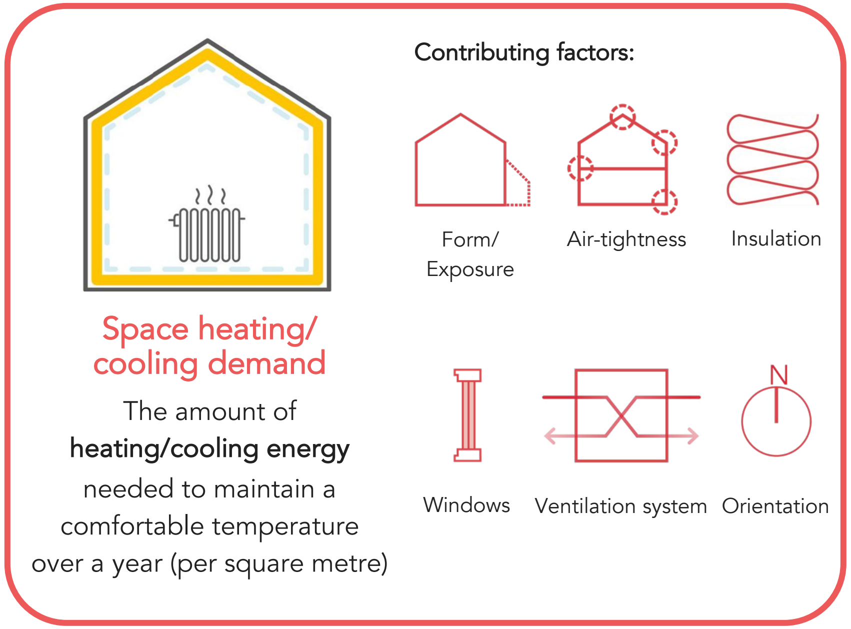
Energy efficiency is important for a number of reasons. An energy efficient building:

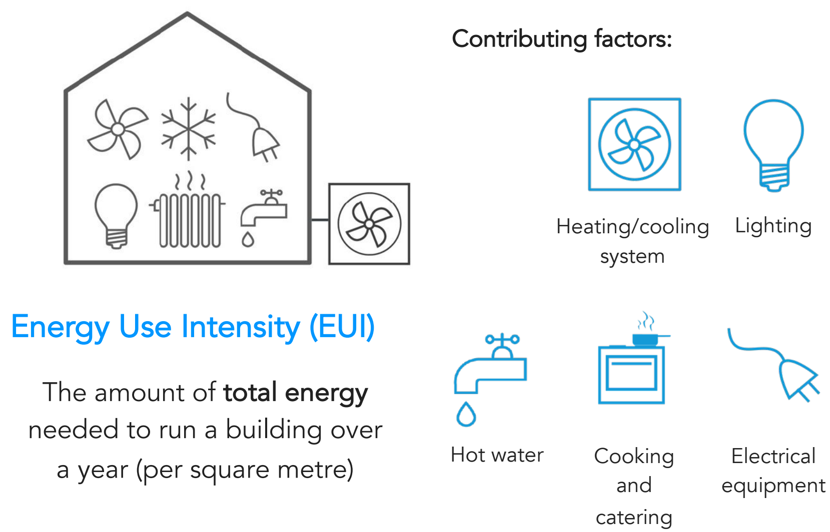
- Reduces energy costs to users and occupants and provides a comfortable, healthy space in which to live and work.
- Has built-in performance that will last the lifetime of the building and doesn't rely on the occupant's knowledge or skill to work.
- Is more flexible in terms of the heating and cooling system it can use – both direct electric systems and air source heat pumps can be used (although the latter is preferred – see the Low Carbon Heat page).
- Internal temperature changes very slowly (over days not hours). The building can be more flexible about when heating or cooling is needed. This means that a building can be heated and cooled when energy is cheaper and lower in carbon.

How we measure energy efficiency

Energy efficiency can be measured using two key metrics:

- **Space heating/cooling demand**, which is the amount of **energy** needed to heat or cool a building over a year (per square metre). It is a measure of the thermal efficiency of the building ($kWh/m^2/yr$). Various design and specification decisions affect space heating/cooling demand including building form and orientation, insulation, air-tightness, windows and doors and the type of ventilation system.
- **Energy Use Intensity (EUI)**, or metered energy use, is the **total energy** needed to run a building over a year (per square metre). It is a measure of the total energy consumption of the building ($kWh/m^2/yr$). The EUI of a building covers all energy uses: space heating and cooling, domestic hot water, ventilation, lighting, catering and electrical equipment.





Core principles | Low carbon heating and cooling

Low carbon heating and cooling is critical for Net Zero

Net Zero carbon buildings should not burn fossil fuels for energy, this is fundamental in meeting carbon budgets. Low carbon alternatives that are available now include heat pumps and direct electric active systems. Electricity can be met through on-site renewables and through grid electricity, which is becoming increasingly decarbonised.

Heat pumps are the most efficient way to deliver heating and cooling

Heat pumps use refrigerant to efficiently move heat from one place (outside the building) to another (inside the building). They can source heat or dump heat (depending on whether they are in heating or cooling mode) to the outside air, the ground, or a water source. Heat pumps can provide space heating, cooling and hot water and can serve individual buildings or communal networks.

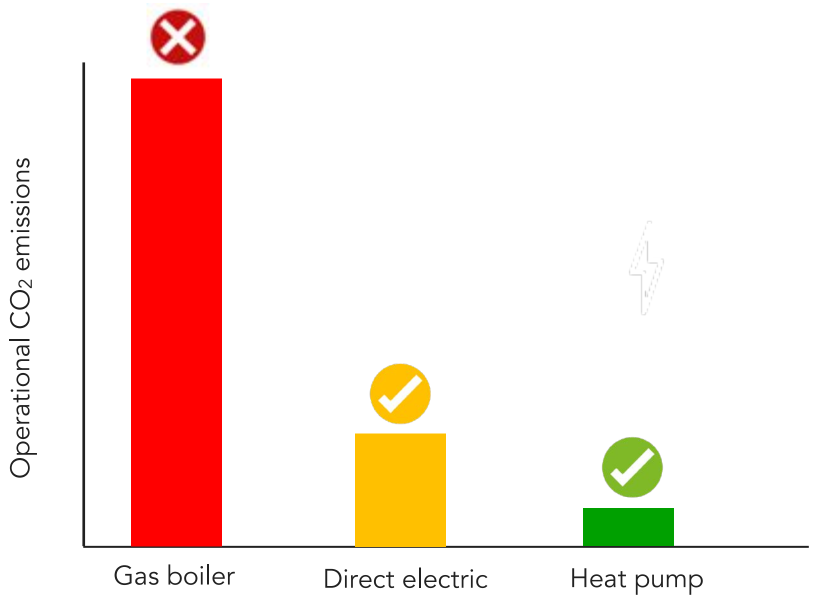
They key benefit of heat pumps is how little energy they use to meet a heating or cooling demand, this is measured by their efficiency. Efficiencies vary, but are typically around 250-300% for an Air Source Heat Pump, meaning that for every 1kWh of electricity they use, they produce 2.5-3kWh of heating or cooling energy.

Direct electric as an option for heating

Direct electric heating systems convert electricity directly into heat through resistive heating. It is typically 100% efficient. The price of electricity can make this a relatively expensive means of heating buildings and providing hot water, unless cheaper off-peak electricity is used. These systems become more realistic when a building's heating demand is reduced to an absolute minimum, especially in smaller buildings such as residential flats.

How the systems can impact on meeting Net Zero targets

Systems that will consume less energy will improve a buildings capability of achieving an energy balance on site and the Net Zero objectives. Heat pumps are the best way to do this.



Options for heat - the choice of system will affect operational CO_2 emissions over a long time. Electric forms of heating (direct electric and heat pumps) will emit a fraction of a gas boiler's carbon emissions (averaged over 2022-2050).

Key points

- New buildings need to be low carbon now: direct electric and air source heat pump systems can deliver this immediately.
- Heat pumps represent the most efficient way to heat or cool a building, they are cheaper to run, and reduce peak loads on electrical infrastructure.
- Delivering heat in the most efficient way is crucial, we all often need heat at a similar time. This puts pressure on energy infrastructure that could be helped by being more efficient.
- Hydrogen for heating or cooling in buildings is still an immature technology and is certainly not currently a low carbon one. Buildings are not the priority consumer for hydrogen, other harder to decarbonise sectors such as manufacturing will need it more.

Core principles | Renewable energy generation

Solar photovoltaics are ideally suited to buildings

Solar photovoltaic (PV) panels generate electricity when exposed to sunlight. They are usually the most appropriate form of renewable energy generation for a building as they are a simple, mature, durable technology that can be installed on both roofs and suitable facades.

Aim for at least an energy balance

A net zero energy balance is achieved when the renewable energy generated in a year matches the energy used in a year (the EUI).

In the UK it is generally possible for blocks of flats up to six storeys in height, most houses, small schools, warehouses, and other low density building types to achieve a net zero energy balance on site through the use of rooftop solar PV arrays, heat pumps and efficient building fabric.

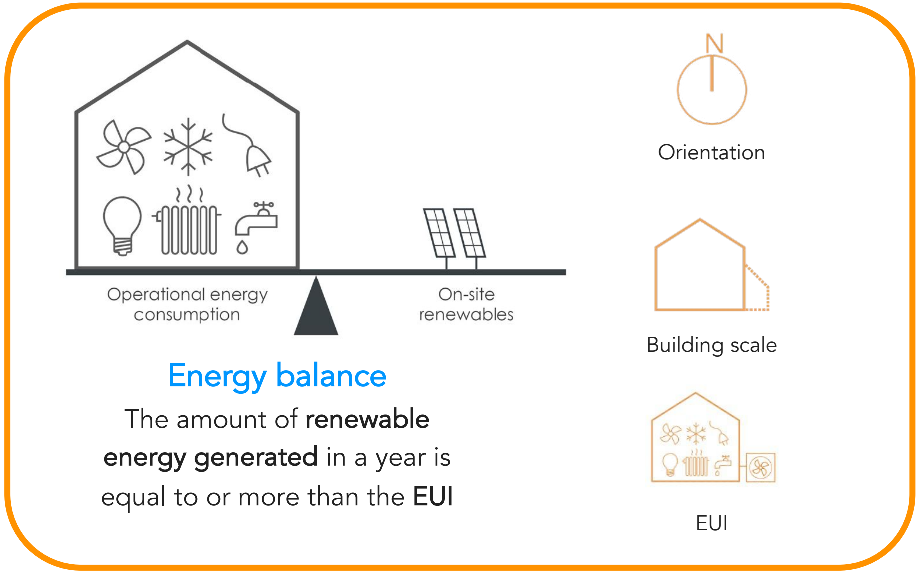
Roof design maximises solar photovoltaic energy generation

By considering solar photovoltaics at the very earliest of design stages, it's possible to optimise roof shape and orientation to maximise solar photovoltaic output – in turn maximising returns for occupants. How well a roof space is designed and utilised can be expressed in kWh of energy generated per m^2 of building footprint.

Renewable energy generation offers many benefits

Generating electricity at the point of use offers several advantages, including:

- provision of cheap electricity close to a place that needs it, that can offset electricity consumption at full retail price,
- the ability to directly power building systems or charge electric vehicles from renewable energy, and
- immediate decarbonisation of electricity supplies (rather than having to wait for the UK grid to decarbonise).



Key points

New buildings need to play their part in renewable energy generation:

- Solar deployment across the UK is currently insufficient to stay within our carbon budgets. All suitable opportunities should be taken to install PV, buildings are one of these.
- Buildings provide much of the supporting structure needed for solar panels with little additional material needed. This reduces the overall carbon impact of installing renewables across the UK.
- PV electricity generated on a building can be directly consumed at the point of generation reducing overall transmission losses.
- Offsite PV (such as those on fields) systems may be needed in addition to the building systems but should not be considered as an alternative.

Core principles | Embodied carbon

Reducing emissions across the lifetime of a building

Embodied carbon refers to the greenhouse gas emissions associated with the:

- Manufacture, transport and construction – the **upfront** carbon,
- Repair, maintenance and replacement – the **in use** carbon, and the
- Deconstruction and disposal – the **end of life** carbon.

As the operational energy in buildings is improved (and its associated carbon) the embodied carbon becomes an increasingly significant component of a building's carbon footprint. It is important that both operational carbon and embodied carbon are fully measured and reduced. The two can often be related.

Reducing embodied carbon can feel like a challenge, but following some simple steps will help:

- Identify big ticket items early on and spend time trying to reduce the quantities of higher carbon materials used,
- Specify high quality materials that are designed to be robust, this will improve the longevity of the building, and
- Ensure that as much of the building as possible can be deconstructed at the end of its life to improve the potential for reuse parts of the building.

Upfront embodied carbon

Upfront embodied carbon covers the emissions up and until the building is ready for occupation. In general, it represents the largest chunk of the embodied carbon across the building lifetime. Setting clear targets for measuring and reducing it should be undertaken from the very earliest design stage.

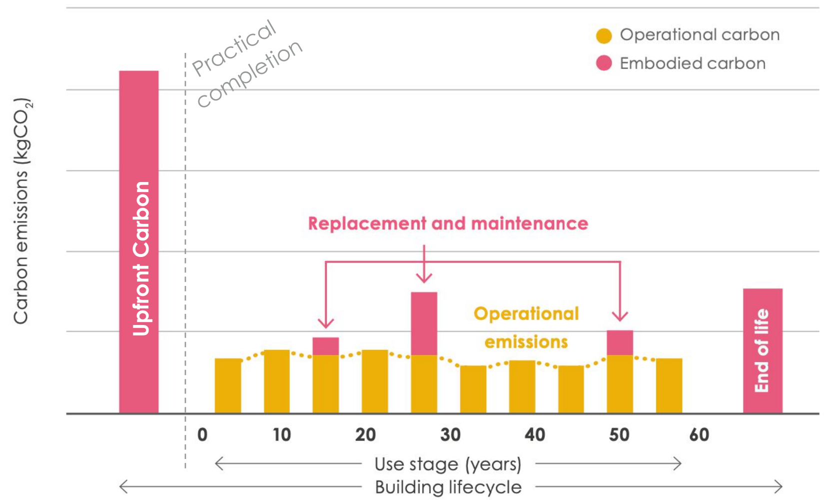
The biggest savings can often be found in the building's structure and collaborating early on with the responsible engineer to develop the leanest possible structural arrangement.

In use carbon

The emissions from operating and maintaining a building (ignoring energy consumption and water use) are accounted for in this stage. Building services are often an important component and should be fully calculated in the embodied carbon assessment. Other big hitters can include the routine replacement of building components such as windows or internal finishes.

End of life carbon

When the building comes to the end of its usable life there will be a process of deconstruction, removal of material and processing – which are captured in this phase. Planning for a building's eventual deconstruction is an important, often over-looked part of design. Creating buildings that are easier to break-down into their composite materials (promoting reuse and recycling) is both important in reducing embodied carbon as well as being a fundamental part of the circular economy – see the circular economy section for more information.



Embodied carbon is the carbon emissions associated with the full life cycle of the building: its production, construction, maintenance and end of life stages. In low energy buildings the embodied carbon is a significant proportion of the overall carbon footprint of a building, especially the upfront carbon emitted before practical completion. (Source: LETI Embodied Carbon Primer)

Core principles | Site wide sustainability

Considering the wider sustainability picture

A development that achieves its purpose successfully is one that works well with its wider context. The design and layout of a development is often a qualitive exercise, based on it's impact on the environment such as ecology, social value, health and wellbeing and water environment. But the decisions made at site level can have the ability to make or break whether the buildings can achieve Net Zero Carbon and whether it supports the local community, biodiversity and other wider sustainability goals. It is not practical to set Net Zero targets for a site in the same way as at building level, however the following principles can be followed:

Site Appraisal

The site appraisal should be the first step to determine the opportunities and constraints of the site and identify the sustainable characteristics and potential. This will allow the design team to understand where the big wins are for retention of existing buildings, orientation, overshadowing, massing, density and connections to the wider area.

Retrofit First

The optimal choice would be to reuse and retrofit the suitable existing buildings and structures on-site as this reduces additional embodied carbon from new build elements.

Designing for Net Zero at masterplan level

A Net Zero development will fully consider how it will consume other resources and change the place in which it is located, both positively and negatively as well as now and in the future. Orientation and massing of the building should be optimised, to allow useful solar gains and prevent significant overshadowing in winter.

Sustainable transport

Schemes should integrate high quality travel and transport infrastructure with consideration of and connection to walking, cycling and public transport routes in and beyond the site. Ensure connectivity and permeability with existing footpaths, cycle routes and public transit routes.

Blue and green infrastructure

Maximise green and blue infrastructure to benefit local wildlife and help a site to have a circular water cycle that reduces the risk of flooding. More nature/plants help to improve air quality and lower local air temperatures. All have a knock-on effect on human wellbeing.

Community

Consider a radius of amenities within a 15 min walk from the home is best practice for residents to avoid using a car. It is also crucial to provide wider accessibility to employment facilities, shops and cultural attractions that are accessible via sustainable transport methods such as cycling or public transport.

The core principles of site wide sustainability

Sustainability Assessment Schemes and Targets

This page sets out a series of assessment methods that have targets to achieve wider sustainability goals. The table on the following page also outlines various best practise performance measures for beyond net zero sustainability that are associated to developing a sustainable, environmentally friendly neighbourhood.

One Planet Living is a framework created by Bioregional with the World Wide Fund for Nature, based around 10 principles with detailed goals and free guidance, addressing environmental, social and economic sustainability. This framework is based on the ideology that we only have one planet and therefore living within its means. It focuses on how people live and work and therefore a good framework for small to large projects with community in mind.

Home Quality Mark (HQM) is a certification scheme designed by the Building Research Establishment (BRE). The guides are available to download for free and can be used to guide design decisions whether or not a development is to be certified. This is principally concerned with environmental sustainability and should be used for beyond energy measures.

BREEAM is a certification scheme used for mixed use or commercial developments. BREEAM compliance is certified through a third party certification of the assessment of an asset's environmental, social and economic sustainability performance, using standards developed by BRE. A BREEAM assessor is required to carry out the assessment. The criteria however could be used to inspire and set KPIs for projects of all types.

The **WELL building standard** is a certification scheme that uses a performance-based methodology for new and existing buildings measuring, certifying, and monitoring built-environment qualities to gain WELL CertifiedTM accreditation. The WELL Building Standard addresses health in the built environment holistically, covering behaviour, operations, and design.

The Royal Institute of British Architects (RIBA) has developed the **RIBA 2030 Climate Challenge** which sets a series of stepped targets for architects to adopt to reduce operational energy, embodied carbon and potable water for schools, commercial and residential buildings to reach net zero. It is recommended that the targets for 2030 is used to ensure buildings are future proof and built to net zero standards.

The **Living Building Challenge** is a certification scheme by the Living Future Institute that sets ambitious targets for truly regenerative design based on actual, rather than modelled performance with buildings demonstrating at least twelve months prior to audit to verify compliance. All Living Building Challenge projects must be holistic—addressing aspects of all seven petals through the core imperatives of the framework.

The **Building with Nature** standard is a certification scheme for high-quality green infrastructure by bringing together policy and practice guidelines on health and wellness, sustainable water management, and biodiversity. It can be used for residential, commercial and infrastructural developments. There are two types of rating certification standards; a BwN Design Award is used to validate projects at an early stage of design, such as an outline planning application for larger developments. The BwN Full Award is used to accredit projects at a later stage of development and includes a post-construction assessment.

Core principles | Beyond net zero | Performance metrics

	Best practice metrics		Assessment methods, tools and references
Water use	Homes - <95 l/person/day (with grey water recycling)	<105 l/person/day (without grey water recycling)	•RIBA 2030 Challenge •BREEAM Water •CIBSE Guide G •Living building challenge •AECB water standards
	Offices / commercial - <10 litres/person/day		
	Schools - <0.5m3/pupil/year (approximately equivalent to 3 litres/person/day)		
	Grey and rainwater recycling for waste water from sinks, dishwashers, showers and baths, and process it and recycle it back into toilets, washing machines and outside taps		
	Reduce flow rates on taps and showers		
	No potable water should be used for irrigation		
Flooding	Utilise Sustainable Urban Drainage appropriate to the scale of the development		•Flood risk assessment •BREEAM Water •Living building challenge
	Ensure floor levels are more than 600mm above the flood level predicted for a 1:100 year flood event (plus climate change)		
	If greenfield site 40% improvement on existing run off rates (accounting for climate change)		
	If urban brownfield site improve or reduce run off rates increase from the existing (accounting for climate change)		
Ecology and biodiversity	Positive biodiversity net gain of at least 20% improvement on all sites		•Building with nature •Nature recovery networks •CAVAT assessment •BREEAM Ecology •One planet living •Living Building Challenge •i-tree benefit tool •Susdrain's B£st •Green Infrastructure Valuation Toolkit
	Existing tree retention for all category A and B trees		
	For urban sites achieve an urban greening factor of >0.5		
	Incorporate Building with Nature principles. Include blue green infrastructure where possible		
	Habitat provision for insects, mammals, birds, bats and bees within the site and buildings		
	Provision for food growing such as community or individual allotments		
Circular economy & waste	At least 90% of construction waste to be diverted from landfill		•Living Building Challenge •ARUP Circular Economy Toolkit •Urban Flows Observatory Regenerate Tool
	Work with a structural engineer to optimise the structure and facilitate re-use		
	Source reclaimed materials where possible		
	Utilise building components in a way that they can be re-used.		
	Design convenient, adequately size storage for recyclable waste, food waste (such as composting) and general waste		
	Consider future adaptability of the masterplan and the buildings such as communal parking courts that change use in the future.		

Core principles | Beyond net zero | Performance metrics

	Best practice metrics	Assessment methods, tools and references
Thermal comfort	Comply with Part O of the Building Regulations (Overheating) and pass CIBSE TM59 Overheating risk assessment	•**Building Regulations Part O** •**TM59 overheating assessment** •**BREEAM** •Good homes alliance overheating checklist
	No single aspect apartments and maximise dual aspect.	
	Solar shading such as brise soleil and window ratios should be used first to mitigate overheating	
	If g values have to be used if above methods do not go far enough do not use g-values below 0.5	
Sustainable transport	Ensure connectivity and permeability with existing footpaths, cycle routes and public transport routes	•**Building Regulations Part S** •**BREEAM transport** •**Transport for New Homes checklist** •One planet living
	Comply with Part S of the Building Regulations (Infrastructure for charging electric vehicles)	
	One EV car charging point (min) for every household regardless of driveway, communal car parking or on street parking.	
	Provide 50% Active and 50% passive EV charging points for non-domestic	
	Visitor cycle stand provision (include electric bike charging). For larger sites provide bike repair facilities.	
	Minimum of 2 cycle spaces per household and secure cycle storage that is easily accessible	
	Provide a mobility hub appropriate to the scale of the site	
Community	Accessibility to existing facilities within 15-20 minute walk or cycle from the building: children's play space, activity/recreation spaces, food shops, schools, green space, community facilities	•**Healthy streets assessment** •**Reset Air standard (in use)** •RIBA Social Value Toolkit •BREEAM Communities •BREEAM Health
	Provision of public and private amenity space such as communal gardens, food growing, children's play, wellbeing walk routes on site.	
	Provide community hub with facilities appropriate to the scale of development.	
	Multigenerational inclusive design responding to all ages and mobilities.	

Key Performance Indicators | New Buildings

Setting the right brief and targets is key

To achieve Net Zero carbon both in design and when a building is being used, it is important that the brief and targets reflect this ambition from the start. A strong brief needs to provide tangible guidance on how targets will be achieved. Best practice KPIs for new buildings are listed in the table and all KPIs must be met for a building to be considered Net Zero carbon.

Getting the right team

Delivering Net Zero carbon relies on the effective and successful coordination of a shared vision. Therefore, getting the right team on board at the right time is critical. The early appointment of an energy consultant with a specialism in Passivhaus (or similar standards), as well as the early consideration of embodied carbon are recommended. A 'Net Zero carbon kick-off workshop' can be used to ensure the wider consultant team are clear on the targets and their responsibility in achieving it. Project gateways should be used to continually check the performance of a building against the KPIs.

Consider Passivhaus certification

Passivhaus certification is a robust means to meet the space heating demand and energy use intensity KPIs. It also drives quality assurance during construction. This involves the early appointment of a Passivhaus 'designer' to steer the design from concept stage and carry out PHPP (Passivhaus Planning Package) modelling. A Passivhaus 'certifier' will be required to act as an impartial quality assurance check on predicted performance during design and to carry out site inspections.

Accurate energy models will help inform Net Zero performance

PHPP is one example of accurate modelling, other examples include TM54 and NABERS. Building an accurate energy model will help test options during the design phases and understand building performance when they are occupied and in use.

	KPIs New housing	KPIs New apartments	KPIs New schools	KPIs New commercial
Energy demand	Space heating demand 15 kWh/m²/yr *or a heating load of 10 W/m²*			
Energy consumption	Energy Use Intensity			
	35 kWh/m²/yr		65 kWh/m²/yr	70 kWh/m²/yr
Renewable energy	Electricity generation 120 $kWh/m^2_{fp}/yr$ (m^2_{fp} : m² building footprint)			
Embodied carbon	Upfront carbon good practice benchmark			
	300 $kgCO_2e/m^2/yr$	500 $kgCO_2e/m^2/yr$	600 $kgCO_2e/m^2/yr$	
Water consumption	Water use on average*			
	95 litres/person/day		3 litres/person/day	10 litres/person/day

**see previous page (Performance Metrics) for more details*

3 PLANNING FOR NET ZERO

This chapter examines the cost of Net Zero, the skills necessary, and a planning timetable to aid developers and architects in determining what to consider prior to planning and during construction via a checklist that corresponds to the RIBA work stages.

Planning for Net Zero | Capital costs

Available evidence: completed buildings

More and more buildings have been constructed with the key 'ingredients' of Net Zero buildings:

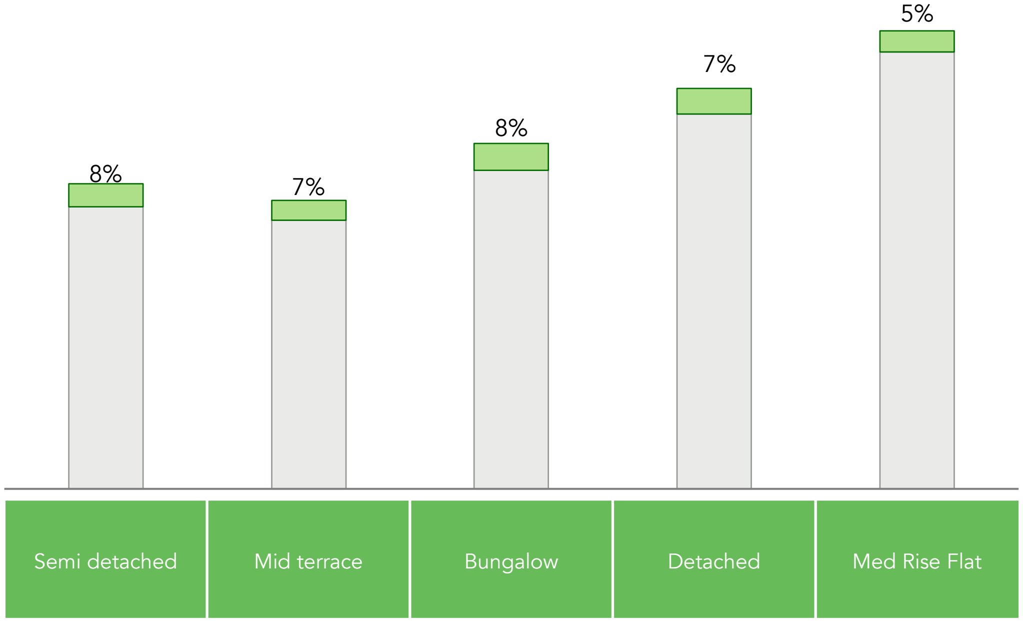
- **Energy efficiency:** in the UK, more than 1,300 buildings have achieved Passivhaus certification at the end of construction and there are many other non-certified energy efficient buildings of all types.
- **Low carbon heat:** more than 20,000 heat pumps are being installed every year in the UK and this is predicted to increase to 600,000 a year.
- **Renewable energy generation:** many buildings already have a PV system in their roofs.

Although many buildings combining these three 'ingredients' are being designed and built at the moment, very few buildings have already been completed, making it hard to have 'as built' data on the cost of Net Zero buildings.

Available evidence: cost and viability assessments

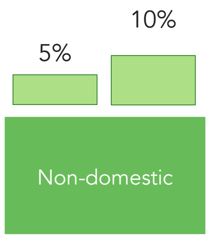
The main source of evidence for the additional cost of Net Zero carbon buildings is therefore various cost analyses undertaken by cost consultants in support of the evidence base for new local plan policies, or strategic work undertaken for public and private sector clients interested in building Net Zero Carbon buildings.

Cost consultants Currie & Brown in particular have undertaken a number of these analyses for Greater Cambridge, Cornwall Council and the Isle of Wight Council. An example of their work is shown on this page. Some of these studies and their findings are publicly available. However it should be noted that these studies are based on local cost data and should therefore be reassessed to factor in local baseline and additional costs.



Extract of an analysis undertaken by Currie & Brown into the additional cost of Net Zero Carbon new buildings

The uplift in construction costs of Net Zero Carbon homes (in operation) compared with Part L 2021. This 'Net Zero' premium is considered acceptable particularly in comparison with other cost increases affecting the housing market. It is also important to see it as a premium that can only be reduced over the next 30 years as Net Zero becomes the norm.



Non-domestic buildings

Because of the variety of non-domestic buildings, published data on cost uplifts is less available. Typically the uplift range is estimated to be between 5% and 10%.

In buildings where there is more standardisation, such as schools or hotels, the cost of meeting Net Zero can be towards to lower end of this range.

Planning for Net Zero | Ongoing costs

The ongoing costs of buildings include several potential variables:

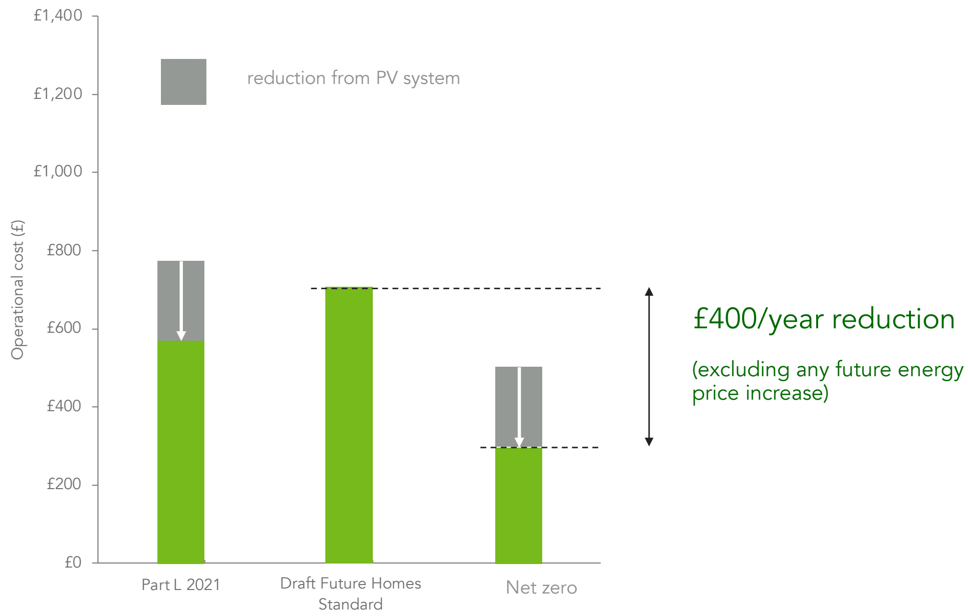
- **Energy tariffs** – the cost per unit of electricity or gas. This can vary depending on the type of tariff and the time of use.
- **Standing charges** – a regular cost added to energy bills irrespective of the amount used.
- **Maintenance costs** – a regular cost to maintain a system in good working order as well as replace parts periodically.
- **PV generation** – the energy generated from PV that can either be consumed directly by the connected building or exported to the grid.
- **Export Tariff** – the energy exported to the grid will receive a financial remuneration. The export tariff determines the rate per kWh of this remuneration.

Agility is the key to saving money and carbon

Heating energy can often be the most inflexible energy, as peak heat loads for many buildings coincide. Net Zero buildings avoid this need, often needing very little heat even in colder weather due to their energy efficiency. This means the heating system can operate during off peak hours to maintain a comfortable temperature in the building.

The way we meter and pay for energy is changing rapidly in the domestic market and has already evolved in the non-domestic one. The ability to be flexible with when you can use energy means that you can buy energy at off-peak rates, saving you money. Often the cheapest electricity coincides with lowest carbon energy. Alongside this, tools are increasingly available that help consumers monitor the carbon intensity of the grid and use energy in a smarter way.

OFGEM has signalled that the energy market will head towards higher frequency billing, with half-hourly metering becoming standard within the next few years. This will give more options to those who can be more flexible about when they need energy.



Potential domestic savings from constructing to Net Zero standards compared to current and future versions of the building regulations. As shown the the incremental improvements in buildings regulations do not always translate to a reduction in costs for residents.

Planning for Net Zero | Skills

Upskilling across the construction sector is needed if we are, as a country, to shift towards Net Zero buildings. As much as central government carries a heavy responsibility for this, the construction sector start constructing to the standard now. All the parts are there to construct Net Zero buildings today

On-site supervision and programming

The disparity between how buildings are designed and how they are constructed has been major contributor to creating the performance gap. To rectify this construction sites need to evolve and site managers must lead the change. Constructing low energy buildings does not rely on a substantial change in our current approach but simply better management and monitoring, more consideration for sequencing, and comprehensive post-construction commissioning and checks.

Install the low carbon technology available today

All the technology required to meet Net Zero standards is in existence and well understood. Designers and developers must allow for these systems from a project's inception and set targets for optimum performance. Installers should then take responsibility for implementing these plans and testing that the technology meets the designed performance.

Simple upskilling options are out there

Training courses for both building designers and contractors are available that take their existing knowledge and adapt it to help construct low energy buildings. Seeking out these courses before starting fully on a project will help with both the immediate projects and future ones.

The Passivhaus community in particular has courses for designers and contractors that provide the skills needed to meet the Net Zero targets.

A significant part of reducing energy demand in buildings is minimising heat losses and air leakage and paying attention to detail. Site supervision and empowering construction teams to take responsibility for these performance items is a crucial part of this. The images above show techniques for reducing and testing for air leakage. This can be achieved by using off the shelf products and considering construction sequence from an early stage.

Technology that drives down energy consumption is easily available. Designers and contractors must however allow for these systems early-on in scheme conception and pay close attention to their installation, commissioning and maintenance. Allowing space on floor plans from an early point in design is crucial. The above images show the integration of (from left to right) an individual heat pump, a mechanical ventilation system with heat recovery, and roof mounted photovoltaics.

Planning for Net Zero | Planning timeline

Delivering Net Zero carbon relies on the effective and timely coordination of a project across all stages. Aspiration for both site and building level net zero should be from day one even if the details of the planning application are not fixed yet. This timeline gives an overview of the key actions required for the client and design team to be aware of in order to meet Net Zero carbon up to planning and tender. Construction has been left out of this timeline but a detailed checklist can be found on page 31. Considerations should also be made to in use monitoring to ensure the buildings achieve the KPIs in use.

SETTING THE RIGHT BRIEF

Setting the brief and getting the right team

- Brief assessment: is a new building required? Can an existing building be retrofitted?
- Site assessment: what are the key ingredients for the sustainability strategy and what are the strengths and weaknesses of the site?
- Include Key Performance Indicators (KPIs) requirements in the brief .
- Appoint the relevant consultants and specialists e.g. sustainability consultant with Passivhaus or relevant expertise.
- Ensure design team collaborate with consultants such as ecologists, highways, flood etc.
- Embodied carbon assessment included in scope (particularly for medium to large scale developments).
- Overheating assessment (Part O, TM59 & TM52) included in scope at an early stage to feed results into design
- Predictive energy modelling (e.g. PHPP) included in scope
- Specify use of low carbon heating options e.g. heat pumps

PLANNING

For pre-application and full planning permission

- Include KPI requirements stated in the brief
- Include a site wide sustainability strategy that acts as a guide to how the project will achieve its KPIs covering energy and site wide sustainability

Outline planning permission

- It is really important to include clear Key Performance Indicators (KPIs) requirements in the brief and as part of any feasibility study
- It is difficult to upgrade ambition further down the line so that these are followed through on each reserved matters application
- If phased development, include a clear sustainability strategy that states the KPIs at each phase if applicable

PRE-CONSTRUCTION

Detailing, specification and choosing the right products

- Include KPI requirements stated in the brief in the tender
- Detail build ups of all external elements including thickness and conductivity of all materials and contact suppliers for confirmation of U-values
- Detailed U-value calculations and thermal bridge analysis
- Ensure design team identify all thermal bridges and conduct thermal bridge calculations
- Define airtightness testing requirement for contractor
- Specify high performing solar panels
- Consider post occupancy evaluation (POE) and agree scope
- Continue to assess and reduce embodied carbon

In use monitoring against KPIs

- Provide building user guides and instructions e.g. sticker on MVHR for filter replacement routine
- Carry out lessons learnt review
- Carry out POE (if within scope) during the first five years of use to verify KPIs have been met
- Ideally, publicise performance against all KPIs and POE reports e.g. on a company website
- Consider carrying out a post construction embodied carbon assessment
- Final as-built energy (PHPP) model provided at hand-over

Planning for Net Zero | Checklists for design and construction

Delivering Net Zero carbon relies on the effective and timely coordination of a project across all stages. This checklist gives the client, design team and contractor a clear list of actions using the RIBA Plan of Work for Net Zero and Beyond Energy.

RIBA Work Stage 1 – Preparation and Brief	
Brief appraisal – is a new building necessary, or can existing buildings be retrofitted to meet the requirements of the brief?	
Site appraisal – looking at opportunities and constraints in terms of net zero and beyond energy measures	
Sustainability workshop to work through KPIs with design team and include KPI requirements stated in the brief	
Conduct relevant ecological, protected species and tree surveys	
Assess existing assets, facilities and green infrastructure that exist on and around the site	
Demolition audit of any existing structures to see what can be reused whether that it the whole building or its materials	

RIBA Work Stage 2 – Concept Design	
Optimise building orientation to balance solar gain and increase south facing roof area. Design roof to maximise density of renewables.	
Calculate and report the building form factor for design options	
Identify insulation line and highlight unheated areas within building envelope.	
Allow sufficient construction thickness for all insulated walls, roofs and floors.	
Identify the location for ventilation systems that reduces ductwork lengths.	
Carry out preliminary overheating risk assessment using the Good Homes Alliance overheating checklist to allow results to feed into window design at an early stage.	
Carry out initial energy model (PHPP or similar)	
For projects using Passivhaus certification, look to appoint a certifier.	
Identify design team members to carry out embodied carbon assessment. Carry out multiple embodied carbon calculations of key elements to demonstrate low carbon design choices.	
Conduct a circular economy workshop appraisal with design team and client	
Arrange embodied carbon workshops with design team to target lean design principles and reduce big tickets items e.g. structure	
Establish concept for landscape strategy for biodiversity and flood mitigation	

RIBA Work Stage 3 – Spatial Coordination	
Review mark-up of insulation line on all plans and sections and carry out initial U-value calculations.	
Carry out heating options appraisal for low carbon heat systems.	
Hold a thermal bridge workshop. Include the structural engineer for review of columns, masonry support etc.	
Provide MVHR layout including duct distribution and measurement of intake and exhaust duct lengths to external walls for sample dwellings.	
Carry out full embodied carbon assessment of whole building and compare against embodied carbon target. Implement reductions where necessary.	
MEP consultant to review embodied carbon impact of services and reduce the amount of kit where possible. Use CIBSE TM65 embodied carbon in building services to assess impact.	
Carry out PHPP modelling alongside SAP/SBEM calculations. List all model assumptions including U-values, thermal bridges and system specifications etc.	
Carry out overheating assessment (Part O, TM59 & TM52) and eliminate overheating through passive strategies where possible. Ensure all element assumptions match PHPP and SAP/SBEM models	
Calculate electricity generation intensity of solar panels arrays and review against KPI.	
Define airtightness strategy and identify airtightness line on plans and sections	
Measure heating and hot water pipe lengths for sample dwellings. Minimise distribution or standing losses. Demonstrate distribution losses have been calculated and reduced.	
Prepare RIBA Stage 3 report and include predicted operational cost to tenant	
Conduct a circular economy statement or report	
Explore grey water recycling systems and on site natural water processing systems	
Finalise landscape strategies for ecology and biodiversity and flood mitigation. Carry out Biodiversity net gain calculation or urban greening factor for urban sites	

MVHR: Mechanical Ventilation with Heat Recovery

PHPP: Passivhaus Planning Package

This design checklist provides a list of key actions that should be carried out at each work stage to meet the KPI targets for new buildings.

This should be shared with the design team to check off after each stage is complete.

Planning for Net Zero | Checklists for design and construction

RIBA Work Stage 3+ – Early Technical Design (and Tender)	
Detail build-ups of all external elements including thickness and conductivity of all materials.	
Detailed U-value calculations (including masonry support system, etc.).	
Identification of all thermal bridge junction types (e.g. parapet A, parapet B).	
Thermal bridge calculations for a selection of the most important junctions.	
Definition of airtightness testing requirements for contractor.	
Include requirements for Environmental Product Declarations (EPD) in the tender. Make EPDs obligatory for structural materials, primary façade and any other major materials.	
Include KPI requirements in the tender.	
Agree scope of Post-Occupancy Evaluation in tender. Identify level of participation from contractor and design team.	

RIBA Work Stage 4 – Technical Design (in addition to Stage 3+)	
Develop junction details for window and doors.	
Review airtightness line on each drawing and identification of airtightness requirements for service penetrations.	
Carry out a thermal bridge workshop to review thermal bridge lengths and calculate Psi-values for all junctions.	
Review MVHR layout including duct distribution and measurement of length of intake and exhaust ducts for all homes.	
Measure heating and hot water pipe lengths for all communal areas and homes.	
Carry out embodied carbon assessment of whole building using accurate Bills of Quantities.	
Specify high performing solar panels panels.	
Demolition audit and feed materials into specification.	
Revise circular economy statement to final specification - Review the materials specified. Specify reused materials. Specify recycled or recyclable materials.	

RIBA Work Stage 5 – Manufacturing and Construction	
Run an introduction to ultra-low energy construction workshop on-site.	
Encourage site manager and team training on construction quality requirements covering insulation and airtightness.	
Prepare toolbox talk information for site team inductions on low energy construction quality	
Review alternative materials or products proposed by the contractor. Ensure substitutions do not compromise the thermal performance or embodied carbon target.	
Carry out regular construction quality assurance site visits and reports (depending on the size of the scheme – at least six) in tandem with regular visits.	
Develop site quality tracker, assess against KPIs and update regularly.	
Require leak finding airtightness tests at first fix and second airtightness test pre-completion.	
Witness commissioning of Mall environmental control systems	
Carry out predicted in-use energy model of each building leading to the final 'as built' PHPP model.	
Consider recalculating embodied carbon using 'as built' information.	
Materials management plan include a collection plan for reusable waste and a plan for adaptable reuse and deconstruction	
Ensure waste tracker is utilised on site to achieve minimal construction waste on site.	

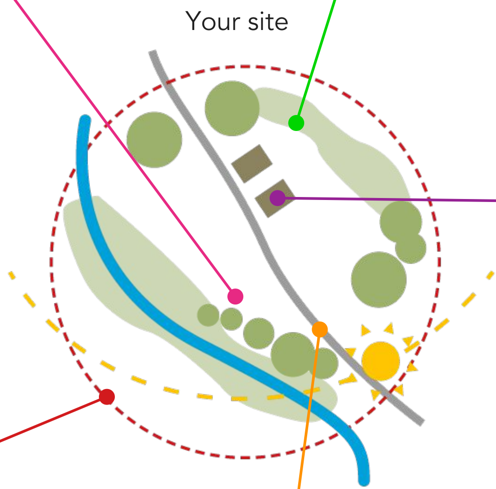
RIBA Work Stage 6 – Handover	
Provide building and operational information to residents in the form of site inductions and simple building user guides and instructions (e.g. sticker on MVHR for filter replacement).	
Consider embodied carbon as part of the replacement and maintenance strategy and include in the O&M manual.	
Carry out post-occupancy evaluation during first 5 years of use and verify KPIs have been met.	
Lessons learnt project review with team.	
Publicly report KPIs.	
Include circular adaptability and reuse management plan Materials and conservation management plan include a collection plan for consumables and durables and a plan for adaptable reuse and deconstruction	

4 ONE-PAGE DESIGN GUIDES

This chapter condenses everything stated in the document into one-page design guides for three types of structures: homes, flats, and non-domestic buildings such as commercial buildings or schools. It also mentions the rural and urban character areas of Folkestone and Hythe, as well as two examples of net zero design approaches in those contexts.

Design Guide | Site appraisal

To determine the opportunities and constraints for achieving net zero, it is necessary to appraise a site and identify the sustainable characteristics before any development. It should be noted that the optimal option should be to reuse any existing structures on the site as this removes additional carbon from any new build elements. The following topics outline the elements to consider when assessing your site for sustainability principles and reaching net zero:



Site characteristics

Initial site assessment, consider reusing and retrofitting any existing structures. Unless there is sufficient evidence to justify demolition, if this is to be the case, consider reuse of the materials on the site or on other sites.

Look at the orientation of the site – consider potential site layout opportunities to have as many south facing buildings as possible.

Observe overshadowing on the site from neighbouring structures or trees – this will affect daylight and solar panels .

Identify flood risk zones, rainwater run off and the direction of water flow on the site – this will identify where not to build (flood plain) and where swales, wetlands could potentially be located.

The brief

Conduct feasibility study of net zero development.

Check viability to ensure high specification of building fabric can be afforded on the site.

Include Key Performance Indicators (KPIs) requirements in the brief.

Appoint the relevant consultants and specialists e.g. sustainability consultant with Passivhaus expertise. The earlier the better to ensure net zero is built into the scheme from the offset avoiding future cost.

Accessibility & sustainable transport

Promote connections to transportation links cycle routes, walkability, public transport, and road or rail networks.

Create permeability across the site and provide safe routes with pedestrian/cyclist priority. Promote a low traffic neighbourhood.

Identify need for central mobility hub that will act as a transport interchange for the site.

Ecology and biodiversity

Identify existing green spaces in the local and wider context - is there potential to connect them using the site? For example if there are two green spaces nearby consider connecting them using a green spine through your site.

Create linkages to any local nature recovery strategy, wider networks or district level green and blue infrastructure strategy

Asses ecological value of the site - identify existing flora and fauna species on the site. Conduct ecological surveys and a tree surveys. Any designated sites or priority landscapes should be protected.

Identify existing water courses that you can use and enhance.

Consider temporary landscapes meanwhile methods to clean soil.

Community

Public consultation and engagement with a diverse group of people to ensure an equitable and inclusive design process.

Consider temporary meanwhile use to engage with the local community and determine what is best for the site and identify opportunities to integrate into existing communities.

Connect existing green spaces surrounding the site. Identify and check the capacity of existing shops, cafes, schools, parks, playgrounds that would serve the site. There may be requirements to provide more.

Ensure design can be self sustaining – the site should have all the amenities, goods or entertainment needs without getting in a car. If the site or surroundings cannot provide this as it stands you will need to add provision for this in the masterplan.

Check the local capacity of the closest allotments - make food growing accessible for all.

Identify children's play space provision and check capacity and type of play. For example if there is formal play equipment consider providing nature based play.

Identify activity space provision for young adults and adults and check capacity and type of activity. For example if there are tennis courts, perhaps provide a football pitch or running routes.

Design guides | Character areas

Below is a summary of how Net Zero and Beyond Energy measures can be affected by character areas. For example, a town centre's large and dense buildings can inherently have less heat losses than many smaller buildings, but conversely they have less roof area available (compared to internal space) and can be higher in embodied carbon.

Urban development

Net Zero

Orientation – Often constrained but internal layouts can be based around solar gains. Avoid overshadowing between buildings, keep taller elements to the north.

Form factor – Bigger buildings help but keep form simple and compact. Avoid overhangs, recesses and steps in the roof. Connect buildings as far as possible, terraces instead of individual homes.

Renewables – Prioritise roof space for renewable generation. Angle roofs towards south and use monopitch where possible to increase available area.

Low carbon heat – All buildings should use low carbon heat source, prioritise heat pumps.

Embodied carbon – will be significant for bigger buildings. Avoid basements, podiums and large transfer structures. Explore alternative options for structural materials.

Beyond Energy

Flooding – Design in SuDS early on. Green or blue roofs can be used for water retention but prioritise ground level landscape.

Ecology and biodiversity – Use ground level space for urban greening, connect these into surrounding context to create green corridors and courtyards. Vertical greening should also be prioritised. Green roofs can be combined with PV (biosolar roofs) if roof space is needed.

Circular economy – Audit the existing materials onsite as soon as possible. Aim to reuse or recycle materials onsite first and then offer them to other local sites to promote local reuse networks. Seek out material from other demolition projects.

Sustainable transport – Specify a primary or secondary mobility hub. Provide easy to access cycle storage for users and visitors. Provide clear routes for cycling and walking and connections to public transport. Provide EV charging for occupants and visitors.

Community – Mixed use buildings with active frontages at ground floor help to encourage community and natural surveillance. Include green community courtyards and roof terraces in apartment buildings.

Rural development

Net Zero

Orientation – A rural site has more control over the building orientation. Site layout should prioritise south facing roofs and buildings should be designed around solar gains.

Form factor – Give priority to connected buildings - terraces or semi-detached for homes. Keep building form simple and compact.

Renewables – Roof design should fully consider renewables from early stages. South facing asymmetric and monopitch roof designs are the priority

Low carbon heat - All buildings should use low carbon heat source, prioritise heat pumps.

Embodied carbon - Lower density opens up possibility for timber structure which reduces embodied carbon. Incorporate lean design principles and engage a structural engineer early to calculate and reduce embodied carbon.

Beyond Energy

Flooding – Use SuDS and swales to work with the natural landscape. Wetlands on the site to maintain nutrient neutrality.

Ecology and biodiversity – More opportunity for creating and connecting into existing green space. Consider woodland and wetlands walks.

Circular economy – Identify opportunities to use local recycled materials. Explore ideas for how the buildings might change and grow through their lifetime and help facilitate this in the design.

Sustainable transport – Specify at least a minimal mobility hub but aim for tertiary mobility hub. Provide shared surface and pedestrian only routes, Clear routes for cycling and walking, connection to public transport. Prioritise layouts for people not cars and don't let parking dominate the landscape.

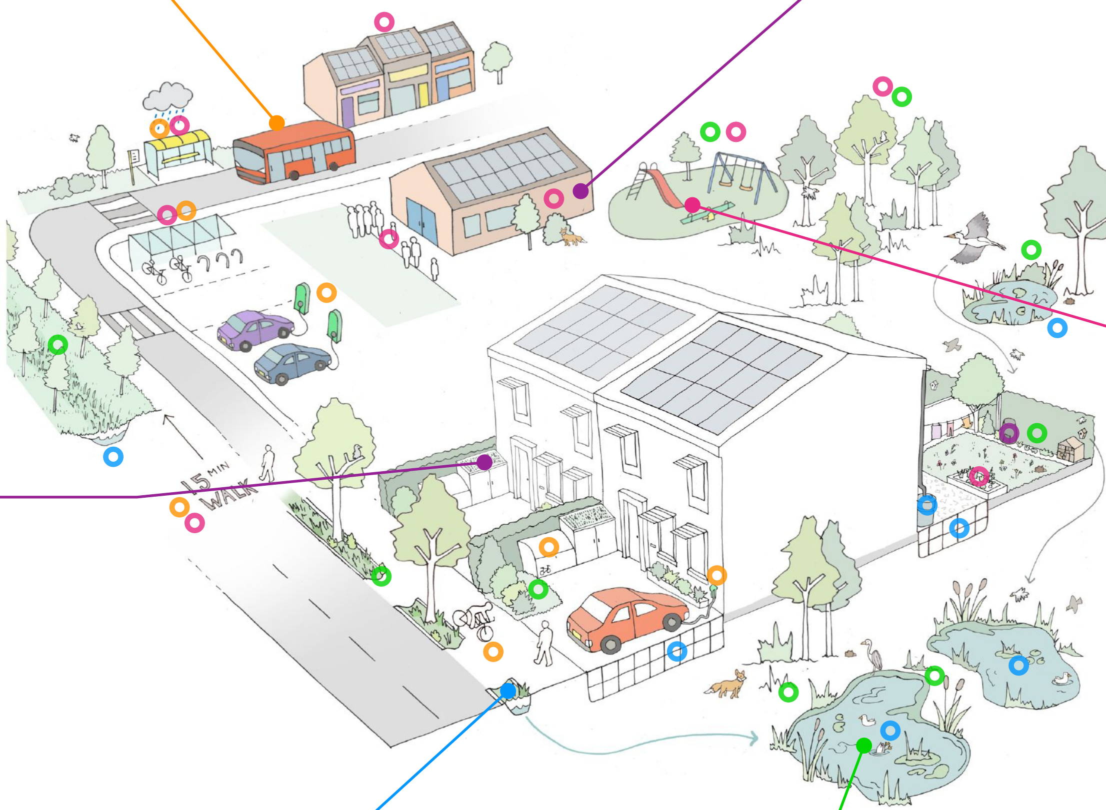
Community – Include a community hub to match contextual needs of the site. Recreation and play space accessible by all homes. Food growing opportunities.

Design guides | New homes | Site level

Click (1) to navigate to focus page

Transport (15)

- Connect to existing walking and cycling routes.
- Create a clear hierarchy of pedestrian, cycle and public transport routes.
- Provide secure, easy to access cycle parking.
- Provide a mobility hub to suit numbers of residents.
- Provide one electric car charging point per dwelling.



Circular economy (17)

- Reuse and retrofit existing buildings
- Reused or recycled materials in building and / or landscape.
- Encourage community sharing schemes of items, appliances, cars etc.
- Adaptable spaces both internally and externally of the buildings.

Waste (18)

- Design convenient, adequately size storage for recyclable waste, food waste and general waste.
- Provide easy access external waste storage that facilitates efficient collection by refuse vehicles.
- Provision for resident composting.

Community (16)

- Ensure there is public consultation and engagement with a diverse group of people.
- Design easily accessible and inclusive spaces.
- Provide a community hub to suit needs of the area.
- Design to encourage neighbourly chance and organised encounters.
- Provide easily accessible spaces for play, sport and recreation.
- Provide wellbeing routes – such as high quality walking and running routes allowing access to nature.
- Provide food growing opportunities for residents and the community.

Flooding and water consumption (12)

- Provide blue green infrastructure methods that capture stormwater and mitigate flooding.
- Provide rainwater collection such as water butts or underground storage tanks.
- All hardscaped surfaces must be permeable.
- Where applicable create on site natural water processing systems.

Ecology and biodiversity (13)

- Use and protection of existing flora fauna.
- Connect existing and provide new green spaces.
- Select diverse native species of planting.
- Create and provide habitats in the landscape and the building.
- Encourage engagement and stewardship over the natural environment.

Click (1) to navigate to focus page

Form (2)

Create compact, simple buildings.

Connect homes as much as possible, terraces over detached. Avoid bungalows.

Calculate the form factor (ratio of internal floor area to external surface area) early on in design and test options for reducing it.

Fabric (3)

Continuous thermal line insulating the building. All major structure to be thermally broken. Allow for envelope build ups needed from an early stage by showing thicknesses on plans.

Thermal bridging

- Y-Value of 0.10 W/m.K

Roof – 450-520mm

- U-value 0.09 W/m².K

N.B Insulation is best placed at ceiling level with the roof void ventilated as shown.

Walls – timber 350-450mm, masonry 550-600mm

- U-value 0.09 W/m².K

Ground floors – 200-250mm of insulation

- U-value 0.09 W/m².K

Renewable energy (8)

Create asymmetric roofs facing south and use full roof area for PV panels.

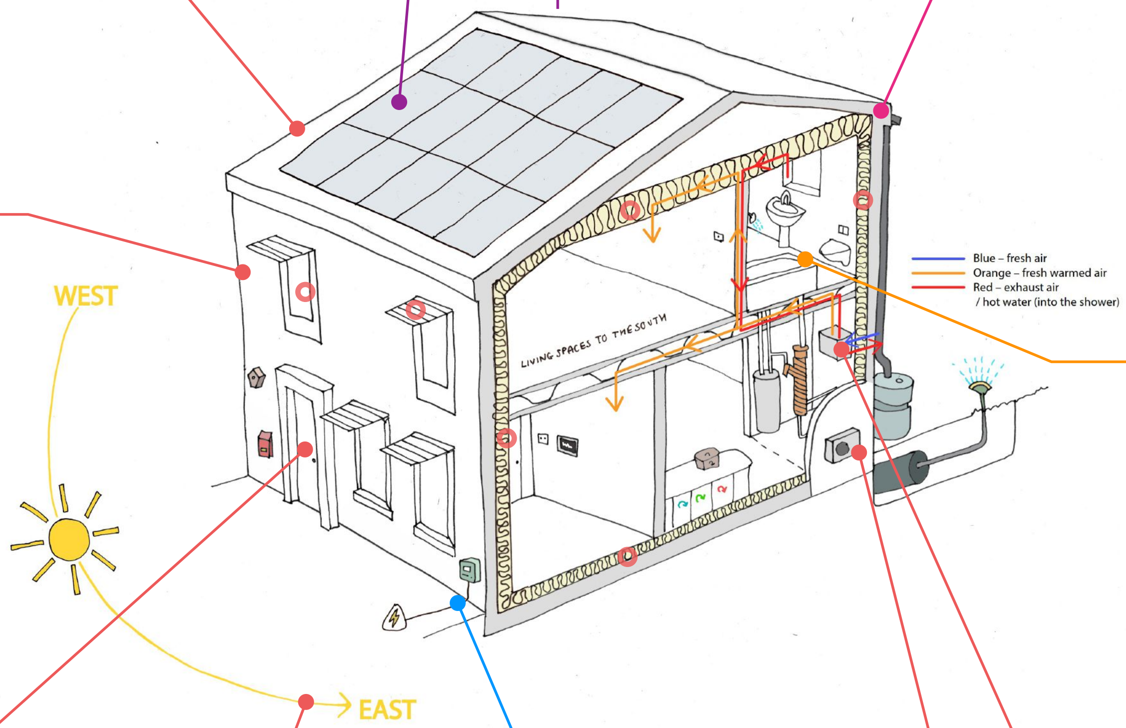
Embodied carbon (9)

For low embodied carbon use timber or other similar natural materials to form main structure and as an external finish.

Test and calculate carbon for different foundation options and materials.

Circular economy (17)

Look at ways the building can be deconstructed or easily adjusted in its lifetime.



Water (12)

Use low flow fixtures and fittings throughout.

Install hot water tank and use wastewater heat recovery in the shower/bath.

Provide rainwater collection

Consider for greywater recycling.

Windows and doors (1)

Provide overhang shading to all south windows & shutters or similar on west facing. Restrict glazing ratios. Avoid letter boxes in the door - keep these on the outside of the building.

External insulated doors

- U-value 0.9-1.0 W/m².K

Triple glazed windows

- U-value 0.8 W/m².K

Orientation (1)

Orientate main elevation within +/- 30° of south.

Arrange rooms with the main living space on the south side of the building.

Storage and circulation can be to the north.

Electricity (5)

Provide the infrastructure to allow residents to monitor and control their energy use.

Submeter where possible so that different energy consumers in the building can be distinguished.

Heat (7)

Use a heat pump to provide space heating and hot water.

Install a hot water tank and use wastewater heat recovery in the shower/bath.

Insulate and reduce the lengths of all circulation pipework.

Ventilation (6)

MVHR 90% efficiency.

Keep exhaust/intake ductwork as short as possible less than 2m from an external wall.

Airtightness (4)

An airtight building fabric of 1m³/m².hr

Design guides | New flats | Site level

Click 1 to navigate to focus page

Transport 15

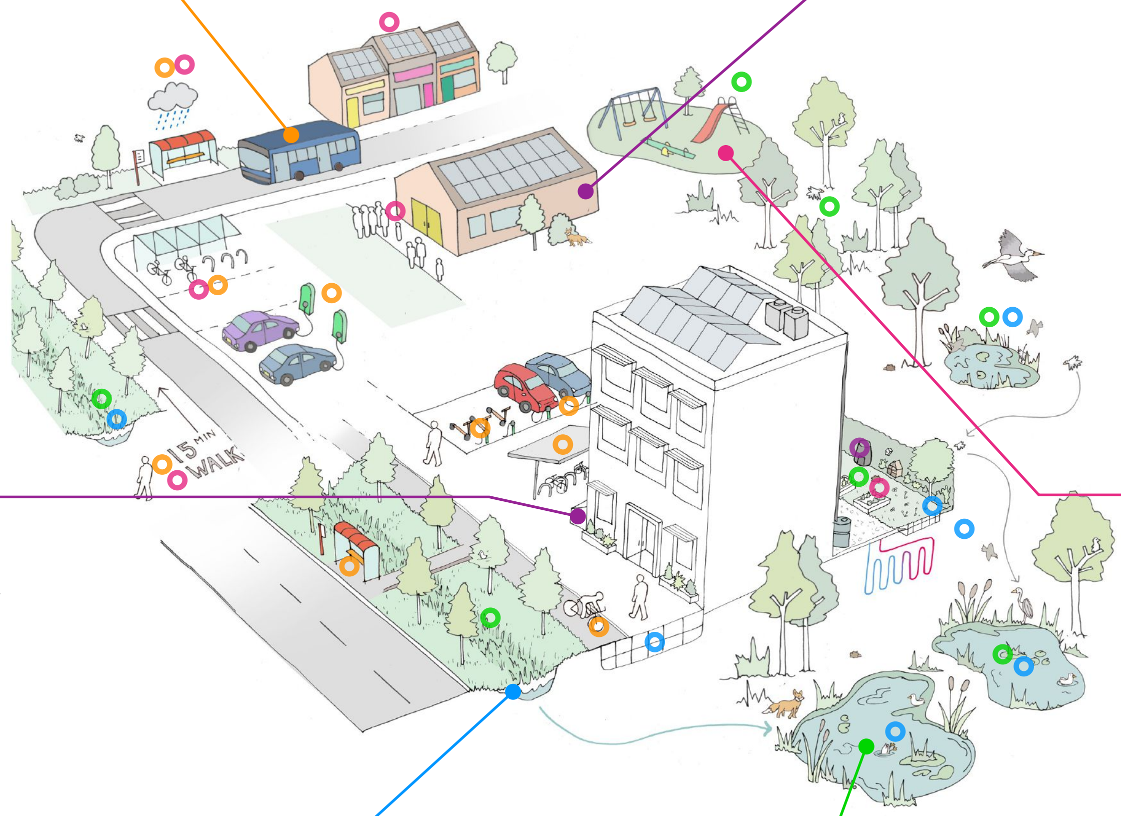
Connect to existing walking and cycling routes.

Provide secure, easy to access cycle parking for residents and visitors. Consider cycle facilities such as bike fixing station.

Provide a mobility hub to suit numbers of residents.

Provide one electric car charging point per dwelling if car parking is provided.

Offer priority parking for car sharers.



Circular economy 17

Reuse and retrofit existing buildings.

Reused or recycled materials in building and/or landscape.

Encourage community sharing schemes of items, appliances, cars etc.

Adaptable spaces both internally and externally of the buildings.

Ensure the building is designed to be deconstructed or easily adjusted in its lifetime.

Waste 18

Design convenient, adequately size storage for recyclable waste, food waste and general waste.

Provide easy access external waste storage that facilitates efficient collection by refuse vehicles.

Consider shared composting for residents

Community 16

Ensure there is public consultation and engagement with a diverse group of people.

Consider mixed use development that integrates affordable workplace and homes.

Active ground floor frontages and provide spill out space for businesses into public realm.

Consider providing community hub within development

Easily accessible and inclusive design

Legible environments to better navigate comfortably for pedestrians and vehicles.

Flooding and water consumption 12

Provide blue green infrastructure methods that capture stormwater and mitigate flooding.

Provide rainwater collection e.g. water butts or underground storage tanks.

All hardscaped surfaces must be permeable.

Where applicable create on site natural water processing systems.

Ecology and biodiversity 13

Use and protection of existing flora fauna and trees.

Connect existing and provide new green spaces.

Select diverse native species of planting in new green space.

Create habitats in the landscaping and the building where possible.

Encourage engagement and stewardship over the natural environment.

Design guides | New flats | Building level

Click (1) to navigate to focus page

Form (2)

Create compact, simple buildings.

Avoid overhangs, stepped roofs, balconies. Group unheated spaces in the building together.

Calculate the form factor (ratio of internal floor area to external surface area) early on in design and test options for reducing it.

Fabric (3)

Continuous thermal line insulating the building. All major structure to be thermally broken. Allow for envelope build ups needed from an early stage by showing thicknesses on plans.

Thermal bridging

- Y-Value of 0.10 W/m.K

Roof – 250-300mm of insulation

- U-value 0.10 W/m².K

Walls – timber 350-450mm, masonry 550-600mm

- U-value 0.09 W/m².K

Ground floors – 200-250mm of insulation

- U-value 0.09 W/m².K

Renewable energy (8)

Create concertina PV system facing east/west, using all available area.

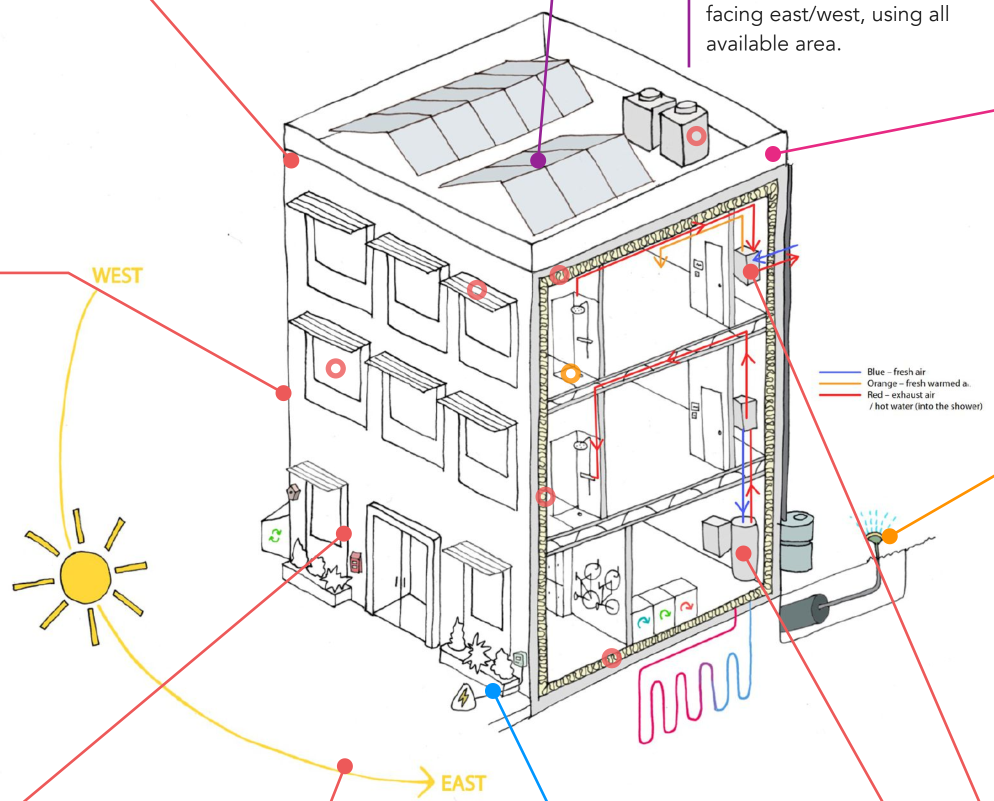
Embodied carbon (9)

Examine options for natural materials but if not possible keep cement strengths low and curing times longer.

Test and calculate carbon for different foundation options and materials.

Circular economy (17)

Look at ways the building can be deconstructed or easily adjusted in its lifetime.



Water (12)

Use low flow fixtures and fittings throughout.

Provide rainwater collection to supply irrigation demand at least.

Review options for greywater recycling.

Windows and doors (1)

Provide overhang shading to all south windows & shutters or similar on west facing. Restrict glazing ratios. Provide security to ground floor windows.

External insulated doors

- U-value 0.9-1.0 W/m².K

Triple glazed windows

- U-value 0.8 W/m².K

Orientation (1)

Orientate main elevation within +/- 30° of south.

All flats to be dual aspect, with living space to the south elevation, use deck access to help facilitate this.

Electricity (5)

Provide the infrastructure to allow residents to monitor and control their energy use.

Submeter in each flat and also landlord supply to better understand energy consumption.

Heat (7)

Use a heat pump to provide space heating and hot water. Individual flat systems should be preference.

Use a wastewater heat recovery tray system.

Insulate and reduce the lengths of all circulation pipework.

Ventilation (6)

MVHR 90% efficiency.

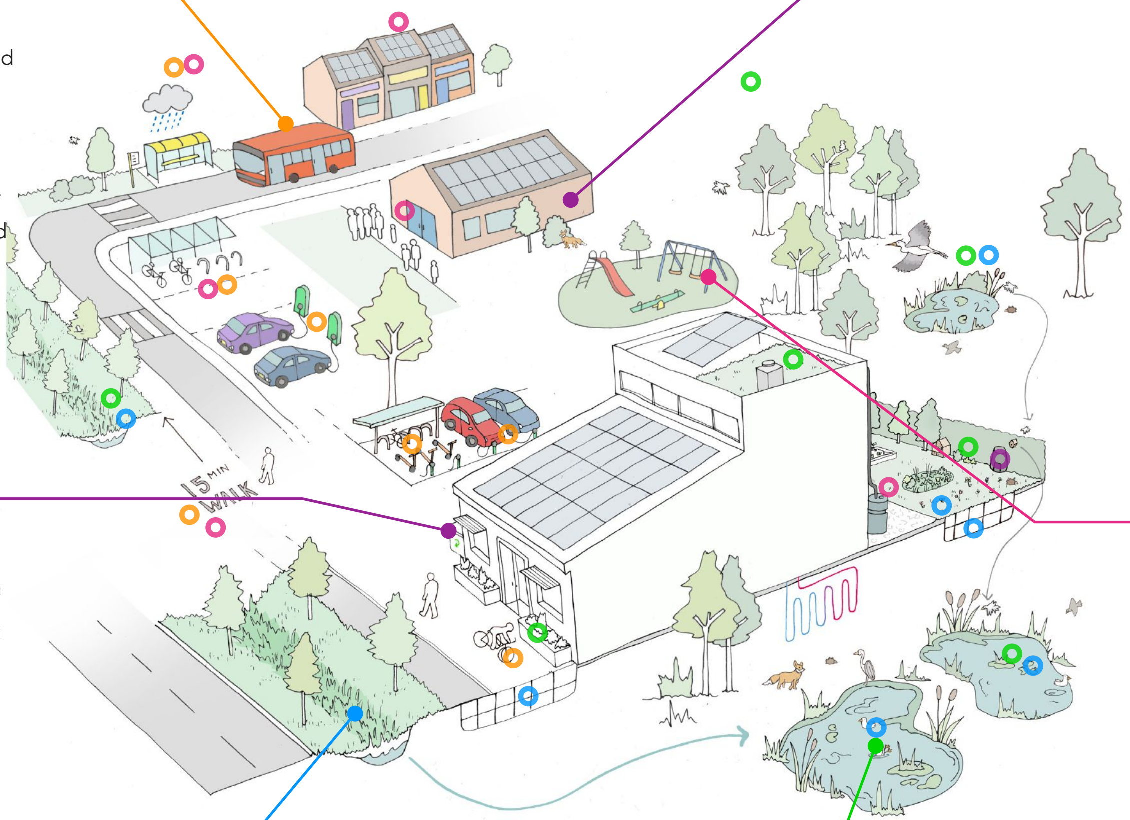
Keep exhaust/intake ductwork as short as possible less than 2m from an external wall.

Airtightness (4)

An airtight building fabric of 1m³/m².hr

Design guides | New non-domestic | Site level

Click 1 to navigate to focus page



Transport 15

Connect to existing walking and cycling routes

Provide secure, easy to access cycle parking and facilities such as bike pump stations, showers and lockers.

Provide a mobility hub that provides an interchange for transportation methods on site.

Provide electric car charging points for staff and visitors.

Offer priority parking for car sharers.

Circular economy 17

Reuse and retrofit existing buildings.

Reused or recycled materials in building and / or landscape.

Encourage community sharing schemes of items, appliances, cars etc.

Adaptable spaces both internally and externally of the buildings.

Waste 18

Design convenient, adequately size storage for recyclable waste, food waste and general waste

Provide easy access external waste storage that facilitates efficient collection by refuse vehicles.

Consider shared composting for neighbourhood.

Community 16

Public consultation and engagement with a diverse group of people ensuring an equitable and inclusive design process.

Plan for meanwhile uses and community driven events.

Consider community uses of the building.

Active ground floor frontages and provide spill out space for businesses into public realm.

Easily accessible and inclusive design.

Accessible and appropriately wide paving and well positioned and frequent urban furniture.

Easily accessible spaces for play, sport and recreation.

Encourage hot spots of culture and arts.

Flooding and water consumption 12

Provide blue green infrastructure methods that capture stormwater and mitigate flooding.

Provide rainwater collection such as water butts or underground storage tanks.

All hardscaped surfaces must be permeable.

Where applicable create on site natural water processing systems.

Ecology and biodiversity 13

Connect existing and proposed green spaces.

Select diverse native species of planting in courtyards or gardens and include living roofs.

Use and protection of existing flora fauna and trees. Create habitats in the landscaping and the building where possible.

Incorporate living roofs and biosolar roofs.

Design guides | New non-domestic | Building level

Click 1 to navigate to focus page

Form 2

Create compact, simple buildings.

Allow popups to bring daylight into deeper buildings.

Avoid complicated façade geometries and opt for clean lines.

Fabric 3

Continuous thermal line insulating the building. All major structure to be thermally broken. Allow for envelope build ups needed from an early stage by showing thicknesses on plans.

Thermal bridging

- Y-Value of 0.10 W/m.K

Roof – 250-300mm of insulation

- U-value 0.10 W/m².K

Walls – timber 350-450mm, masonry 550-600mm

- U-value 0.09 W/m².K

Ground floors – 200-250mm of insulation

- U-value 0.09 W/m².K

Renewable energy 8

Use all available pitched and flat roof space for PV panels. Combine with biodiverse roof if needed.

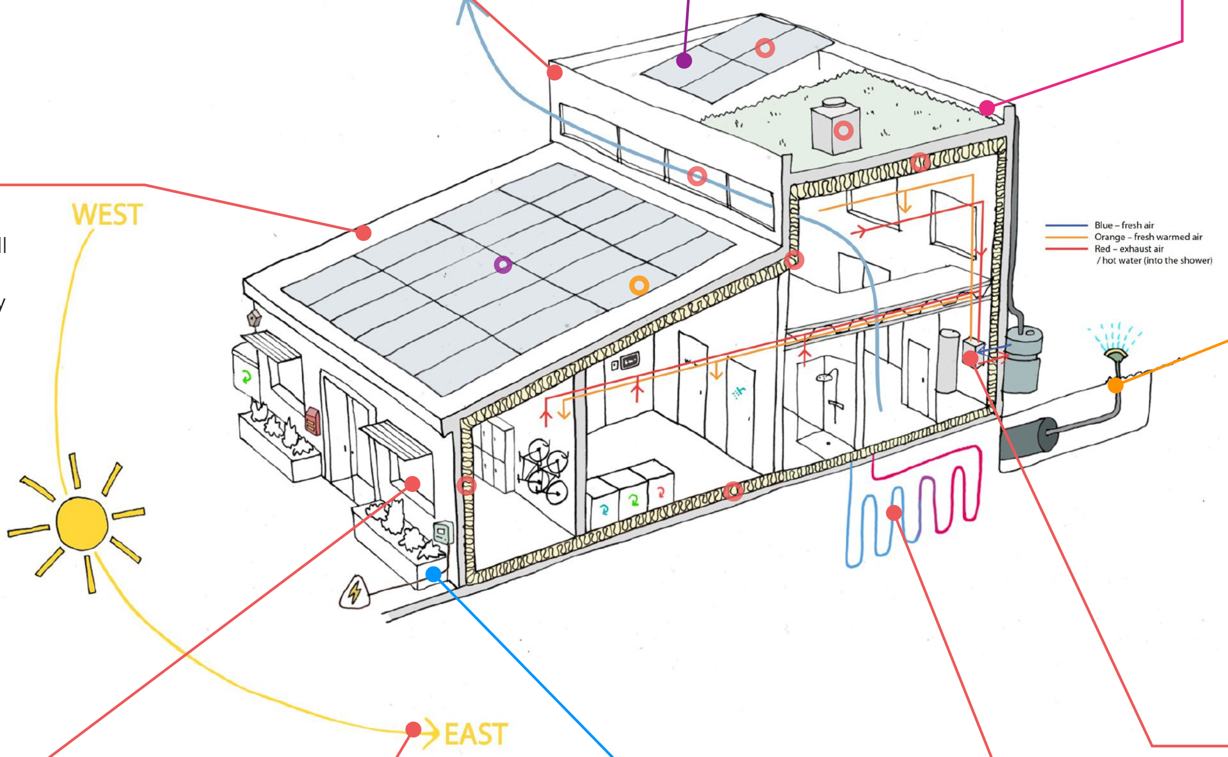
Embodied carbon 9

For low embodied carbon use timber or other similar natural materials to form main structure and as an external finish.

Test and calculate carbon for different foundation options and materials.

Circular economy 17

Look at ways the building can be deconstructed or easily adjusted in its lifetime.



Water 12

Use low flow fixtures and fittings throughout.

Collect rainwater from building and landscape.

Include greywater recycling systems.

Windows and doors 1

Provide overhang shading to all south windows & shutters or similar on west facing. Restrict glazing ratios. Avoid letter boxes in the door - keep these on the outside of the building.

External insulated doors

- U-value 0.9-1.0 W/m².K

Triple glazed windows

- U-value 0.8 W/m².K

Orientation 1

Orientate main elevation within +/- 30° of south.

Arrange rooms with the main living space on the south side of the building.

Storage and circulation can be to the north.

Electricity 5

Submeter by system type and zone throughout the building.

Use controls that monitor daylight, occupancy and air quality levels to avoid wasting energy in unoccupied spaces.

Heat 7

Use a central heat pump to provide space heating/cooling and hot water.

Insulate and reduce the lengths of all circulation pipework.

Ventilation 6

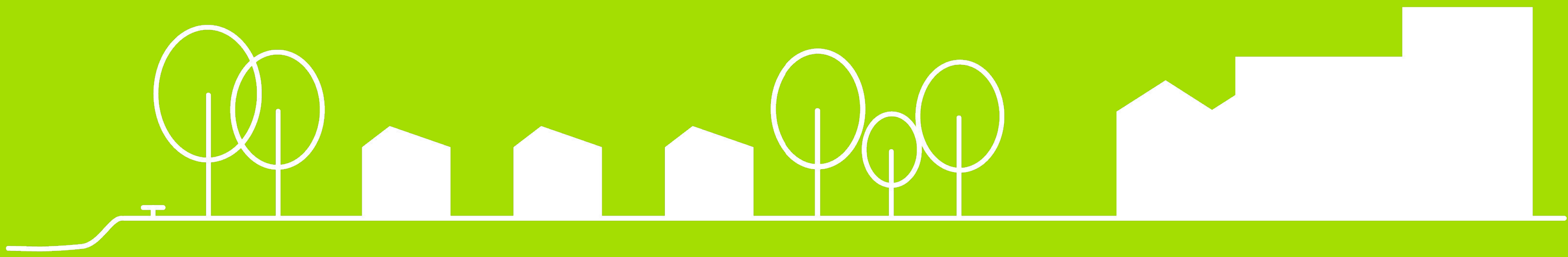
Keep exhaust/intake ductwork as short as possible, less than 4m between external plant and internal space.

Airtightness 4

An airtight building fabric of 1m³/m².hr

5 NET ZERO DESIGN

This chapter outlines the key focus points for designing a Net Zero building for both domestic and non-domestic.



Net Zero Design | Focus 1 | Orientation and overshadowing

Orientation

Thinking about the orientation of the site at an early stage in the design of a building can have a large impact on its performance. It is important to make the most of solar gain to reduce the space heating demand. There are a number of ways to do this: the orientation and massing of the building should be optimised, if possible, to allow useful solar gains and prevent significant overshadowing in winter. Encourage south facing buildings (+/- 30°) with solar shading and prioritise dual aspect. To make the most of the southern sun it may be advantageous to angle the roofs to make the most of solar panels opportunities to the south.

Overshadowing

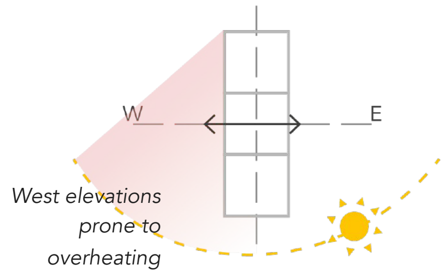
Overshadowing of buildings on and around the site should be avoided as it reduces the heat gain from the sun in winter. Allow a distance of 1/1.5 times the buildings height between buildings to avoid overshadowing and impacting solar gains and daylight.

Massing and Density

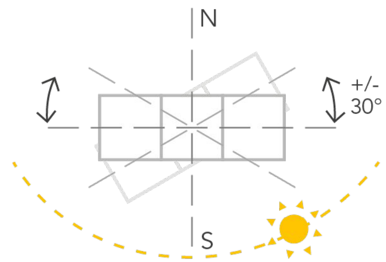
The density and massing of the development must also be considered. It is best practise to avoid placing higher elements to the south of a site, which would effectively prevent the sun from entering the site. Particularly consider sunlight in amenity spaces and allotments. All the angles of the sun throughout the year must be considered when designing. Additionally, the higher and larger the building the more embodied carbon as it has more structure. Lower density developments such as houses are better suited to timber frame and therefore will benefit from lower embodied carbon.

Harnessing energy from the sun for heating and electricity

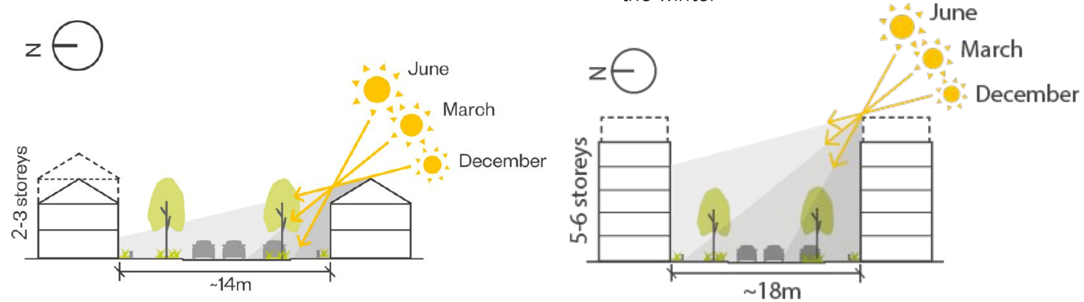
Consider how the building form supports the capture of renewable energy, such as south facing roofs for PV. Utilise principles of passive solar design to reduce winter heating load, limit summertime overheating and implement efficient natural ventilation where possible.



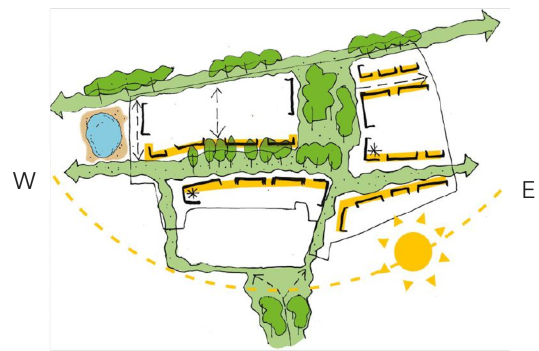
Inefficient Design *- Avoid east west facing as this can mean the building is prone to overheating*



Optimised Design *- Ideally south facing allows for solar winter gain. Elevations facing +/- 30° south will benefit from useful solar gains in the winter*



Allow a distance of 1-1.5 times the building's height between buildings to avoid overshadowing



Site layout should maximise the N-S orientation and the south facing aspect to make the most of winter solar gains and PV energy generation. However, the feel of a place should also be considered. Allowing certain buildings to depart from their orientation in order to make way for green space, landmarks, and other essential urban and landscape design initiatives.

Net Zero Design | Focus 1 | Orientation and overshadowing

Orientating the building to capture passive solar gains

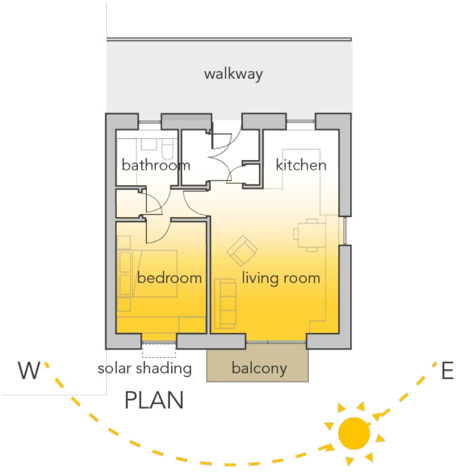
Positioning buildings on a new development must optimise for useful solar gains. This is done by designing the largest elevations to face south (+/- 30°), as well as arranging the internal layout of a building to have the spaces with highest occupied hours along the south side of the building. Making sure these spaces do not then overheat is important, but this can be achieved with suitable solar shading and by prioritising dual aspect. Alongside this these spaces will be well lit by natural daylight. Generally, buildings with a south facing elevations (as opposed to east/west) are easier to control the solar gains as externally fixed shading devices can be used rather shutters which relies on the building occupant to operate them effectively.

How much glazing should there be

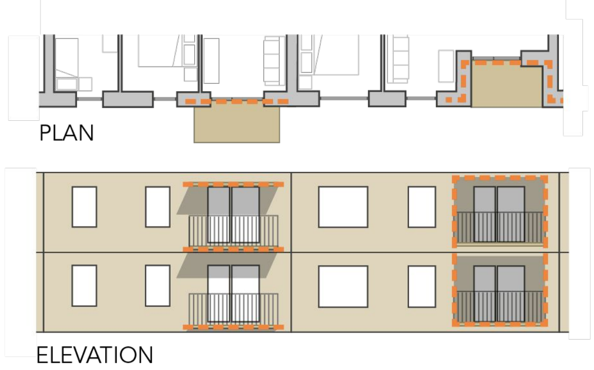
Getting the right glazing-to-wall ratio on each façade is a key feature of energy efficient design. Windows and doors conduct more heat than an external wall, even when they are super-efficient. It is useful to think about how much energy a window will lose compared to how much solar energy it will capture across the year. This will tell you whether you should really reduce the amount of glazing to a minimum (important on north facing elevations) or provide larger glazing areas (important in south facing elevations). Don't forget that glazing is expensive - being careful about where glazing is used is beneficial for energy, thermal comfort, and the project budget.

Solar shading

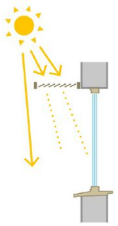
When orientating buildings to the south there needs to be a serious consideration for how they rooms will perform during the hot summer months. This means that in general solar shading will be needed for all elevations facing south (+/- 30°). Balconies offer an opportunity to shade elevations, a preference should be made for projecting balconies. In buildings without balconies fixed shading should be specified such as brise soleil on these elevations.



The spaces where people will spend most of their time are the ones where you want to most natural daylight and warmth in the winter.

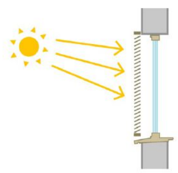


In general, projecting balconies work better than inset balconies for allowing useful winter solar gains and natural daylight into a space as well as not disrupting a building's thermal insulation line (orange line represents the length of the thermal break)



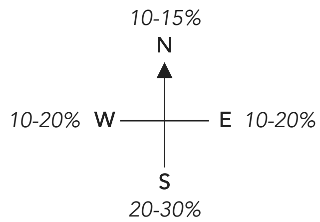
South

High angled sun can be controlled using horizontal shading or balconies above windows.



East/West

Low angled sun creates a overheating risk which can be prevented using external vertical shading e.g. shutters.



Glazing ratio

The ratio of glazed area to the opaque should be based on orientation. Aiming for a balance between capturing winter solar gains and avoiding excessive summer solar gains should govern the glazing percentages. The percentages here show a starting range for the glazed proportion

Net Zero Design | Focus 2 | Building form - massing

Simple, compact shapes reduce energy and material consumption

The cheapest and easiest way to reduce a building's energy demand is to make the form as simple and compact as possible. This will reduce the exposed surface area for heat loss, avoid complicated architectural detailing that will lead to problems in design and construction, as well as ultimately reducing build costs.

Designing simple forms does not mean that the architecture need be boring. If the massing stage is used to develop more simple forms and layouts, there will be greater opportunity to create architectural interest in the details of the building.

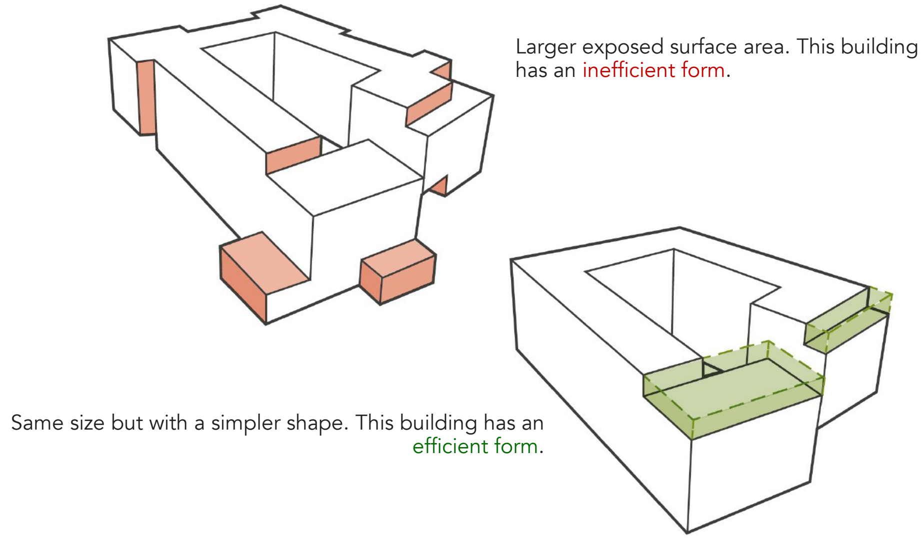
When thinking about the massing focus on:

- Avoiding overly-articulated shapes as these will increase the material and complexity needed in the structure, increase the heat loss area, and break up the thermal line of the building.
- Design out single storey elements – these represent a poor balance between internal livable area and external surface area.
- Bring buildings together – connect as much of a building or site under one thermal envelope will

How different building types perform

Given the scale of the homes, they can often have a high exposed surface area to internal volume. For this reason, connecting them as far possible will improve this. The most efficient house typology is the terrace – by joining the buildings together you are reducing the exposed external surface area and therefore reducing the heat loss.

Non-domestic buildings tend to be larger in scale and therefore have the benefit of increased density. But the overall form should still be thought about and condensed to save envelope area. The diagram to the top right shows the process of rationalising the building form and developing an efficiency building mass.



An efficient form can be achieve using the same floor are but will create a building that has a smaller surface area. In this example the building will also have a smaller footprint.

Goldsmith Street, a Passivhaus development in Norwich won the RIBA Stirling Prize in 2019 and exemplifies how terraced homes with a simple form can still meet high levels architectural quality. (Source: Mikhail Riches)

Net Zero Design | Focus 2 | Building form - detail

Robust, low energy buildings rely on a simple and efficient shape

Avoidance of excessive detail follows from the massing - limit the use of stepped roofs, roof terraces, overhangs and inset balconies as these features will increase exposed surface area and create complex junctions to insulate. If features like dormers are deemed necessary, consider grouping these together, creating one form rather than two separate smaller forms.

If architectural interest is needed try to keep changes in geometry, shading, balconies outside of the buildings thermal (insulation) line. This will keep details simple, making things easier to construct and reducing any breaks in the insulation line, also known as thermal bridging.

Use the form factor to measure performance

The Form Factor is a useful metric for measuring how energy efficient a building shape is. Reducing the form factor should be the next priority after correctly orientating the building as in Focus 1.

The Form Factor is calculated by dividing the external surface area by the gross internal floor area. The lower this number is the more efficient the form of the building thermal performance.

$$\text{Form factor} = \frac{\text{Exposed external surface area}}{\text{Gross internal floor area}}$$

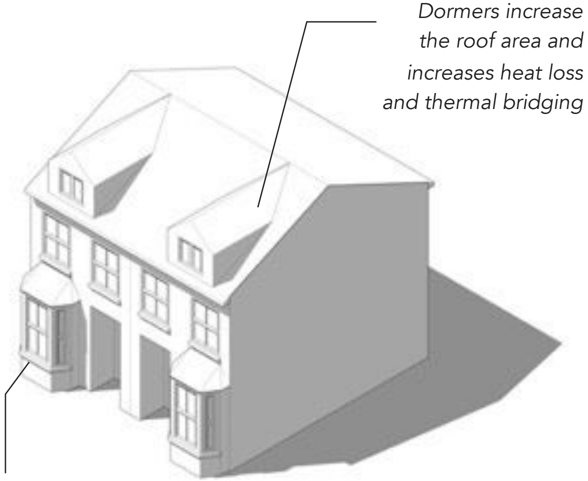
There is an element of push and pull that should occur. The better the form factor the "easier" it is to achieve net zero as this ensures low space heating demand as less heat is lost through exposed surfaces. If budgets are tight, it is recommended that the design is strict.

Further information

- Passivhaus Easi guide

Less efficient

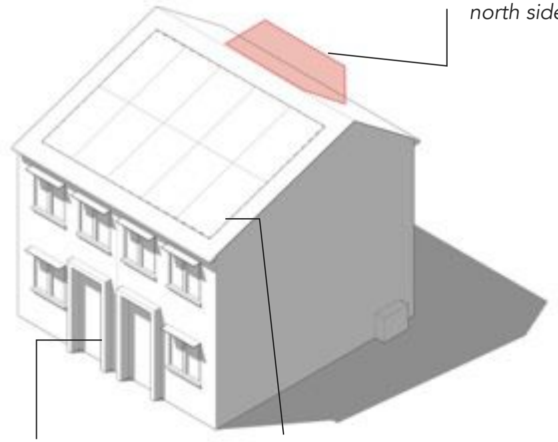
Dormers increase the roof area and increases heat loss and thermal bridging



Bay windows reduce form efficiency and increase thermal bridging

Optimised form

Grouping dormer windows to improve form efficiency and move to north side



Projecting porch are more efficient than a recessed porch

Asymmetric roof to maximise solar panels to the south

Window frames create a thermal weak point therefore large amounts will reduce efficiency

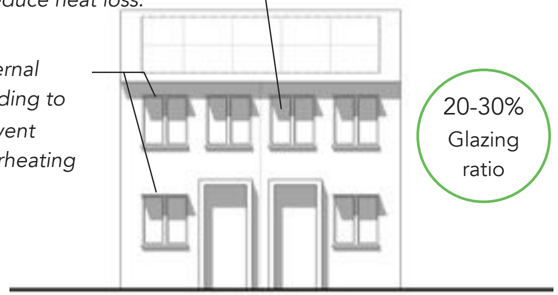
No external shading creating overheating risk

South elevation

Glazing ratio is higher than recommend value for the orientation

Simple glazing design with fewer transoms and mullions to reduce heat loss.

External Shading to prevent overheating



South elevation

Glazing ratio is within recommend value for the orientation

Net Zero Design | Focus 3 | Thermal envelope

Net Zero buildings depending on continuous and robust thermal line

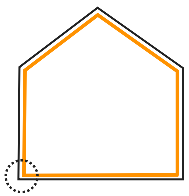
Constructing low energy buildings relies upon a effective line of defence to stop the transfer of heat between the internal and external environment. This will keep buildings warm in winter as well as cooler in summer.

During the early stages of design it is important to allow for thicker major building envelope elements, i.e. the roofs, walls and floors. This page provides some starting points for these thicknesses as well as the target U-values (a measurement of how much heat a particular construction will allow through).

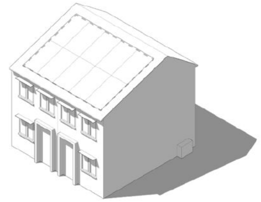
Windows and doors are also a critical part of the thermal envelop. Triple glazing is a requirement of building to Net Zero in new build all doors should be well insulated. Alongside this being conservative with glazing proportions will also help reduce the overall heat lost – windows lose more heat than walls and roofs.

Specifying the insulation requirement is only the first step

Thermal bridges (a disruption to the insulation line) can represent a significant source of heat loss in low energy buildings, especially as the structure gets more complicated. In general the best option is to try and design out thermal bridges by rethinking the insulation or changing the approach to structure but sometimes they are unavoidable. Common and unavoidable thermal bridges will come up on all projects and there are standard off the shelf solutions to deal with them. Products designed for this purpose are called thermal breaks.



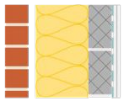
Early on in the design process annotate the plans and sections with the likely thermal line. Use this time to identify the locations where the insulation line will need to be broken (i.e. to allow structure through) and identify what solutions could be used to reduce the heat lost through this bridge.



Smaller buildings

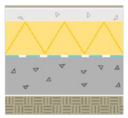
Roofs

U-value Target = 0.100-0.130 W/m².K
Total thickness = 450-600mm
Thermal bridges = connection to external wall, rafters



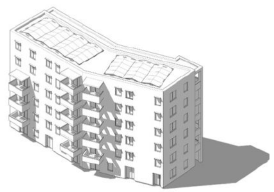
Walls

U-value Target = 0.100 – 0.130 W/m².K
Total thickness = 450-600mm
Thermal bridges = fixings that connect the structure of the wall with finishing material

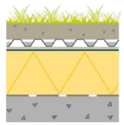


Floors

U-value Target = 0.090 – 0.100 W/m².K
Insulation thickness = 230-350mm
Thermal bridges = connection to external wall

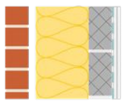


Larger buildings



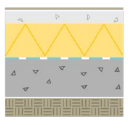
Roofs

U-value Target = 0.110 W/m².K
Total thickness = 450-700mm
Thermal bridges = connection to external wall, parapet walls



Walls

U-value Target = 0.100 – 0.150 W/m².K
Total thickness = 420-550mm
Thermal bridges = structure in the insulation zone, columns, floor slabs, balconies



Floors

U-value Target = 0.190 – 0.270 W/m².K
Insulation thickness = 190-270mm
Thermal bridges = connection to external wall, connection to foundations especially if piling

The importance of airtightness

Airtightness significantly improves energy efficiency and comfort, often for a relatively modest cost. Best practice levels are considered to be <1m³/h/m². When combined with best practice ventilation systems, airtightness leads to draught-free comfortable buildings that will also deliver excellent indoor air quality levels for occupants.

Start with a plan

Building airtight starts with a well thought through airtightness and ventilation strategy. Draw the airtightness line on plans and details, identifying which materials will form the airtight layer, and how they will be joined together. Identify challenging junctions, risks to airtightness, and consider how building services will interact with the airtight layer.

Use the right products

Experienced manufacturers of airtightness products such as Isocell, Isover, Pro-clima and Siga have developed their products to achieve airtightness that lasts for many decades. Specify good quality products and ensure that inferior substitutes are not used on site.

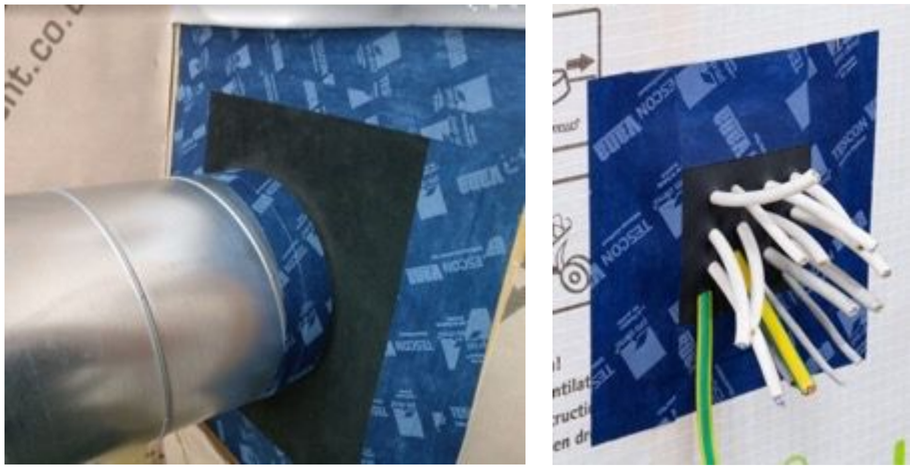
Stick to the plan on site

Once construction starts ensure the airtightness strategy is implemented precisely. Tradespeople should be briefed and the work regularly checked to ensure the airtight layer is being built correctly.

Test, then test again

Plan for at least two air tests on simpler and smaller buildings, larger complex ones will need more testing to meet the airtightness targets. Initial tests should be completed as soon as the building is weathertight and while joints between different components in the airtight layer are still accessible so leaks can be repaired if necessary. Later tests will be carried out near or on completion.

A good airtightness strategy forms the basis of an airtight building. This is an excellent example of taped OSB, with a dedicated service cavity on internal walls. The service cavity means most wires and pipes will not breach the airtight OSB layer.



Services entries present a risk to airtightness, however proprietary grommets are available to ensure airtightness can be achieved. The image on the left is of a ventilation duct as a reminder that airtight buildings must have a robust ventilation strategy.

Net Zero Design | Focus 5 | Infrastructure (electricity)

How does a smart electrical system facilitate net zero carbon?

As we move away from gas to electricity for heating buildings, smart electrical systems will allow us to:

- Control when buildings are heated,
- Maximise the benefit from on-site renewables by using energy when it is generated,
- And in doing the above, reduce energy costs.

Moreover it will help to decarbonise the grid by spreading out demand, reducing peak loads, and using more energy when renewable energy output is high. When renewable electricity generation is low, demand response measures can reduce the load on the grid, reducing the need to fire up gas fired power stations to meet the grid demand.

A smart electrical system should be considered for all new buildings in Folkestone and Hythe.

Intuitive and flexible energy use

Demand response or energy flexibility refers to the ability of a system to reduce or increase energy consumption for a period of time in response to an external driver (e.g. energy price change, grid signal). Energy storage allows these systems to consume, retain and release energy as required in response to specific energy demands. Smart controls respond to these external drivers and demands to manage our systems.

Maximise renewables and stabilise the grid

These measures can help maximise the utilisation of on-site renewables and help stabilise demand on the grid. Moreover it will help to decarbonise the grid: when renewable electricity generation is low, demand response measures reduce the load on the grid, reducing the amount of peak gas plant that must be switched on to meet the grid demand.

Key points

Peak reduction

- Use passive measures and efficient systems to reduce heating, cooling and hot water peaks.

Active demand response measures

- These measures reduce the electricity consumption for a certain period.
- Install heating and cooling set point control with increased comfort bands, controlled with smart thermostats or home energy management systems.
- Integrate thermal storage of heat into communal or individuals' system within a building.
- Reduce lighting, ventilation and small power energy consumption.

Electricity generation and storage

- Use products that can generate electricity and feed into the grid, or power the building.
- Consider solar to water heat storage.

Electric Vehicle (EV) charging

- It is generally accepted that there will be a large increase in electric vehicles, so it is essential to implement demand response to ensure grid stability.
- Charge EVs only when needed and allow the supplier to cut the charging short during peak times.
- Install 'Vehicle to Grid' / 'Vehicle to Home' technology which allows the EV
- Provide 50% active and 50% passive EV charging points for non-domestic sites.
- Battery to be used to supply the home during grid peak periods.

Behaviour change

- Raise awareness of how people use electricity and the impacts.
- Consider incentives to reduce peak demand.
- Encourage responsible occupancy.

Microgrids

- For large masterplan sites, consider being part of a small semi-isolated energy network, separate from the national grid.

Net Zero Design | Focus 5 | Infrastructure (heating)

What is a communal heating scheme?

Rather than each building having its own heat generation system (e.g. heat pump), in a communal heating scheme heat is generated in a central energy centre and distributed. Each connected building or home has a heat exchanger, heat interface unit or secondary heat pump. Traditionally fed by gas boilers, these systems can now rely on heat pumps.

Heat generation: no more gas

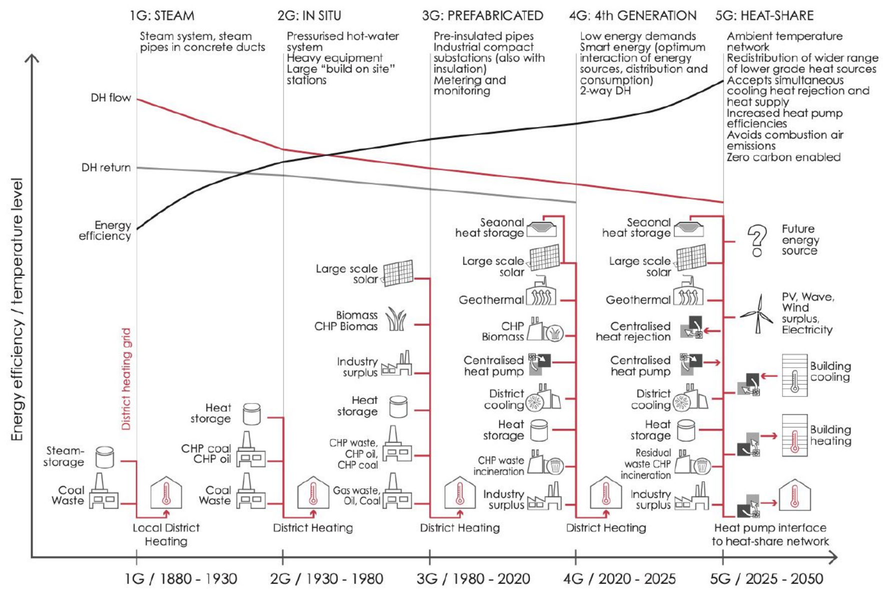
Achieving Net Zero is about phasing out the use of fossil fuels. If you want to claim that your project is Net Zero carbon, it is clear that you cannot use fossil fuels, even in a communal heating system.

Estimating and reducing distribution losses

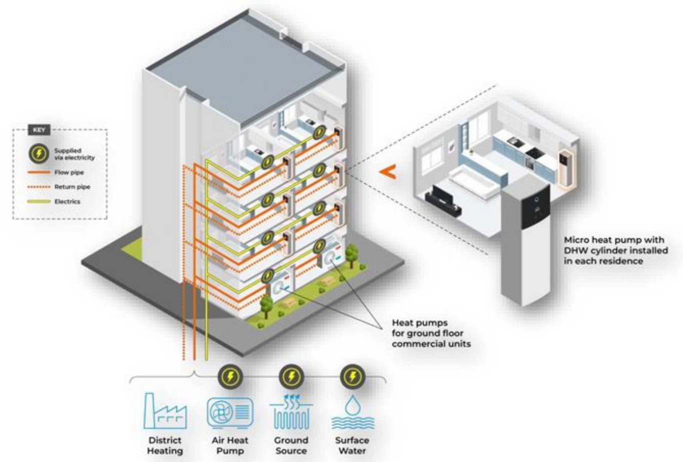
Even with well insulated pipes, heat is lost when you transport hot water through pipes. For ultra low energy schemes that do not need much heat, more than 50% of the heat that is generated by the communal heating system can be lost through the distribution pipe work, this can make communal heating very inefficient.

The supply temperature for communal heating systems is generally between 60-80°C. However, heat pumps operate best at lower temperatures. This and the fact that so much heat is lost through distribution means that lower distribution temperatures are critical.

Ambient loop systems, where the temperature of the distribution system is closer to 25° C, can in some situations be a good way to supply heating. They work particularly well where both heating and cooling requirements need to be met as waste heat (a by product of cooling systems) can be used to provide hot water to buildings that need it.



Summary of evolution of heat networks towards lower temperatures and lower carbon sources (Source: Chris Twinn for LETI's Climate Emergency Design Guide)



Example of ambient loop system with heating and cooling in different parts of the building Source (Vital Energy)

Net Zero Design | Focus 6 | Ventilation in smaller buildings

Controlled air flow through good airtightness

The key to managing ventilation in new dwellings is being in control of where, when and how air flows through a building. This starts with very good airtightness, to limit any uncontrolled infiltration. Trickle vents should be avoided as they do not control infiltration.

Install a Mechanical Ventilation with Heat Recovery (MVHR) unit

To maintain good air quality, and to reduce heat losses within a home, the use of an MVHR is critical. Not only does this unit supply air into occupied spaces, and extract air from cooking areas and toilet/bathroom spaces, it does this using very little energy.

It is important that the unit is positioned as close as possible to an external wall to prevent heat loss from the ductwork that connects to the outside. These ducts should be accurately fitted with adequate insulation to prevent heat loss. Ductwork should avoid having sharp bends which could affect pressure loss and flow.

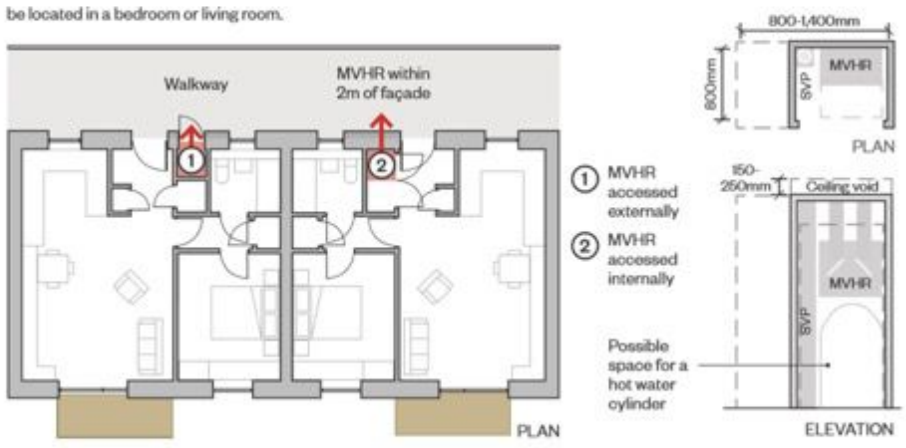
MVHR units include filters that must be changed regularly (usually at least once per year but check the manufacturer's instructions).

You can still open windows

There is a myth that 'sealing up' a building means you can no longer open the windows. This is not true. The benefit of an MVHR is that you do not have to open windows in winter for fresh air, losing heat. Occupants can open windows and use the buildings normally.

Trust the controls

Once a system has been properly commissioned, the controls should not need adjusting. A common issue is a lack of understanding or trust that the unit is working correctly, and then it underperforms due to inappropriate user adjustments, or a user turning off the MVHR.



MVHR systems are an effective way of providing ventilation to airtight buildings. Individual units should be located within 2m of the façade to reduce ductwork and associated heat losses.

Key requirements for a good residential MVHR system	
Distance from external wall	<2m
Specific fan power	<0.85 W/l/s
Heat recovery	>90%
Thickness of duct insulation mm	>25mm
Certification	Passivhaus Certified
Maintenance	Easy access for filter replacement.

In order to have an efficient running MVHR, it is recommended to choose an MVHR that meets the above performance criteria

Net Zero Design | Focus 6 | Ventilation in larger buildings

Reducing heat loss with larger centralised ventilation systems

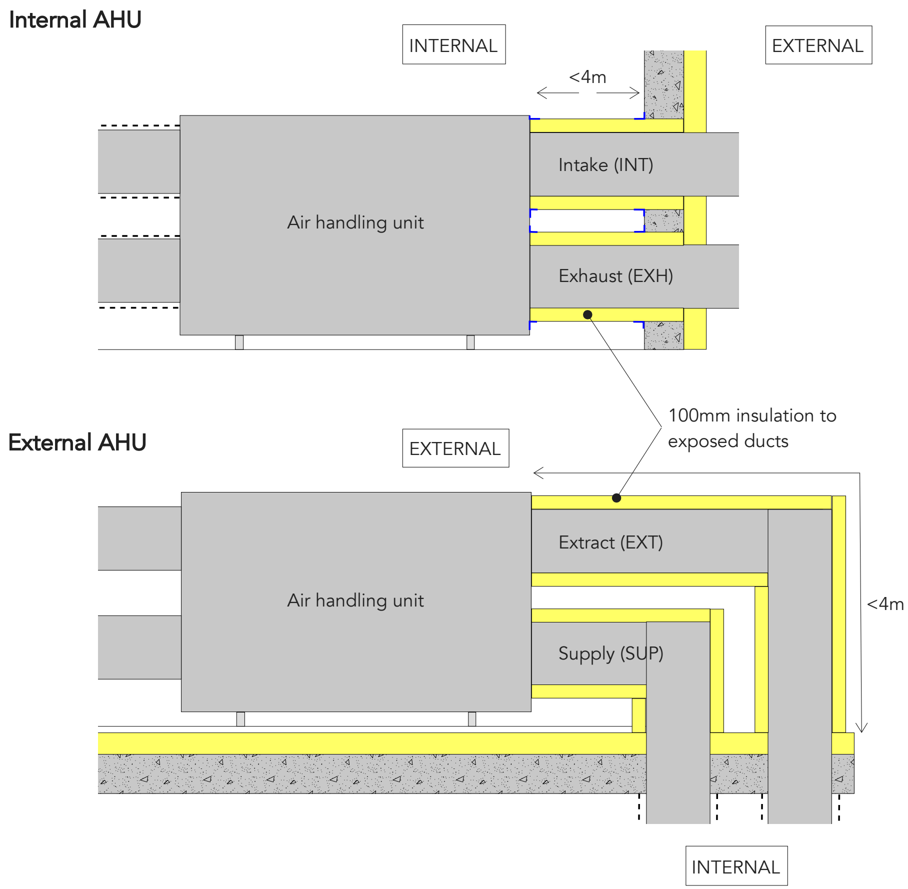
In bigger buildings air handling units (AHU) are often used to provide mechanical ventilation. These are centrally located and can be outside or inside of the thermal envelope of the building.

Ductwork between the AHU and the internal heated can be a significant source of heat loss for the building and therefore there are some key principles to be followed:

- Reduce exposed duct lengths to as short as possible, aim for less than 4m per duct on average.
- Take the shortest route to the building envelope.
- Maximise insulation to exposed ducts – target >100mm rigid mineral wool insulation or similar.
- Pre-insulated ducts should be the preference.
- Insulation must have an external or integral moisture check.
- Insulation must be taped to AHU casing and building air barrier.

Maximise heat recovery efficiency

As in smaller buildings These systems again should include heat recovery and this can often be achieved through different mechanisms, but a priority should be given for the highest efficiency.



Net Zero Design | Focus 7 | Low carbon heat

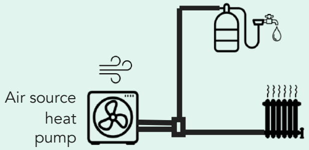
The electricity grid has decarbonised and will continue to decarbonise further, thus the most likely low carbon heat source for now and the future is electricity. This is done most efficiently, and has lower running costs, when using heat pumps.

What types of heat pumps?

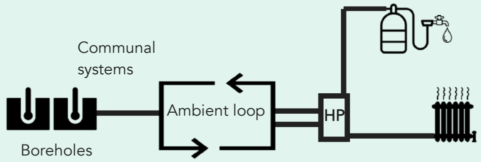
There are lots of different types of heat pumps, broadly in two categories, individual heat pumps and communal heat pumps. The adjacent '**selection process chart**' can be used to find the most efficient heat pump

1 Which heat pumps should I consider first?

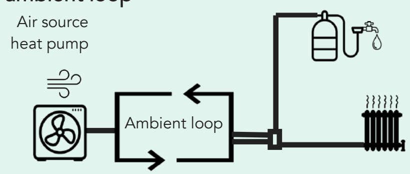
Individual air source heat pump (monobloc or split)



Individual or communal ground source heat pump



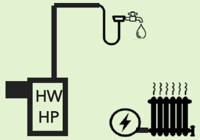
Individual heat pump connected to ambient loop



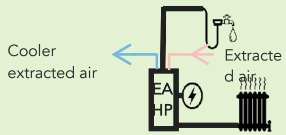
If these systems do not work

2 Which are the next best for new homes with a low space heating demand?

Individual heat pump integrated into hot water tank



Individual exhaust air heat pump



HP: Heat Pump

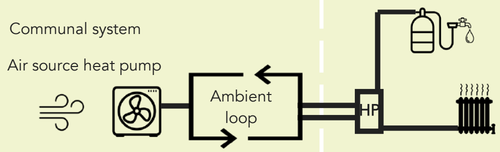
HWHP: Hot Water Heat Pump

EAHP: Exhaust Air Source Heat Pump

If these systems do not work

3 Communal heating system fed by heat pumps

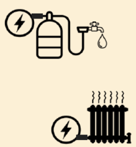
Communal heating systems fed by heat pumps (operating at around 60°C or less)



If this system is not available

4 Direct electric heating and hot water

Direct Electric radiators & hot water tank with immersion heater



Lowest efficiency

Net Zero Design | Focus 7 | Low carbon heat

Designing heat pumps

Make sure that the heat pump is sized correctly to meet the heating and hot water load. Choose a heat pump with a refrigerant that has a low Global Warming Potential (GWP) - propane is currently market best practice. Minimise pipe lengths (e.g. between the external unit and the domestic hot water store) to reduce heat losses from distribution. Choose a heat pump with a high efficiency (often referred to as the Coefficient of Performance or COP).

Radiators might be larger

Heat pumps run best at lower temperatures (around 35-45°C degrees). This means that radiators need to be slightly larger to emit the same amount of heat as they would in a higher temperature heating system. However this may be countered by the fact that ultra low energy buildings will require less heat.

Commissioning and handover

Heat pumps should be correctly commissioned ensuring hydraulic systems are pressure tested and balanced. Make sure the user understands how the heat pump works and why it is set to operate in a certain way.

Note on larger systems

Heat pumps can form part of a communal heating system. They can be based on air source heat pumps or ground source heat pumps. If the former their location on the roof will have to be considered early during the design.

They can also feed a larger heat network but distribution losses will need to be carefully evaluated to ensure that this does not result in a poorly energy efficient system.

Key points

- **Reduce distribution losses** - All pipework must be insulated and designed to ensure there are no 'dead legs' containing more than 1 litre. Tapping points (e.g. taps, shower connections) should be clustered near the hot water source.
- **Insulate to minimise losses from hot water tanks** - the standby losses of hot water tanks are highly variable, and can have a significant impact on overall energy use. Target a hot water tank heat loss of less than 1 kWh/day equivalent to 0.75 W/K.
- **Install waste water heat recovery systems in shower drains** - A simple technology that recovers heat from hot water as it is drained. Vertical systems can recover up to 60% of heat, horizontal systems 25-40%.

Net Zero Design | Focus 8 | Renewable energy generation

Where to install solar PV panels

Solar Photovoltaic (PV) panels are typically installed on roofs as these often provide unshaded locations facing the sun for much of the day. They can be installed on flat roofs, pitched roofs, and even on walls or pergolas. A solar installer can advise as to the most suitable locations.

Can solar panels help to reduce energy costs?

The lifetime cost of solar electricity in the UK is typically around half the price of grid electricity. Solar solar panels will therefore save not only carbon emissions but also money by avoiding the need for your home to import higher carbon electricity from the grid, and by exporting surplus energy back to it. Expect to use anywhere from 15%-50%+ of solar energy directly, depending on how well a building's consumption is matched to the sun with export tariffs typically paying around 5.4p per unit of electricity sold.

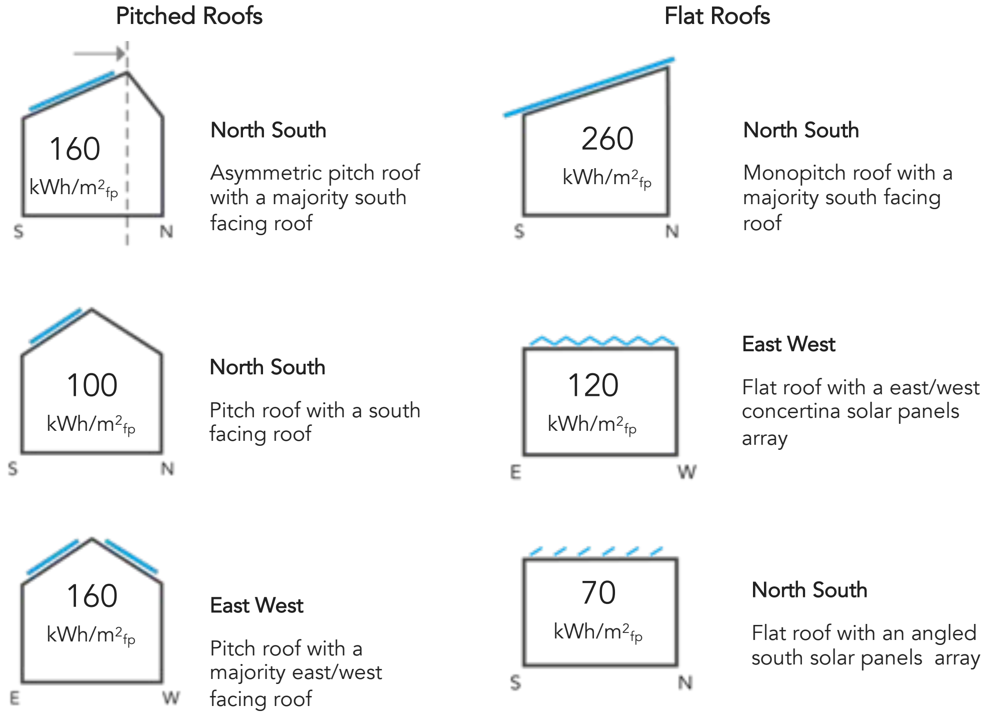
Choosing a good installer

Prices and installation quality vary between installers, so it is important to choose carefully. Small residential systems should typically cost around £1,500 per kW. Latest average prices are published regularly by the government to provide useful benchmark figures. A genuine and experienced Microgeneration Certification Scheme (MCS) certified installer with a track record should install the system.

Specification of panels and inverters.

450+ Wp solar solar panels are now readily available at comparable costs and panel sizes to lower capacity units. Specifying microinverters or DC optimisers can help maximise power output from the panels.

Many solar panels are now able to generate more than 450W of power, a significant increase compared with older panels (© LG)



Roof design can be optimised to maximise energy output from photovoltaics. Optimised South facing work best for pitched roofs and east-west concertina solar panel array work best for flat roofs.

How well the roof space is utilised can be expressed in kWh generated per m² of building footprint (kWh/m^2_{fp})

Net Zero Design | Focus 9 | Embodied carbon

Reducing the embodied carbon is a key pillar of constructing to a Net Zero standard. This page highlights some areas to focus but everything that goes into a constructing and maintaining a building will make a contribution in carbon emissions. The impact of embodied carbon must be at the forefront of all procurement decisions: is everything being specified 'value for carbon'?

As a minimum all buildings must: **measure** the embodied carbon, test alternative **options/scenarios**, and push for **data** from manufacturers and suppliers - ideally though Environmental Performance Declarations (EPDs).

Key concerns for structural design

- **Prioritise reuse:** If there is an existing structure or foundations onsite could they be reused in the new building. Fully investigate the existing material.
- **Concrete use:** Only use concrete where necessary – this is typically in higher density residential buildings. Low rise residential and non-domestic buildings have more choice in materials and should consider timber, timber/steel hybrids or reused elements from deconstructed buildings
- **Concrete strength:** Where concrete is needed specify lower strength concrete and longer curing times to open up options for lower carbon cement alternatives. C32/40 is the most efficient grade.
- **Simple layouts:** Maintain a consistent vertical line for all walls and column, avoiding the need for bulky transfer structures. Distribute these vertical structural elements evenly throughout a building so that the horizontal structure can be as slim as possible.

Key concerns for façade design

- **Simple form**: By not complicating the geometry of the facade less material will be needed to enclose a building, reducing the build cost as well.
- **Use glazing sparingly**: Window proportions should be restricted based on the elevation and focussed on capturing passive solar gains (See Focus 1). Windows and doors need regular maintenance and replacement increasing their embodied carbon.

Building Services

Meet the Net Zero operational KPIs: Achieving the Net Zero KPIs set out in this document will significantly reduce the demands placed on mechanical and electrical equipment. This allows smaller systems to be used which will reduce costs, floor space required for these systems and embodied carbon associated with services.

Location, location, location: Consider where the main mechanical plant is located in a building and how this will impact on ductwork, pipework, cabling etc. By considering the length of all these elements the energy efficiency of the systems will be improved as well as the the embodied carbon associated them.

Material and product choice: Ask suppliers for details on their product's performance in terms of embodied carbon, this is often found on EPDs. Prioritise products with lower maintenance requirements and longer lifespans. Ensure equipment is easily accessible, and can be maintained without hassle. Specify products, where components within the product can be replaced, rather than the whole product.

Refrigerant leakage: Products such as heat pumps contain refrigerants. Refrigerants gradually leak from equipment and, when in the atmosphere, increase global warming. Prioritise systems with refrigerants that have a lower Global Warming Potential (GWP) and lower leakage rates. Take particular care with split heat pump systems – the likelihood of refrigerant leakage is much higher than for packaged systems.

Further information

- **LETI Embodied Carbon Primer** - a general introduction to the subject with advice that covers all aspects of buildings.
- **IStructE How to calculate embodied carbon** – comprehensive guidance for structural engineers on how to calculate and start reducing emissions.
- **CIBSE TM65** – guidance on how to calculate the embodied carbon of building services.

Net Zero Design | Focus 10 | Modelling building performance

Using building regulations methodology alone is risky

There is a well known performance gap between predicted energy use from building regulations compliant models (SAP/SBEM) and real life performance. The models created for Part L assessments were designed as a compliance tool rather than a design tool. But often they are the only energy model completed for a building and designers will use them to make important decisions.

Additionally planning policy often refers to energy performance in the context of Part L, making planning targets which are seemingly ambitious, fall short of the expectation.

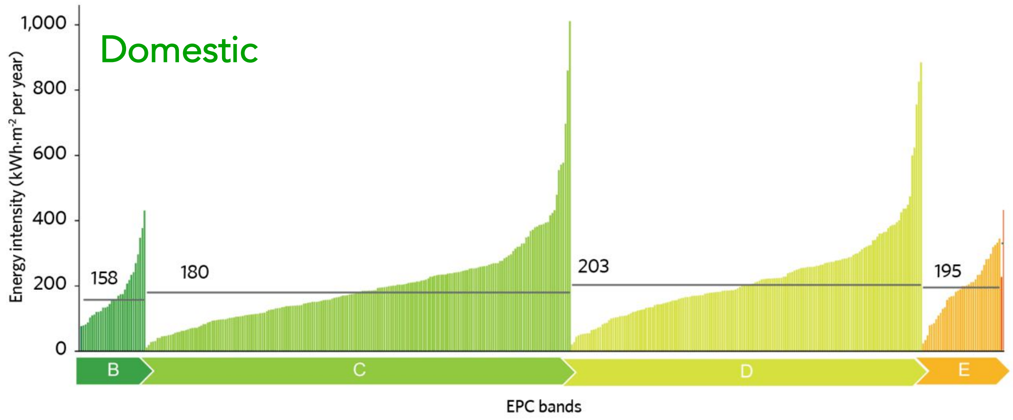
There are however modelling methodologies that have been shown to better represent real life building performance, choosing these methods will significantly help a building meet the Net Zero KPIs.

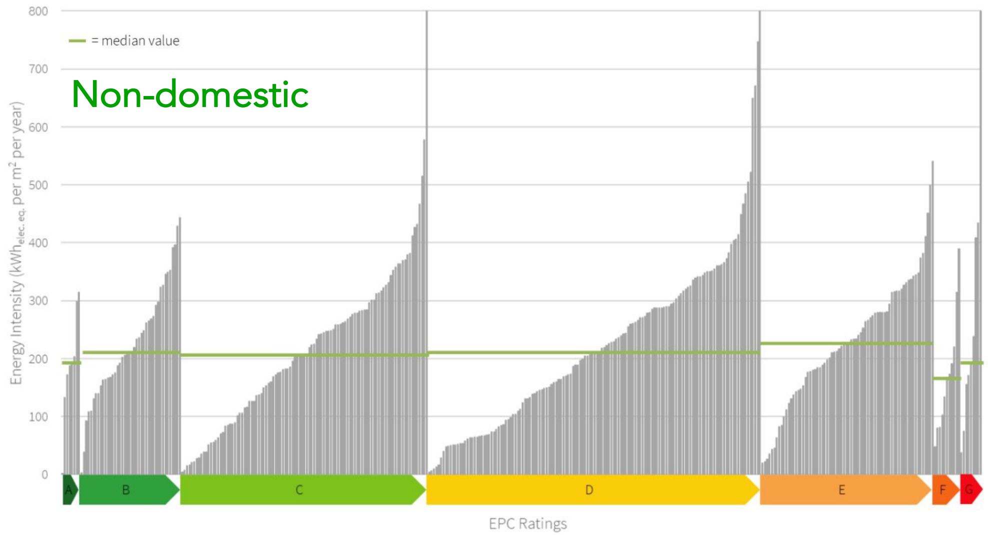
Modelling for Net Zero carbon performance

Best practice energy modelling requires design teams to be more inquisitive and comprehensive. Fundamentally models must include:

- Coverage of all energy uses in a building.
- Variables that represent reality for the building (internal heat gains, building location etc) and are fully justified by the modeller.
- Detailed modelling of complex systems (centralised HVAC for example) which significantly contribute to the EUI.
- Stress testing to understand how performance will vary if the building is used in a different way.
- Honesty about how the model has been built to allow others to interact, interrogate and use the models to improve performance in-use.

There are two main modelling methodologies that have been demonstrated to produce estimates that match real life performance: the Passivhaus Planning Package (PHPP) for domestic and non-domestic buildings, and CIBSE TM54 for non-domestic.

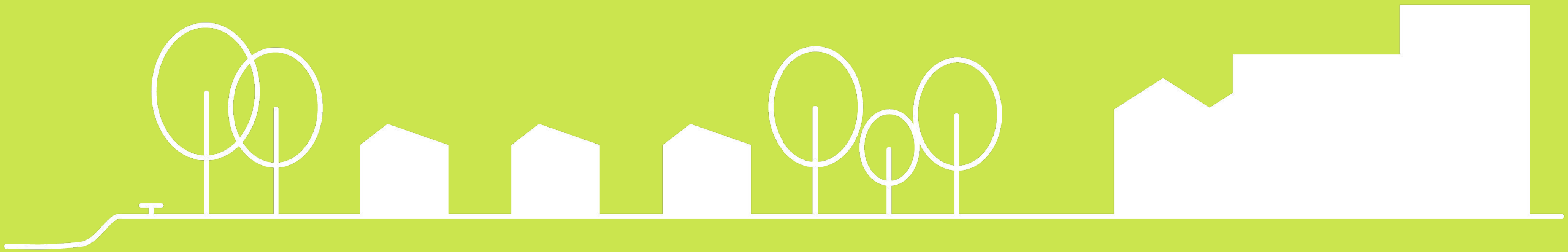




There is substantial and well-proven gap between the modelling methods used to create EPCs (and demonstrate compliance with the Building regulations) and actual building EUIs. PHPP and CIBSE TM54 represent better options for modelling in order to meet Net Zero standards.

6 BEYOND ENERGY DESIGN

This chapter outlines the key focus points related to the overall sustainability of a site, both domestic and non-domestic.



Beyond energy | Focus 11 | Flooding

A key impact of climate change will be an increase in the frequency and severity of flood events. For Folkestone and Hythe being on the coast makes it vulnerable to flooding and has issues of nutrient loss and contamination of the environment. Overwhelmed drainage systems will also pose an increasing problem. It should be considered that all developments, both existing and new, will be at risk of flooding in the future regardless of its flood risk level. New development should not increase flood risk onsite or cumulatively elsewhere and should seek betterment over the minimum requirements wherever possible.

Mitigate flood risk naturally - Avoid building on flood plains. Proposals should avoid constructing man-made flood prevention infrastructure and instead work with the natural environment and its features to reduce the risk of flooding (not only on-site but also off-site), using Natural Flood Management (NFM) approaches such as tree planting and swales.

Resilience - Design buildings, streets and open spaces that are resilient to flooding, utilising flood resilient construction and implementing flood mitigation measures. Streets should utilise SuDS. Utilise flood resilient materials and construction methods that allow a building to recover more quickly after a flood.

Water storage and recycling – Rainwater collection should be utilised for every project at least in rainwater butts or larger tanks under gardens. This will allow residents to water their gardens without using mains water reducing consumption and excessive surface water. Rainwater can also be used in a grey water recycling system.

Further information

- The SuDS Manual (C753), CIRIA
- Susdrain, Delivering SuDS (including retrofitting SuDS)
- Kent County Council Drainage and Planning policy statement
- Susdrain, Water People Places

Flood risk management hierarchy

Assess	Check flood risk level on Environmental Agency website and regardless of flood risk level ensure new development doesn't increase flood risk on site or elsewhere
Avoid	Avoid development in areas of high risk of flooding. Do not increase the risk of flooding on-site or elsewhere.
Control	Incorporate a range of landscape that capture stormwater and mitigate flooding e.g. SuDS, swales and other natural infrastructure flood mitigation
Mitigate	Employ flood resilient construction

What you should do

Small and large sites domestic and non domestic should provide:

- Slow the flow of water on the site through planting trees, hedgerows, buffer strips.
- Intercept rainfall using vegetation in rain gardens, especially tree leaves, intercept rainfall so it doesn't reach the ground.
- Store water in rainwater harvesting, green roofs, permeable paving, bioretention systems (e.g. rain gardens), trees, swales, ponds, wetlands, detention basins, infiltration basins, soakaways
- Increase infiltration through improving soil structure, creating permeable surfaces. Utilise flood resilient materials and construction methods that allow a building to recover more quickly after a flood. Large areas of impermeable hardstanding should be avoided.
- Ensure floor levels are more than 600mm above the flood level predicted for a 1:100 year flood event (plus climate change). Provide safe access and egress routes above the predicted flood level.
- Improve run off rates accounting for climate change - 40% improvement for greenfield run off rates. improve or reduce run off rates for brownfield sites aim for an improvement from the existing.
- SuDS should be utilised on every site, considered at every scale and designed in from the beginning of a project. Take a creative approach to reduce the long-term risk of flooding and enable natural environments to absorb water.
- Wetlands should be included where possible to store and clean surface water to ensure nutrient neutrality.
- Grey water recycling of water systems and/or rainwater should be considered to encourage circular water use.

Beyond energy | Focus 12 | Water consumption

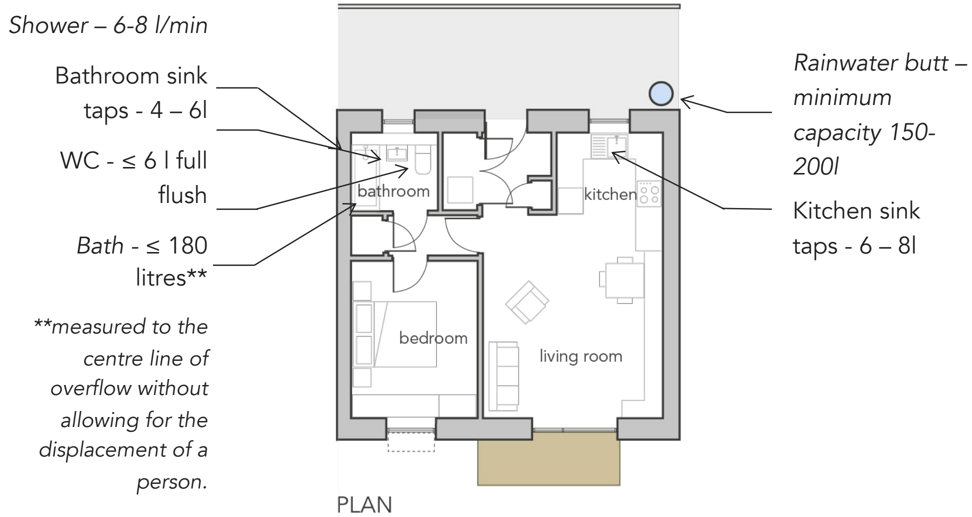
Water is a precious resource and pressure on water supplies is increasing. Climate change is bringing unpredictable patterns of precipitation putting further stress on resources. It's vital that all buildings use water efficiently. All developments should exceed the minimum building regulations requirements.

Clean water and water recycling – Nutrient neutrality is a means of ensuring that project does not add to existing nutrient burdens so there is no net increase in nutrients as a result of the project. The national generic nutrient neutrality methodology provided by Natural England sets out how calculations can be undertaken. Any water that needs to be released into the environment should ideally pass through a natural water filtration system such as a wetland. Maximise opportunities for betterment of water quality, amenity and biodiversity. Natural mitigation methods within the development site should ideally be considered first to minimise the contribution from the development itself, but where it is not possible to provide or secure the necessary mitigation in this way, then mitigation on land outside the development can be considered.

Grey water recycling – Grey water recycling is the process of treating waste water and reusing it. Systems collect rainwater and the water used in sinks, dishwashers, showers and baths, and process it and recycle it back into toilets, washing machines and outside taps. Grey water can also be cleaned to be used for potable water but this can be expensive and energy intensive. Sites should endeavour to reuse greywater that is not potable in toilets, washing machines and outside taps as this is a sure way to achieve the ambitious water consumption target of <95 l/p/d.

Further information

- AECB standard



RIBA 2030 Climate Challenge targets:

<101 l/p/d	<95 l/p/d	10 l/p/d	<0.5m³ /pupil/yr
Housing without grey water recycling	*Housing with grey water recycling*	Office	*Schools* - equates to approximately equivalent to 3 l/p/d.

What you should do

- Reduce flow rates using he AECB water standards provide clear guidance on sensible flow rates for showers and taps in low energy buildings.
- Larger sites should endeavour to provide greywater recycling for non potable in toilets, washing machines and outside taps
- Every site should provide rainwater collection for outside taps
- Do not use potable water for irrigation

Beyond energy | Focus 13 | Ecology and biodiversity

Enhancing biodiversity benefits occupants, the larger community, and the economy, as well as species and habitats.

Consider context – Assess the existing ecological value of a site to determine the presence of UK protected and priority habitats and species. Masterplans should integrate existing habitats and preserve and enhance existing features such as meadows, ponds, existing trees and hedgerows. Tree and ecology surveys should be conducted and subsequent reports should be followed in the design.

Ensure connectivity – Any existing green spaces, trees, green corridors, or other habitats should be linked in the local and wider context. Clever tree provision in the design can help to connect the streets and natural spaces together. Plants can be used as a natural barrier in place of fences. Create new green corridors to encourage connection and provide foraging and shelter areas as well as transit routes for wildlife.

Wellbeing - Design multifunctional green and blue infrastructure that supports the health and wellbeing of people through creating safe spaces for active travel, recreation, and connection with others and make nature accessible to the community promoting wellbeing recreational routes that include engagement with nature and education signage.

Nature recovery and Resilience - Create and prioritise diverse complex habitats that positively enhance biodiversity and successfully deliver biodiversity net gain on site. Design green infrastructure and native species with climate change resilience and long-term sustainability in mind, taking into account the abundance of sunlight and water provided on the site. Planting should not require irrigation.

Further information

- Biodiversity Net Gain: Good Practice Principles for Development
- Kent Biodiversity Strategy
- Building with Nature Standards
- Designing for biodiversity guide

Biodiversity net gain hierarchy

Avoidance	Avoid impacts on existing biodiversity on the site by leaving areas of nature alone
Minimisation	Minimise any impacts on existing biodiversity by retaining existing trees, green spaces and existing habitats
Enhance	Achieve a measurable gain on biodiversity and the services ecosystems provide through new trees, green spaces and planting
Compensation	Where not possible to deliver BNG on site refer to F&HDC for support with a suitable off-site contribution strategy as compensation.

What you should do

Small scale sites (single homes, individual buildings):

- Assess the existing ecological value of the site. Protect and enhance existing features for biodiversity, ensuring local baseline and opportunity maps for the Nature Recovery Network are used to plan wider ecological objectives beyond the site.
- Protect and enhance habitats for priority and endangered species.
- Retain all category A and B existing trees.
- Proposals should include an assessment of existing and proposed natural capital assets.
- Incorporate Building with Nature principles, helping to shape multifunctional green infrastructure for people and nature.
- Include blue infrastructure such as ponds, lakes, streams, rivers to enhance biodiversity, manage flood risk and provide amenity.
- Habitat provision for insects, mammals, birds, bats and bees within the landscaping of the site and buildings.

Large scale sites as above, plus:

- Follow Biodiversity net gain hierarchy and achieve 50% improvement.
- Provision for food growing for residents.
- Conduct a public open space assessment.
- Connect to any green space in local and wider context.

Beyond energy | Focus 14 | Green and blue infrastructure

Green and blue Infrastructure is an urban design approach to flood mitigation and ecology and biodiversity. It uses natural infrastructure to help recreate natural water processes and encourage wildlife. Focus your green infrastructure on a native palette and species, to enhance the offer to wildlife through seed producing and nectar bearing plants, nesting opportunities and shelter. These are known to provide wildlife benefit, encourage human interaction, flood risk mitigation, improve air quality and lower local air temperatures. Within Folkestone and Hythe this is extremely important for flood risk and maintaining nutrient neutrality. Each site will offer different opportunities depending on the context:

Green roofs

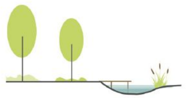
Adding green roofs can retain <75% rainwater runoff. They can also create further opportunities for habitat creation and can help in reducing urban heat island effect. **Brown roofs** offer higher biodiversity as they are self seeded. **Biodiverse roofs** introduce plants to the roof substrate when it is built. It is important that these plants are native and suitable to the amount of sunlight available on site. **Blue roofs** offer some water retention of stormwater. Which can be used in conjunction with SuDS to prevent flooding. **Bio solar roofs** allow green roofs to have solar panels on them which can help to increase biodiversity and renewable energy generation.

Green walls or green facades

Green walls of water intensive plants should not be designed to have an intensive connection to the water supply but instead be self sufficient off rainwater and occasional watering. Green walls such as climbing plants can allow water retention of up to 75% for little monetary and water cost.

Rain gardens

Planting placed below areas where rainfall is likely to hit such as below roofs, deck access or balconies allows rainwater the be slowed before entering the environment. Target pollinators and birds.



Wetlands

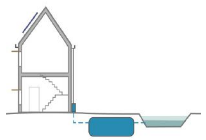
Wetlands allow surface water to be cleaned before it enters the environment ensuring nutrient neutrality of the surroundings.

Sustainable urban drainage systems (SuDS)

Integrating SuDS into a development can reduce surface water run-off by up to 72% . They can be structured or as simple as a natural channel in the ground that allows water to gather and drain naturally to direct water to areas for storage or an infiltration system. Observing the water direction on the site will help to inform where to direct water.

Street tree planting

Street trees in tree pits can retain up to 43% of rainwater. If those trees are part of SuDS system they can retain up to 78% rainwater.



Hard infrastructure

Using hard non permeable surfaces to guide surface water should be avoided as this does not help soak and reduce water but merely transports it elsewhere. Surface water should be tackled at its source and reduced. Attenuation tanks should be the last resort but can be used to store rainwater for reuse. But disturbing the soil to put them in can release carbon and damage ecology.

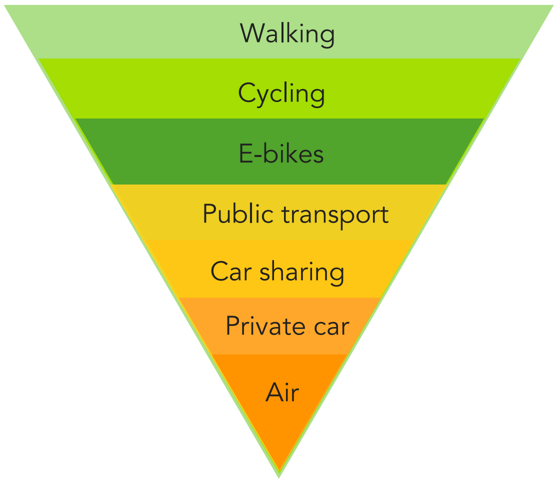
Further information

- UKGBC's Nature Based Solutions to the Climate emergency
- Making the Case for Green Infrastructure
- Natural England's Green Infrastructure Guidance
- Trees and Design Action group
- Natural England green infrastructure mapping tool
- C40 Knowledge Hub
- Carbon conscience analysis tool
- Natural England GI standards

Beyond energy | Focus 15 | Transport

Sustainable transport has two primary elements: the first, is to make it easier for people to avoid driving by reducing the need for journeys by providing facilities and local amenities on the doorstep. Secondly reducing the environmental impact of the journeys that have to be made by both encouraging active transport (cycling and walking), good connections to public transportation and providing charging points for electric vehicles. Sustainable neighbourhoods should support shifts in transport and travel behaviour towards the sustainable transport hierarchy below.

Masterplans should enable sustainable travel choices. Schemes should integrate high quality travel and transport infrastructure with consideration of and connection to walking, cycling and public transport routes in and beyond the site. Ensure connectivity and permeability with existing footpaths, cycle routes and public transport routes.



The Transport Hierarchy - applications should prioritise the modes of transport in the order they appear in the transport hierarchy, in the design and amenity provided in developments.

What you should do

Small scale sites (single homes, individual buildings)

- The Transport for New Homes checklist should be completed.
- At least a Tertiary Mobility Hub appropriate to the scale of development. See next page for details.
- Create direct connections to existing communities and facilities.
- Convenient, easily accessible secure, well-lit and covered cycle storage, 2 cycle spaces per household (min).
- If car parking is required limit to one space per dwelling.
- Provide one EV car charging point (min) for every household regardless of driveway, communal car parking or on street parking.
- Visitor cycle stand provision (include electric bike charging)

Medium and large scale domestic sites and non domestic buildings as above plus:

- Instead a primary and secondary mobility hub will provide an interchange of sustainable transportation methods as well as community facilities and an informal meeting point for the community. See next page for details.
- Visitor cycle stand provision (include electric bike charging). For larger site provide bike repair facilities. For non domestic sites provide facilities for cyclists, including lockers, showers, changing space and bike repair.
- Create open and permeable networks of streets and connected networks of green, off-road routes.
- All parking spaces to be provided with EV car charging points whether outdoor, covered communal car parking or on street parking.
- Provide 50% Active and 50% passive EV charging points for non-domestic sites.
- Innovative and future flexible approaches to parking should be sought, including shared parking courts, shared parking between employment and residential uses. Consider flexibility to change use in the future to a park or shared allotment.
- Large expanses of surface parking should not be permitted, and parking spaces should be broken up with planting.

Beyond energy | Focus 15 | Mobility Hubs

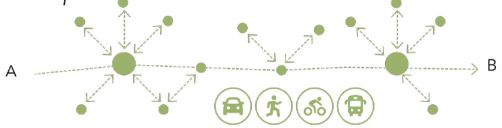
What is a Mobility Hub?

A mobility hub can provide residents with an interchange for sustainable modes of transportation to take them further afield. A mobility hub should provide connection between at least two types of sustainable transportation such as bus to train or at a smaller scale bus to bike. They will look different for different types and scales of projects, depending on the number of users and how good the existing current connections are. Mobility hubs should be designed in a central location that is accessible to all. In addition to transport connections they can include community facilities that reduce car use such as a café, co-working space, parcel collection and cycle maintenance facilities. They provide a meeting point for residents. This has multiple benefits beyond saving energy and carbon: improved local air quality; health and wellbeing benefits from being more active; greater potential for social interactions and facilitating a car free life.

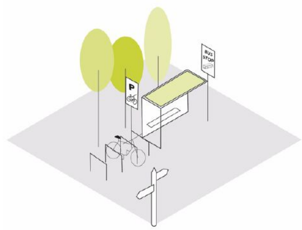
Designers should work with highways consultants and consider the type of transportation connections required for both immediate and distant facilities and assets. All mobility hubs should consider how residents move in and around the site and should connect to existing walking and cycle routes to wider facilities such as schools, medical centres and parks.

Private vehicle journeys from A to B means more vehicle miles and higher emissions.

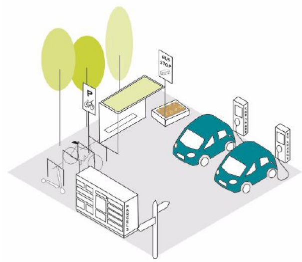
Linear public transportation means lower vehicle miles but longer journey times.



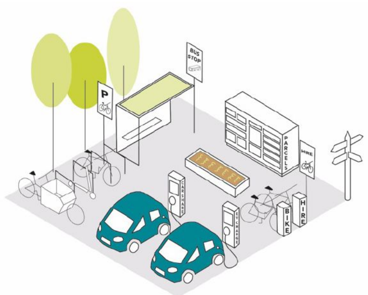
Mobility hubs allow for lower vehicle miles and more direct routes using a variety of vehicle and active travel methods.



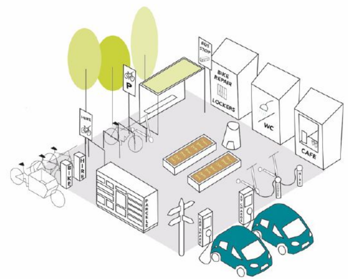
Minimum Mobility Hub – At the least provision for swapping between two modes of transport e.g. bus and bike. Supports travel inside the neighbourhood and connection to another transport interchange for wider connections.



Tertiary Mobility Hub - Supports some local routes and connects to a number of nearby assets and facilities. It builds upon the minimum mobility hub and adds in community facilities such as food growing space, parcel collection point or a car share scheme.



Secondary Mobility Hub – Supports several routes to assets and facilities, connecting to wider transport routes. Building on the tertiary, a secondary should provide access to a cargo bike, public food growing, cycle hire, parcel collection, car share scheme and EV charging point for visitors.



Primary Mobility Hub - Supports travel to and from the development connecting to wider railway and town centres. Provision of a bus stop, cycle stands, cycle and scooter hire, car share schemes, EV charging points, parcel collection. Provides additional community facilities such as café, co-working space, showers, WC, and lockers. As well as parks, recreation spaces and community allotments.

Beyond energy | Focus 16 | Walkable and Healthy Neighborhoods

Walkable neighbourhoods

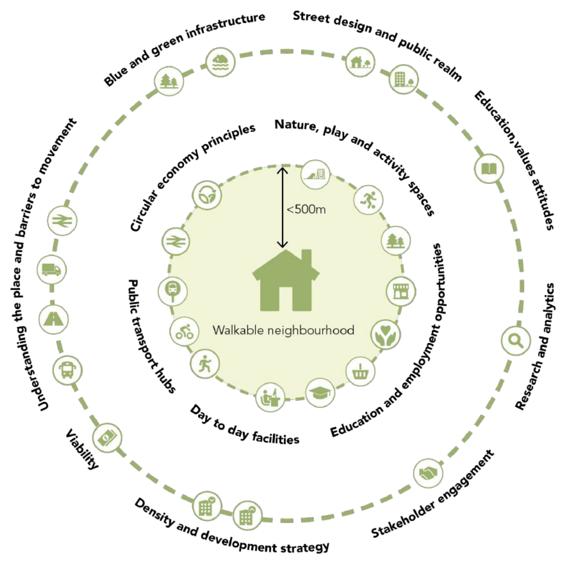
First and foremost, projects should be designed to provide a "15-minute neighbourhood," with employment, schools, nurseries, community amenities, and open spaces all within a 15-minute walk or cycle of a new home. Particularly, when planning a non domestic building, consider how distant workers will travel to and from the building. A project should look at the qualitative aspects of walkability and sustainable transport such as a clear hierarchy of pedestrian, cycle and public transport routes. A radius of amenities within 500m from the home is best practice for residents to avoid using a car. It is also crucial to provide wider accessibility to employment facilities, shops, and cultural attractions that are accessible via sustainable transport methods such as cycling or public transportation.

Linking to existing facilities and land uses

It is important to link existing land uses and facilities where possible. Understanding current and new land uses will help to inform what will work best for certain sites, with the aim of creating balanced footfall through an area. It is also important to consider activity hubs and streets nodes of a site to suit density and character.

Creating community

Developing a community is critical to the scheme's long-term viability. Whether it is to encourage the stewardship of community facilities and green spaces, or the creation of community hubs to meet contextual needs in order to increase social capital. It is important to ensure there is public consultation and engagement with a diverse group of people ensuring an equitable and inclusive design process. A scheme may propose a community building, such as a market hall or civic hub, depending on the assets available to provide a place for the residents to gather and use. Mobility hubs will provide community facilities and provide an informal meeting point for the community.



Ingredients of sustainable neighbourhood

What you should do

- Design schemes close to town centres with connection to any existing facilities such as schools and shops.
- Make sure there is adequate connection to public transport such as bus stops and train stations
- Create walkable streets and create walkable routes within the masterplan and connect to surrounding routes
- Connect to existing cycle networks or establish new routes including inside the site.
- Provide shops, restaurants and culture accessible by foot, cycling or public transport
- Connect new and existing green spaces and provide children play parks and all age activity spaces
- Consider future adaptability of the masterplan such as communal parking courts or driveways that are flexible enough to change use in the future.
- For empty or abandoned sites organise meanwhile uses and community driven events to begin to foster a community.

Beyond energy | Focus 17 | Circular Economy | Existing site

The circular economy is a place where materials and resources stay in use, at their highest possible value for as long as possible. In the context of construction we can simply look at:

- What is already available – the **existing** site; or
- What we are adding – the **proposed** site?

Retrofirst: Can the existing site be kept or only minimally changed?

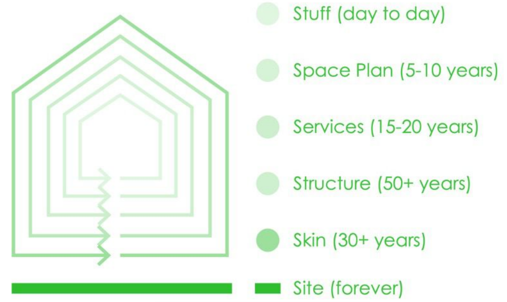
There is a clear hierarchy in how to approach an existing site:

1. **Maintain –** retain the building in its existing state for as long as possible through considered long-term maintenance.
2. **Refurbish/retrofit –** redevelop through restoring, refinishing and future-proofing whilst avoiding unnecessary major replacement.
3. **Repurpose –** redevelop with significant major changes and replacement of particular building elements e.g. keeping a buildings structure but constructing a new facade and interior.
4. **Deconstruct and reuse –** taking a building apart and breaking it down into parts with the intention of reusing the parts either onsite or locally.
5. **Recycle –** breaking the building down into materials and either using those materials for another purpose or recycling them. This step requires additional energy and often devalues material, which is why is should be considered last.

Learn about the existing site to inform the future design

An existing site with buildings or particular materials on it already is an opportunity to avoid buying new construction components. If successful this will be one of the biggest steps a development can take to reduce it's overall carbon footprint. Take time to fully consider opportunities for reuse before taking big design decisions.

An audit of the existing material should be conducted by someone with the knowledge to identify if the existing site/building/material can be retained, refurbished, repurposed or reused either onsite or locally.



The 'building in layers' principle is a key concept in circular economy. Existing sites should be looked at through the lens of this principle: can each of the layers be separated and reused in their current condition? It's important that buildings aren't demolished simply because a small number of the layers no longer meet their function. The longer the lifetime of a layer, the more important it is to try and keep it, as the cost (both in resources and financially) will be the highest. (Source: LETI)

Retrofit example

Zetland Road, Manchester by Ecospheric

Two Victorian semi-detached homes, originally built in 1894, retrofitted to achieve Net Zero levels of energy performance measured through EnerPhit certification (the Passivhaus retrofit standard).

Reuse example

Resource Rows, Copenhagen by Lendager Group

New build apartment block where all the brick needed for the façade was sourced from surrounding demolition sites. Brick panels were cut from the existing sites in 1m x 1m sections, mounted onto a frame and then connected into the main structure of the new apartments.

Beyond energy | Focus 17 | Circular Economy | Proposed site

Following the decisions on the existing site there may be new buildings or elements proposed as part of a development. The new materials must be specified and designed with a plan for what will happen across its entire lifetime.

Striking a balance between adaptability and longevity

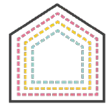
Making buildings adaptable extends their usable life and reduces the overall impact on resource consumption. Residents and occupants are also happy as they can adapt a building to meet their needs.

The layers with shorter lifespans (see previous page) will need to be the most flexible (elements like internal partitions) as they will be changed more frequently. Longer lifespan layers (structural elements or external walls) should target longevity. Think about:

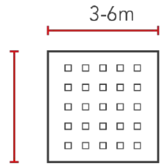
- Designing in layers – avoid sticking things together and favour mechanical fixings that can be undone.
- Creating simple structural grids - design to standard dimensions.
- Tall floor to ceiling heights – encourages future flexibility / adaptability of the building into other uses.
- Testing options for extending a building in the future, how could the design or the materials help with this process.
- Specifying high quality materials – aim for ones that are robust and require little maintenance.
- Circular neighbourhoods - multi generational neighbourhoods, buildings and spaces that evolve with people.
- Parking spaces may have a limited lifespan, make it easier for them to change into something else in the future.

Designing for deconstruction

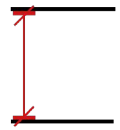
All layers should be considered from a deconstruction perspective, with the aim that they are completely reusable at the end of their life. Thinking of the buildings we are constructing today as 'materials banks' for the future offers up the the opportunity for future construction to reduce its dependency on virgin materials.



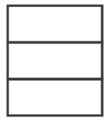
Design in layers for maintenance and changing needs



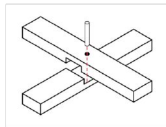
Simple structural grid



Tall floor to ceiling heights to for future adaptability

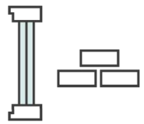


Design in standard dimensions to reduce wastage



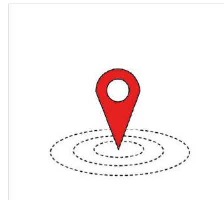
Detail for disassembly

Specify high quality durable long lasting materials



Re-use of materials in the building on the site or supply to other sites and buildings

Specify recycled and recyclable materials



Specify local materials to support local businesses

Beyond energy | Focus 18 | Waste

The appropriate management of waste can reduce Folkestone and Hythe's impact on climate change. There are three areas in the design and construction process of a development where waste-hierarchy principles must be applied to reduce this impact effectively.

Proposals should take steps to prevent, reuse, recycle, recover waste in the design of recycling storage in both new and existing buildings as well as in the management of waste through the construction process.

Key considerations in the design of recycling storage

- Provide dedicated, practical and sufficient space for sorting and storing of different waste streams: food waste, recyclable waste, garden waste and general waste.
- Provide dedicated, practical and sufficient space outside for storing different waste streams until collection.
- Provide a space for large waste collection.
- Ensure ease of access to external waste storage for residents and building users.
- Enable ease of collection by refuse lorries by providing sufficient access and appropriate areas for turning where necessary.
- Provide a recycling reuse fixing facility to encourage people to fix and reuse appliances and furniture.
- Food composting inside (caddy) and outside (compost heap) in residents gardens or in communal allotments
- Include space provision for food composting caddy on kitchen counter length.

What you should do

Develop a construction waste management plan

Waste and water consumption should be minimised throughout construction. A plan should both contain target rates for recycling and define processes to manage different waste streams. This plan should also contain a commitment to preventing any biodegradable waste going to landfill.

Integrate recycling storage

Domestic extensions - Consider improving storage space for recyclable waste as part of a kitchen re-design or addition of a utility room.

Non-domestic buildings - Provide clearly labelled bins and dedicated areas for waste recycling. Calculate predicted waste streams and provide sufficient, labelled waste storage in bin stores before waste collection.

Large developments - Consider use of accessible, communal waste storage for efficient storage of waste.

Sufficient internal storage

Convenient external storage

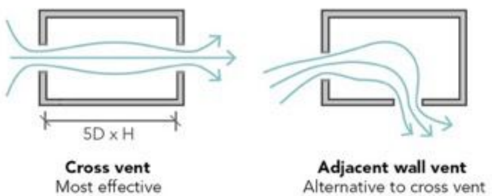
Ease of collection

Beyond energy | Focus 19 | Overheating

Climate change is already bringing warmer summers with more extreme temperature highs. With this, overheating in buildings is becoming an increasing threat to occupants' health and wellbeing, particularly for vulnerable people. In future years, this is set to become even more of an issue.

All projects should prioritise natural methods of reducing overheating over energy-intensive technology like air conditioning. The first step is to use exterior solar shading to limit the amount of direct sunlight that enters the building. The second step is to promote natural cross ventilation through dual-aspect spaces to increase air circulation to naturally cool a building. The incorporation of blue green infrastructure into the masterplan can also help to reduce the indoor and outdoor temperature. Green walls, green roofs, trees, and bodies of water such as SuDs in the landscape will assist to keep the local temperature lower and aid in cooling, but they should not be depended on alone.

Green and blue infrastructure helps to cool the surrounding environment naturally and reduces the urban heat island effect. Water bodies are known to cool the air and can contribute to the formation of a microclimate on the site. Trees outside a building can provide some shade, but they should not be depended on as the sole source of solar shading.



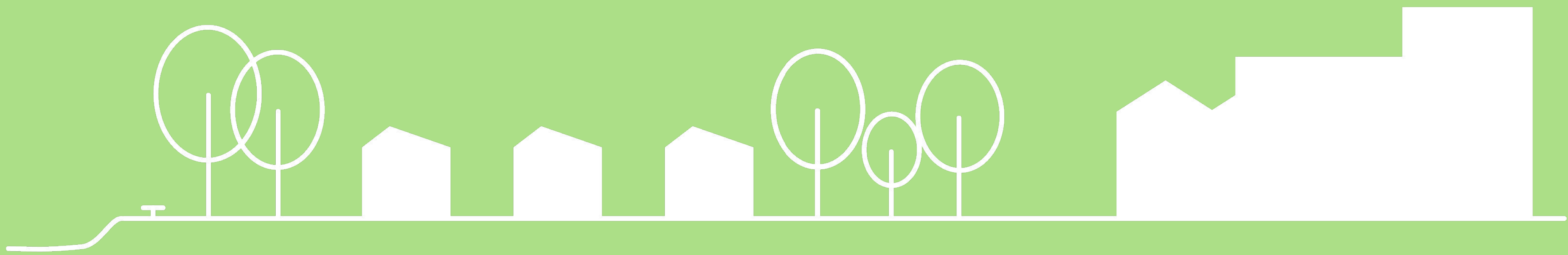
More openable area and cross ventilation is one of the drivers that can mitigate overheating. Offers the opportunity to provide natural refreshing of the air through the inside of a building requiring no energy.

What you should do

- Use the Good Homes Alliance overheating tool and checklist to demonstrate that the design is at low risk of overheating.
- Demonstrate compliance with Part O of the building regulations, Chartered Institute of Building Services Engineers (CIBSE) Technical Memorandum 59 (TM59) for domestic buildings or TM52 for non-domestic buildings.
- Use the Acoustics and Noise Consultants (ANC) Acoustics, Ventilation and Overheating Guide to find a balanced approach to acoustics, daylight and overheating risk.
- Ensure glazing areas are not excessive i.e. not more than 20-30% of facade on south or west façades. Encouraging wider windows with a windowsill in favour of full height glazing.
- Provide appropriate external solar shading. South façades should have horizontal shading over the window and the west façade should ideally have efficient movable shading e.g. shutters. Do not rely on internal blinds – these can be ineffective.
- Build in secure natural ventilation. Design window openings to take advantage of cross-ventilation (from one side to another) and/or stack ventilation (from bottom to top). Avoid fixed panes and maximise opening areas of windows. Side hung windows typically allow more ventilation than top hung.
- Select a g-value (the solar factor indicating how much heat is transmitted from the sun) for glass of around 0.5 where possible. It should be noted that glazing with g-values of below 0.4 could compromise the thermal performance of the home.
- Use thermal mass in buildings to help reduce temperature fluctuations throughout the day, and collaborate with secure natural ventilation to offer passive night-time cooling. Concrete flooring, for example, exposed to sunlight in the summer may store heat during the day but release heat at night, potentially leading to further overheating.
- Utilise green and blue infrastructure to provide natural cooling to the local environment and reduce the urban heat island effect.

7 CASE STUDIES

This chapter contains case studies on domestic, non-domestic, and beyond energy projects that have been built or will be built in the near future. It allows readers to see the guidance provided in action.



Case studies | New homes

Ultra low energy design is fast becoming the new normal

Many self builders and developers are choosing to go beyond building regulations for energy efficiency because it makes sense. Not only can low energy building be cheaper to run, they can be easier and cheaper to maintain and crucially, will not need further expensive retrofit in the future.

Beautiful and efficient homes

Lark Rise in the Chiltern Hills is certified to Passivhaus Plus standards. It is entirely electric, and generates 2.5 times as much energy as it consumes in a year. Careful optimised design has meant that it has a mostly glazed facade, minimal heat demand and stable temperatures over summer months.

Passivhaus/Ultra-low energy can be delivered at scale

Developers are building Passivhaus at scale. Example developments include Springfield Meadows in Oxfordshire, which delivered social and private housing to exemplary standards, including ultra energy efficient fabric with low embodied carbon and nature based solutions to landscaping and SuDS. Other examples include a mixture of houses and flats at Wimbish, Essex (where the average heating costs for the houses are £130/year), Goldsmith Street in Norwich, Agar Grove in Camden and many other developments across the Country.

Lark Rise, Chiltern Hills.

Passivhaus Plus certified.

(Source: Bere:architects)

Springfield Meadows

(Source: Greencore construction with Bioregional)

Goldsmith Street

Passivhaus

(Source: Mikhail Riches)

Case studies | Non domestic

All types and scales of buildings can be low energy

There are many examples of low energy non-domestic buildings. Oak Meadow Primary School in Wolverhampton was one of the first Passivhaus certified schools in the UK. Large windows allow for useful solar heating in the winter, while external shading limits overheating in the summer. Spaces are ventilated through openable windows and ventilation panels in the summer. A mechanical ventilation system provides heat recovery in the winter.

Bicester Eco Business centre is aiming to become the UK's first commercial building certified to Passivhaus Plus. It achieves with all-electric air-source heat pumps, on-site energy storage, and on-site renewable energy. The building adopts a hybrid construction system that consists of a concrete frame and timber larson-truss infill panels which minimises its embodied carbon impact.

Mobility hubs

Mobility hubs are a new typology that is still being developed. Plans for them are increasing, with Otterpool Park proposes a series of mobility hubs. Further away, Manchester City Council approved proposals for the Ancoats Mobility Hub in November 2020. The Ancoats Mobility Hub aims to challenge city-centre parking, street usage, mobility, and logistical conventions. It features car parking, a delivery facility, EV charging, cycle hire and changing facilities, and a cafe to serve local residents and change travel habits.

Bicester Eco Business Centre

Aiming to become the UK's first commercial building certified to Passivhaus Plus.

(Source: Architype)

Ancoats Mobility Hub

(Source: Buttress)

Oak Meadow Primary School

Passivhaus

(Source: Architype)

Case studies | Beyond Energy

Beyond energy

It is just as vital to prioritise the environment and community when creating masterplans as it is to design ultra low energy buildings. It is becoming more common to see developments designed with wider sustainability principles. The ultimate objective is not simply to enhance a place's physical environment, but also to guarantee that it is maintained in a way that fosters economic growth, social cohesion, and long-term sustainability.

These projects place the health and well-being of its occupants ahead of the quantity of dwellings that can be built. Walking routes have been considered, with the purpose of establishing safe, well-lit, beautiful routes that promote chance encounters, reducing loneliness and isolation and developing a feeling of community. Creating inclusive intergenerational activities that provide opportunities to bring people together, such as community gardening initiatives, and that aid in the treatment of mental health issues such as depression.

Derwenthorpe, in York, pictured here is an excellent example of a rural development that incorporates nature and neighbourhood. The homes in this development did not target net zero but provides a precedent for good placemaking between the buildings. Lovedon Fields, on the other hand, has integrated PV panels and a good efficient building forms, which although not quite net zero perhaps again demonstrates what a net zero development could look like.

Cool towns in Kent is a great example of working with an existing site and community utilising nature solutions such as SuDs, street trees, green roofs and walls, and green space to assist socio-environmental concerns such as increased flooding occurrences, water security, air quality, biodiversity, and health and wellbeing.

Derwenthorpe York

(Source: Joseph Rowntree Housing Trust)

Lovedon Fields

(Source: BD Landscape Architects)

Cool towns, Margate

(Source: KCC Media)