

IMPORTANT POST-HOC CAVEAT ON THE VALIDITY OF THE CONTENT IN THIS REPORT

Written Ministerial Statement of 13th December 2023

This report was developed through Summer and Autumn 2023. The insights that form its basis were gathered mainly over the preceding four years, gained from experience in all aspects of local planning from policy development and consultation to refinement, examination and implementation.

The content in this report was before 13 December 2023.

However, on 13th December a new Written Ministerial Statement (WMS) was released, that may impact some of the content herein. The WMS **completely changes the levels of 'planning acceptability/national policy' risk** associated with any policy approach that doesn't use SAP TER for the energy efficiency components.

This new WMS was made by Lee Rowley (Minister of State for Housing) together with Baroness Penn (Parliamentary Under Secretary of State for Levelling Up, Housing and Communities). Its stated topic is "[Planning - Local Energy Efficiency Standards](#)".

It places severe new limitations on the exercise of existing powers held by local planning authorities to require improvements in the energy and carbon performance of proposed new buildings in their area. The WMS does not remove the ability to set improved local standards, but it limits them in this way:

- Local planning policies for energy efficiency **must be expressed as percentage reductions on the Building Regulations Part L TER (Target Emissions Rate)**, using a specified version of SAP.
- Policies that go beyond national building regulations should be "**applied flexibly to decisions ... where the applicant can demonstrate that meeting the higher standards is not technically feasible**, in relation to the availability of appropriate local energy infrastructure ... and access to adequate supply chains." We presume that this still only applies to energy *efficiency* policies as per the Statement's title and the fact that the Statement does not mention other types of policy for the purpose of carbon reduction (e.g. renewable energy).

This WMS thus goes against precedents already set in recently adopted plans (Cornwall, Central Lincolnshire, and Bath & North-East Somerset), whose policies use much more effective metrics for energy and carbon performance, such as energy use intensity and space heat demand.

The WMS also states that proposed policies should be rejected at examination if they do not have "a well-reasoned and robustly costed rationale that ensures ... that development remains viable, and the impact on housing supply and affordability is considered in accordance with the National Planning Policy Framework". This last point is not entirely new, but reinforces the existing need for justification that we would already expect to provide on rationale and cost.

Also 13th December, Government released a new [consultation on the Future Homes Standard](#) (Part L 2025). It lays out two options for building specification. Unlike the [2019 consultation](#), the new proposals make no fabric improvement on the current standard (Part L 2021) except for slightly improved airtightness in 'Option 1'. The 'Options 1 and 2' laid out in this new consultation appear to match the [Future Homes Hub](#) 'contender specifications' CS2 and CS2a. Sadly, [analysis by the Hub](#) has already shown that CS2 and CS2a houses do not achieve the 15-20 kWh/m²/year space heat demand [that we need for the UK's legislated carbon targets](#). On the plus side, both have a heat pump, not gas.

Initial interpretation and commentary on implications for emerging local plan

'Energy efficiency' requirements expressed as % reduction on Part L Target Emission Rate

The new WMS implies the local plan cannot set mandatory targets for EUI or Space Heat Demand.

As the WMS' wording stands, at best an energy efficiency policy would instead be limited to requiring a **certain % of TER improvement to be achieved via energy efficiency**, as distinct from further % improvements via renewable energy (similar to the London Plan 2021). To be effective, this will need careful definition of what is an 'energy efficiency' feature. We see nothing to prevent a policy seeking a **certain % TER improvement via fabric improvements only**, if this can be proven feasible and viable.

The new WMS' instruction that energy efficiency policies 'should be expressed as % reductions on Part L TER' is counterintuitive in that TER is in fact a *carbon emissions* metric, not an *energy efficiency* metric. Energy efficiency means *using less energy to achieve the same result*, for example by improving insulation so that occupants don't have to use so much gas or electricity to keep warm or cool.

While energy efficiency does impact carbon emissions, they are not quite the same, as a home's carbon emissions can be reduced without making the home more energy-efficient – for example through adding solar panels, or by switching from a 'dirtier' fuel to a cleaner one.

Building Regulations Part L does have some actual energy efficiency metrics: 'TFEE' and 'TPER':

- TFEE: Target Fabric Energy Efficiency. This metric applies only to homes, not other buildings. TFEE reflects how good a home is at retaining heat, irrespective of heating *system* efficiency.
- TPER: Target Primary Energy Rate. This applies to all buildings. It reflects not only the amount of energy use at the meter, but also the amount lost to inefficiencies in generation and distribution before the energy reaches the building.


For this reason, some emerging local policies (such as in Warwick, now awaiting its inspector's report) require an improvement on the Part L TFEE. It is yet to be seen whether further clarification will be released on whether or why TFEE and TPER may or may not be used for local plan policy alongside TER.

Using a specific version of SAP to calculate % improvement in local policies

SAP is the national calculation used to demonstrate compliance with Building Regulations Part L in homes. SAP is updated more often than Part L itself. The current [version](#) is SAP10.2. Incoming versions of SAP are sometimes released before they become the official version for use in Part L. Changes between versions can range from small tweaks in how technologies are treated, to major changes in the carbon factors of each energy type (for example, the current version reflects that electricity is now cleaner than gas). The WMS' instruction that local policy must use a 'specified version of SAP' will cause consternation, in that a policy written for SAP10.2 will either go out of date when a new SAP is released – or else the developer will have to do two calculations (one for building control, and one for planning).

Other policy relating to carbon reductions from new buildings

The WMS only mentions *energy efficiency*, not *renewable energy*. Thus, with Energy & Planning Act powers, there is no obvious barrier to local policy requiring renewable energy to meet 100% of *total* energy use (if shown feasible/viable). Similarly, the WMS does not mention *embodied carbon*



South Kesteven Local Plan Review: Zero Carbon Policy Options for Net Zero Carbon Developments

2a. Carbon Reduction

26th July 2023

Rev 01



Background & introduction

Background

Bioregional has been appointed to provide South Kesteven District Council with an assessment of policy options available to achieve net zero carbon developments in South Kesteven District, to inform the emerging South Kesteven Local Plan review.

Our full suite of reports for South Kesteven District Council under this appointment includes:

1. Task 1: Climate change legislation
 - a. LPA duties to address carbon, as per the NPPF and Climate Change Act
 - b. LPA powers, alongside their limitations, to address carbon and energy granted or not by key piece of national legislation, policy and official guidance
 - c. Existing and emerging precedents of local plan policies
 - d. Existing and emerging examples of how planning duties in carbon and climate have been weighed against other duties
2. Task 2: Carbon reduction
 - a. Defining 'net zero carbon' and assessing the desirable carbon reduction trajectories for South Kesteven (sectoral and as a whole), in order to fulfil the climate mitigation duty
 - b. 'Risk matrix' assessing the relative merits of different potential policy options, in relation to how risky each policy is for climate, occupants, infrastructure, and planning acceptability.
3. Task 3: Climate change adaptation and risk assessment
4. Task 4: Local plan policy recommendations.

This report is Task 2(a): Defining net zero carbon and assessing desirable carbon reduction trajectories.

Task 1 (Climate change legislation) provides useful background that helps understand the logic by which Tasks 2a+b explore the net zero carbon definitions, desirable carbon reduction trajectories, and levels of risk involved in pursuing different policy options.

Please note that in the interests of brevity this report uses acronyms and other short terms that are common in the sectors of climate action, planning, and low-carbon building design. A glossary of these terms and acronyms is provided overleaf.

Content of this report

Local planning authorities (LPA), such as South Kesteven District Council, have a legal duty to deliver carbon reductions through the planning process in line with the Climate Change Act 2008.

As previously explained (see separate report 'Task 1'), the provisions of the Climate Change Act include not only the net zero carbon 2050 goal, but also steeply-falling interim 5-yearly carbon budgets.

Analysis (see Task 1 report) has revealed the great magnitude of the challenge of reducing each sector's carbon emissions in line with those five-yearly carbon budgets and the net zero carbon goal, requiring huge, unprecedented effort to reducing *existing* emissions even before adding new growth. The analysis has also shown the stringent level of carbon and energy performance needed in *new buildings* for compatibility with this net zero carbon transition, in addition to changes needed in the transport sector and the expansion of renewable energy. Specifically, the sectors 'Buildings', 'Energy' and 'Transport' need to reach net zero carbon internally, without simply passing on their responsibility to other sectors via 'offsets'. At the time of writing, most of the progress indicators for these required changes are not on track given the current national policy regime and current market incentives.

All sectors and all parts of the UK, including South Kesteven, will need to pull their fair weight towards carbon reductions in a concerted effort if the UK's legally binding carbon targets are to be achieved.

These legally binding national carbon targets set through the Climate Change Act – in combination with the analysis showing that progress is not on track – therefore provide a strong justification for local plan policy to require new development to be 'net zero carbon' (as well as spatially distributing growth so as to ensure that car use is not the most realistic choice for daily travel, and creating a favourable policy environment for renewable energy to come forward).

However, a 'net zero carbon development' and a 'net zero carbon district' can be (and has been) defined in various different ways by different actors using different carbon accounting methods.

Where a district – like South Kesteven – has made a commitment to 'become net zero carbon' by a certain date, there is therefore a need to ensure that this is defined and achieved in a way that actively contributes towards the overarching national transition.

The same is true for 'net zero carbon development'. If a local plan policy requires this, logically it be defined in a way that ensures the development actively contributes towards a net zero carbon district and UK. Without a clear, consistent concept of how the carbon emissions of the development, district and UK relate to each other, it is unlikely that the policy would fully contribute towards the objectives of the Climate Change Act or the district's local commitments around carbon reduction.

This report (Task 2a) therefore explores the various definitions of 'net zero carbon' for developments and local geographical areas, and how these succeed or fail in relating to each other depending on which carbon accounting methodologies are used for each.

Task 2b (Risk Matrix) should be read *after* this report, as it draws on the insights from Task 2a in terms of assessing the level of risk that each potential policy option would succeed or fail in ensuring that development is compatible with the net zero carbon transition of South Kesteven and the UK.



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Glossary of terms and acronyms

BEIS	Government department of Business, Energy, Innovation and Skills. Now renamed 'DESNZ'.		The gap is due to poor prediction methodologies, errors in construction, and unexpected building user behaviour.
BREDEM	Building Regulations Domestic Energy Model. A methodology for (estimating) calculating the energy use and fuel requirements of dwellings based on their characteristics. BREDEM was the basis from which SAP was developed.	PV	Photovoltaics: solar panels that generate electricity.
Carbon, or carbon emissions	Short for 'carbon dioxide' but can also include several other gases with a climate-changing effect (nitrous oxide, methane, refrigerants) that are emitted to the atmosphere from human activities.	PHPP	Passivhaus Planning Package – a tool to accurately calculate a building's energy use. It is used to design buildings that seek Passivhaus certification, but can be used without pursuing certification.
Carbon budget	Amount of greenhouse gas that can be emitted before reaching a level of atmospheric carbon that causes severely harmful climate change	Regulated energy	The uses of energy within a building that are regulated by Part L of building regulations. This covers fixed energy uses in the building – mainly space heating, space cooling, hot water, permanent lighting, fans/ventilation and pumps.
CO ₂	Carbon dioxide. Often shortened to 'carbon'.	SAP	Standard Assessment Procedure – the national calculation method for homes' energy and carbon, used to satisfy building regulations Part L.
CO ₂ e	Carbon dioxide equivalent. The sum of a mixture of gases, in terms of their climate-changing impact in a 100-year period expressed as the amount of CO ₂ that would have the same effect. Often shortened to 'carbon'.	SBEM	Simplified Buildings Energy Model – the national calculation method for non-residential buildings' energy and carbon, used to satisfy building regulations Part L.
DESNZ	Government Department of Energy Security and Net Zero. Formerly 'BEIS'.	TER	Target Emission Rate – limit set by Part L of building regulations on CO ₂ emissions per square metre of floor.
Embodied carbon	Carbon that was emitted during the production, transport and assembly of a building, infrastructure, vehicle or other product, before the product is in use. As opposed to 'operational carbon' which is emitted due to energy use when operating the building / infrastructure / vehicle / other product.	TPER	Target Primary Energy Rate – limit set by Part L of building regulations on 'primary energy' use per square metre of floor. A new metric being introduced to building regulations from June 2022. Unlike metered energy, 'primary energy' takes into account energy lost to conversion inefficiencies during power generation and distribution, or gas combustion.
EUI	Energy use intensity, a measure of how much energy a building uses per square metre of floor.	TFEE	Target Fabric Energy Efficiency – limit on space heat energy demand per square metre of floor, set by Part L of building regulations. Based only on fabric; not affected by building services like heating system, lighting, ventilation.
GHG	Greenhouse gas (CO ₂ and several other gases: nitrous oxide, methane, refrigerants). Often collectively referred to as 'carbon'.	TM54	Method to accurately calculate buildings' energy use. Devised by Chartered Institution of Building Services Engineers (CIBSE).
Part L	Building regulations section that sets basic legal requirements regarding buildings' energy and CO ₂ .	Unregulated energy	Energy uses within a building or its curtilage but that are not regulated by Part L of building regulations. Examples: plug-in appliances, catering, external lighting among other uses. This can represent 50% of the total energy used at a property, depending on the type and use of the building.
Performance gap	The 'energy performance gap' is the difference between the amount of energy a building is predicted to use during design, versus the actual amount of energy it uses.		

Executive Summary

On a global level, ‘net zero carbon’ means a balance between emissions and removals of carbon to/from the atmosphere. ‘Carbon’ can mean ‘carbon dioxide’ (CO₂) or it can mean the sum of all gases that have a global warming effect: CO₂ (~80% of UK emissions), methane, nitrous oxide, and ‘F-gases’.

Carbon emissions are mostly caused by burning of fossil fuels, but also to a lesser extent also by other industrial processes (e.g. the chemical reaction in cement production) and agricultural processes (e.g. the digestive systems of livestock, and breakdown of soil fertilisers). Currently, removals are only achieved by natural features like plants, soils, and water bodies. There are also ongoing research efforts to develop technology to capture and store carbon, but not yet successful in terms of efficiency and scale.

At smaller scales, we need ‘carbon accounting methodologies’ to define which emissions or removals ‘belong’ to a person, organisation, building, or area. This is because activities in one place (e.g. using grid electricity, or buying materials to build a home) often cause carbon emissions elsewhere (e.g. burning fuel in a power station, or producing cement). The same is true for carbon removals.

Organisations and buildings that cannot achieve net zero carbon within their own direct activities are sometimes permitted to use ‘carbon offsetting’ (paying for carbon-reducing actions elsewhere). These actions are sometimes removals (e.g. tree planting) – or sometimes ‘avoided’ emissions (paying for measures that reduce the amount of carbon that ‘would have been emitted’). Most local-scale carbon accounting methodologies agree that ‘net zero carbon’ local status should not include ‘carbon offsets’ from another area. See full report for detail on the carbon accounting methodologies available.

Most UK local and regional authorities track their emissions using official centralised figures from BEIS/DESNZ (Department of Business, Energy and Industrial Strategy, now retitled Energy Security and Net Zero) each year. BEIS/DESNZ uses data on each area’s buildings, energy use, industrial activity, traffic/transport activity, and types of land area, to estimate the amount of emissions and removals in each local area (carbon dioxide only; no other gases), as seen in Figure 1. South Kesteven’s emissions are additionally explored in the full report using the Setting City Area Targets and Trajectories for Emissions Reduction (SCATTER) tool, a local authority focussed emissions measurement and modelling tool.

Every part of the UK, including South Kesteven, will still need to play its role in achieving the overall UK Net Zero Carbon goal by 2050 as per the Climate Change Act. Therefore, efforts to reduce emissions in each local area should be designed to assign responsibility for all emissions caused in the UK, and refrain from double-counting any removals or ‘avoided’ emissions. The risk of double-counting arises if carbon offsets are used instead of reducing emissions at source – e.g. if one area buys ‘carbon offset’ credits generated by another area’s woodland or insulation schemes, but those carbon savings were already counted towards the other area’s carbon account in the official national figures or local accounting.

The local plan therefore needs to consider several different scales of ‘net zero carbon’:

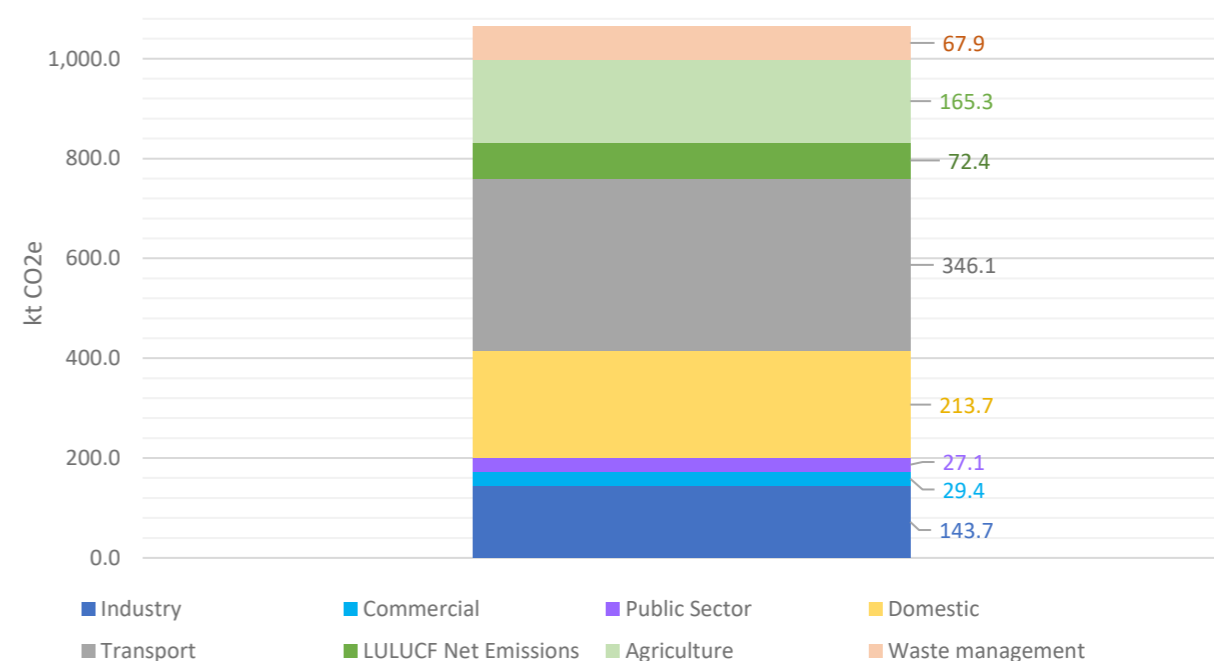
- ‘Net zero carbon new buildings’ – this always includes energy use of the building’s operation, and can also include ‘embodied carbon’ (see [glossary](#))
- ‘Net zero carbon South Kesteven’ – new and existing buildings, transport, industry, agriculture, land use
- ‘Net zero carbon UK’ – all sectors above, plus aviation and shipping. No international ‘offsetting’.

Development and use of land in South Kesteven can affect emissions in all sectors – but new buildings, grid energy and transport are the main issues that the local plan can influence.

‘Net zero carbon’ has different meanings at different scales

- At global level, it means greenhouse gas emissions from human activity are balanced by greenhouse gas removals
- At local or building scale, we need a ‘carbon accounting methodology’ to decide whose carbon is whose (for both emissions and removals)
- ‘Offsetting’ is treated differently depending on accounting method or planning policy precedent – most local authorities use BEIS/DESNZ data to track the local area’s carbon account; this data does not count offsets from outside the area or embodied emissions of goods brought into the area
- The local plan can influence emissions from new buildings, energy & transport – policies should reduce South Kesteven’s total emissions, and avoid double-counting if offsets are permitted as part of ‘net zero’ builds.

Figure 1: 2021 CO₂e emissions per sector in South Kesteven from BEIS/DESNZ subnational emissions data (2023 release).



Transport is the largest source of carbon emissions from activity within South Kesteven (Figure 1), accounting for 32% of overall emissions in 2021, almost entirely due to fossil fuels use in road vehicles. Transport that runs on grid electricity emits less per km, but not zero (we also note that in the DESNZ data, electricity used by trains appears not in the transport sector but in the ‘industry’ or ‘commercial’ sectors). There is currently no way for transport to actively remove carbon emissions (other than purchasing offset credits). Transport carbon will therefore only hit zero when its energy sources are 100% renewable, but electric transport is much cleaner than petrol/diesel therefore a shift to electric transport and less car use is vital for the achievement of [interim](#) carbon budgets. The embodied carbon of vehicles or transport infrastructure would appear in the ‘industry’ sector, if produced locally.

In buildings, there are several ways to define a ‘net zero carbon building’. These definitions rely on **calculations** that variously take into account the following, on an annual basis:

- **Use of different types of fuels and grid energy at the building:** These cause carbon emissions.
- **Renewable energy use at the building:** Usually generated on-site but may include off-site sources.
- **Amount of renewable energy that the building exports to the grid** at times when the building produces more than it is using): This counts as a *negative* amount of carbon emissions, because it actively reduces the amount of fuel burned in power stations to supply grid energy to others.
- **Embodied carbon:** Carbon emitted to produce/transport and use the construction materials.

The official ‘National Calculation Methodology’ for buildings’ energy use and carbon emissions is called **SAP (for homes)** or **SBEM (for other buildings)**. These are used in the **Building Regulations Part L**, which sets limits per square metre per year for carbon, heat demand, and ‘primary energy’ use. However:

- **They only cover operational carbon (energy use)**, not embodied carbon (materials/construction)
- **They do not include ‘unregulated’ energy uses like plug-in appliances**, which can be 50% of total
- **They are predictive-only, not verified in reality, and their predictions are not accurate** – buildings typically use two or three times the amount of energy predicted by SAP or SBEM (see Figure 2).

Thus a ‘net zero carbon’ building defined by the Building Regulations is not actually net zero carbon. Updates to Building Regulations Part L are due in 2025 (the ‘Future Homes Standard’ and ‘Future Buildings Standard’). However, even the 2025 update will not deliverⁱ the very low space heat demand that the UK needs for its legislated carbon budgets. This is partly because SAP and SBEM underestimate energy demand and are not verified in operation, and partly because Part L sets energy and carbon targets that vary by the shape and size of the building, not the absolute targets that are needed for the achievement of UK carbon budgets.

Other calculation methods and definitions are available. The two leading alternative definitions are:

- **LETI operational net zero carbon:** A building that (each year) generates as much renewable energy as it uses, sometimes using grid electricity and at other times sending renewable energy to the grid. The building must also be gas-free, and meet specific energy efficiency targets that match the performance needed for national carbon budgets.
- **UKGBC Framework Definition of Net Zero Carbon:** This has two parts:
 - **Operational:** When the carbon associated with a building’s energy use is zero, by use of renewable energy (from onsite or offsite sources) or purchasing verified carbon offsets.
 - **Embodied:** When the carbon associated with a building’s construction up to the point of completion is zero or negative, through the purchase of verified carbon offsets.

Because the LETI and UKGBC definitions are for actual operational performance not just modelling, they require the use of *accurate* energy calculation methods in the design process, specifically PHPP or TM54 ([see glossary](#)). PHPP and TM54 both account for total energy, not just the share that is ‘regulated’.

Net zero carbon in different sectors relevant to local plan

- **Transport is the most carbon-intensive sector in South Kesteven** and can only reach ‘net zero’ via renewable energy and offsetting, but electrification and reduced car use are vital steps to hit carbon budgets
- **Green landscapes (forest + grassland) remove only a small fraction of emissions** – overall emissions must fall dramatically at source
- **Building Regulations calculation methods for energy and carbon are insufficient to define net zero carbon buildings:** these methods dramatically underestimate buildings’ energy use and do not include embodied carbon or energy use of plug-in appliances
- **The industry has created improved approaches to define net zero carbon buildings** – in particular the LETI and UKGBC definitions, which use more accurate calculation methods.

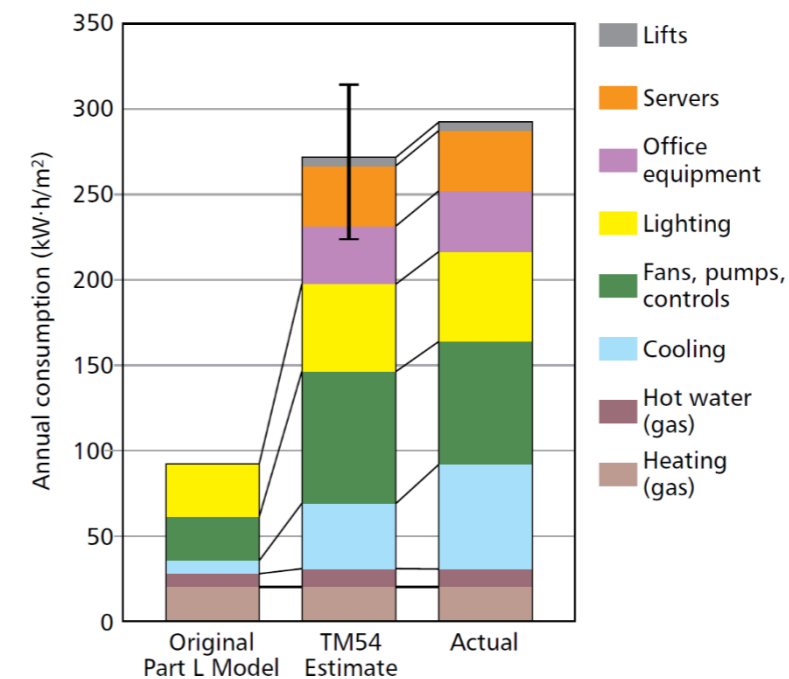


Figure 2: CIBSE graph that reveals the inaccuracies of Part L SBEM prediction of energy use, compared to a prediction using the CIBSE TM54 method, and the building’s actual measured energy use in operation. This is for an office building.



Full report

Defining 'net zero carbon'

Overview

Because climate and carbon emissions are global challenges, consistency of effort is key. If carbon emissions are not consistently accounted for, there will be a risk of not reducing emissions but simply displacing them – or failing to account for the full emissions of new development.

When devising local plan policies for South Kesteven, it will be vital to make sure those policies use a definition of 'net zero carbon development' that fully contributes to the achievement of a net zero carbon South Kesteven and net zero carbon UK, and the UK's interim carbon budgets.

Having separately explored precedents of how local plans have defined and pursued net zero carbon (see our separate 'Task 1' report), we now look at the global, national, area-wide and building-level definitions generally accepted.

This context is important because most of the identified fully adopted precedent local plans use a definition of 'net zero carbon development' that is significantly different to how a fully-fledged carbon accounting methodology would define it for the local area or the UK as a whole.

The reason for this difference is that the local plan adopted precedents have almost always set their 'carbon reduction' requirements based on energy and carbon metrics set by national building regulations. These building regulations metrics do not account for the building's full energy use, let alone the embodied carbon of the building's materials and construction, or the transport carbon that will be induced in the lifestyles of the building's users. The choice to use of building regulations metrics in local plan policy has been mainly due to the way in which planning legislation defines the local planning authority's powers, and the ways in which other pieces of national government policy may constrain how those powers are exercised.

However, as set out in Task 1 (see separate report), some pioneering local planning policy precedents have begun to move beyond these assumed constraints that arose from planning legislation and associated national policy.

This report (Task 2a) firstly looks at the global, national, and county-level definitions of net zero carbon. This makes it possible to understand the relative merits of different definitions of net zero carbon buildings in existing and emerging precedent local plans.

This section also helps contextualise the 'ingredients' that would be necessary to make those definitions a reality – in terms of changes to new buildings, existing buildings, transport, the energy system, and land use.



Net Zero Carbon at global level

At global level, “net zero carbon” means that emissions of greenhouse gases (GHGs) are balanced out by removals of GHGs from the atmosphere.

‘Greenhouse gas’ encompasses a bundle of different gases that have a climate-changing effect. The most common greenhouse gas is carbon dioxide (CO₂) which represents 80% of the UK’s climate impactⁱⁱ. Six other GHGs are also relevant: methane (12%), nitrous oxide (5%), and four types of fluorinated gas (refrigerants, 3%). Some of these have a weaker global warming effect, and some have a stronger effect but stay in the atmosphere for longer and therefore cause more change over time.

As CO₂ stays in the atmosphere for a long time, there is a fixed amount – a ‘carbon budget’ – that we can emit between now and 2100 if the world is to avoid the worst impacts of climate change (limiting global warming to less than 2°C above pre-industrial climate). The other greenhouse gases are not subject to the ‘budget’ approach, because they stay in the atmosphere for a different amount of time, but should still be reduced as far as possible.

Together, the **bundle of greenhouse gases is referred to as ‘carbon dioxide equivalent’ or ‘CO₂e’**. This refers to the global warming effect that the gas would have in a 100-year timeframe, compared to that of carbon dioxide. ‘Carbon emissions’ can refer to carbon dioxide, or the whole collection of greenhouse gases.

‘Net carbon’ or ‘net emissions’ refers to the amount of CO₂ or greenhouse gas that remains after deducting the amount that was removed from the atmosphere, usually over the course of a year.

‘Net zero carbon’ is sometimes used interchangeably with the term ‘carbon neutrality’. These are overlapping concepts which essentially mean the same thing at global level, but at sub-global levels they are used slightly differentlyⁱⁱⁱ, to reflect whether the emissions and removals are achieved *directly by* or *purely on behalf of* a particular country or organisation. This becomes a question of ‘carbon accounting’, discussed next.

Where do the carbon emissions come from and how can carbon be removed from the atmosphere?

The main **source of rising GHG levels** in Earth’s atmosphere is the burning of fossil fuels (as this is an emission of carbon that had been locked up underground for many thousands of years until recently). Greenhouse gas is also emitted by many other human activities including fertiliser use (nitrogen fertilisers are often made from fossil fuel), ruminant livestock’s digestive systems, breakdown of organic waste, and the chemical reaction during the production of cement.

Greenhouse gas **removals** are achieved by plants and soils such as forests, grassland and wetland. These are currently the only reliable and scalable means to remove greenhouse gases, as no appropriate and suitably efficient technology for carbon capture has yet been developed. Still, research is underway to develop such technologies, and future carbon removal technology is a significant part of many countries’ long-term strategy to limit the total amount of carbon emitted this century (including the UK).

Carbon accounting methodologies: whose carbon is whose?

Human activities and economies are highly interconnected across local, organisational and international lines.

Activity by a person in one location (such as using electricity) can cause carbon emissions by another entity elsewhere (such as burning coal to generate energy in power stations).

Therefore we need ‘carbon accounting’ methodologies to work out what share of carbon emissions ‘belong’ to each entity. That entity could be a person, organisation, building, local area, or country.

Returning to the question of ‘net zero carbon’ compared to ‘carbon neutral’, the Intergovernmental Panel on Climate Change^{iv} essentially explains that:

- **‘Net zero carbon’** typically means a balance of **emissions and removals under direct control or territorial responsibility** of the entity reporting them (such as a country, district or sector)
- **‘Carbon neutral’** can also apply to a firm or commodity, and typically also **includes emissions and removals beyond the entity’s direct control or territorial responsibility**.

Following this logic, ‘net zero carbon’ would be the appropriate term if the district or country achieves enough carbon removals within its own area to balance out its own carbon emissions, while ‘carbon neutral’ is a less appropriate term for a country/district but would be the term to use if the emission/removal balance is achieved by buying carbon offset credits from outside that location.

For the purposes of a local plan, we should consider the carbon account of two key entities: firstly **South Kesteven**, and secondly **each new building**. We must consider how the building’s carbon emissions fit into the county’s carbon account, and how the county’s emissions fits within the wider UK’s carbon account which is legally bound to achieve net zero carbon emissions by 2050 and steep carbon reductions in the preceding years ([discussed later](#)). If we use inconsistent definitions or accounting methods, then our ‘net zero carbon’ buildings might not help South Kesteven to achieve its goal to be net zero as soon as viable by 2050, and South Kesteven in turn might not help the UK meet its 2050 goal nor its interim carbon budgets.

Several carbon accounting approaches are available to determine how much carbon a geographical area is responsible for:

- Global Greenhouse Gas Protocol for Cities (GPC) – which has three ‘scopes’
- PAS2070
- Local area CO₂e inventories, released annually by the UK government BEIS/DESNZ
- Tyndall Centre local carbon budgets / SCATTER local carbon emissions accounts

Each of these methodologies is designed to define the area’s ‘carbon account’ based on the degree of direct or financial control the area has over activities that emit or absorb carbon.

Although each methodology differs slightly from the others, a local area would usually achieve ‘net zero carbon’ status when the GHG removals achieved *within the local area* are equal to greenhouse gas emissions from directly within the local area plus the emissions due to production of grid energy the local area consumes. If an area exports grid energy to other locations, any emissions associated with the production of that energy would not count towards the area’s carbon account.

The **methodologies generally agree that the local area’s carbon account should not include offsets purchased from outside the area**. These should be reported separately, if at all. However, such offsets may still help towards the overall UK net zero carbon goals, so long as they are delivered within the UK.

The Global Greenhouse Gas Reporting Protocol for Cities (GPC)

The Greenhouse Gas Reporting Protocol is the **most widely used and accepted methodology** to account for any entity's carbon emissions. The GPC is a version of that methodology that has been adapted for the use of cities or any other local area. Its aim is to enable local area carbon accounts to be tracked consistently enough to be aggregated to the regional or national level.

The GPC **covers several gases** (along with CO₂) and **splits the account into three 'scopes'** which reflect the **degree of responsibility and control** the local area has:

- **Scope 1:** emissions directly from within the area – such as through burning fuel, or through methane emissions from livestock kept within that area. Ditto, carbon removals achieved directly within the area, such as by trees growing in the area.
- **Scope 2:** emissions associated with that area's use of grid electricity which may have been produced inside the area or outside the area.
- **Scope 3:** emissions that happen outside the area but caused by activity or spending by entities inside the area – such as production and transport of goods imported from elsewhere.

The GPC states that if an area purchases carbon offsets from outside the area in order to mitigate some of its emissions, these should be reported separately and not deducted from the total.

If South Kesteven chooses to use any external 'offsets' in its quest for emissions reduction (as a last resort), these should be from within the UK so that they fall within the UK's Scope 1 account and thus contribute to the UK's overall net zero carbon goal (which should not include overseas offsets).

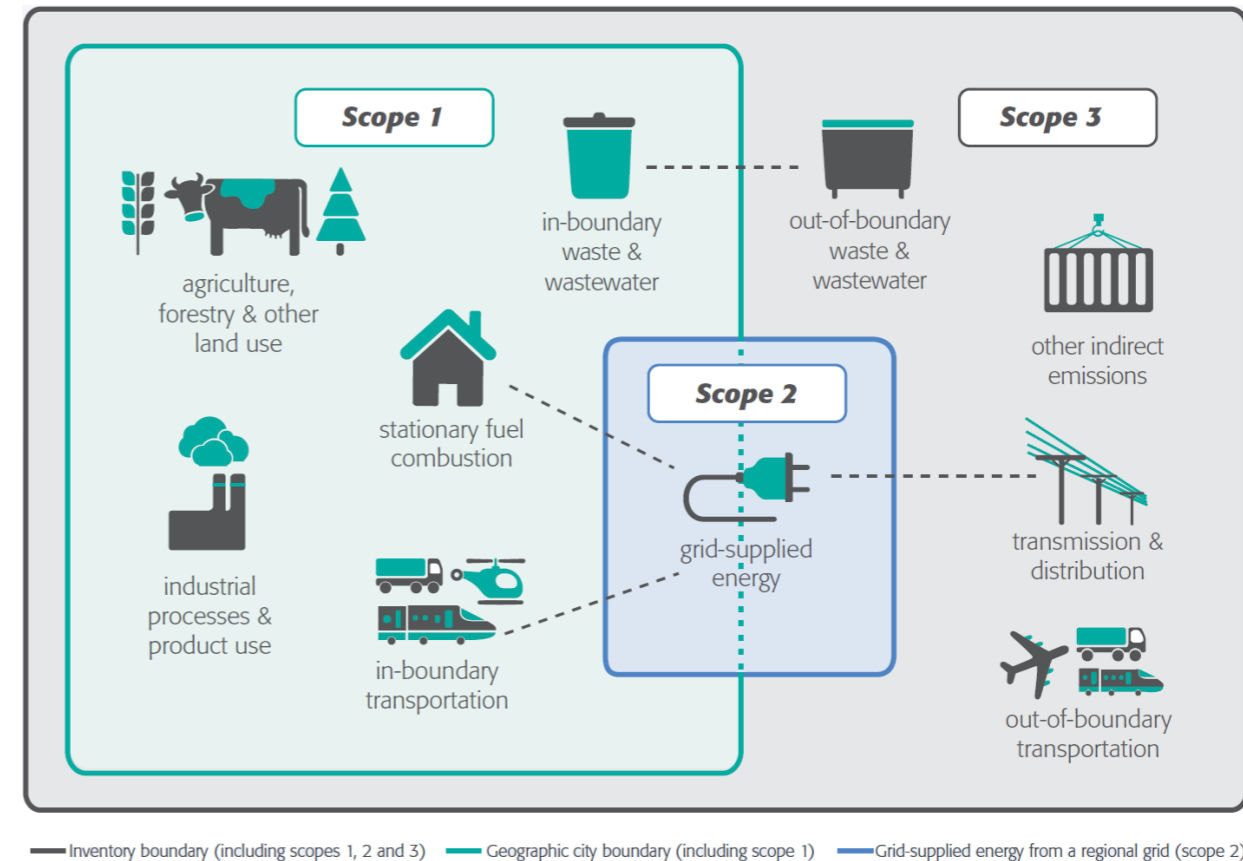


Figure 3: Various emissions sources according to Scopes 1, 2 and 3.

PAS 2070

A PAS is a Publicly Available Specification, which is essentially the precursor to a British Standard or European EN standard. A PAS defines good practice standards for a product, service or process.

PAS 2070 aims to define good practice for the assessment of the greenhouse gas emissions of a city. It **builds on the GHG Protocol for Cities (GPC)** to include a **wider range of emissions sources** and a **slightly wider bundle of gases**. It also offers two ways of accounting, one of which is equivalent to the GPC's three scopes ("direct plus supply chain"), and the other of which allows exclusion of emissions from goods produced in the area that are then exported ("consumption-based emissions").

Just like the GPC, PAS2070 notes that if out-of-boundary offsets have been bought (whether by the municipality, businesses, organisations or residents) these should not form part of the total of a city's GHG account by deducting them from the total. Instead, such offsets should be accounted separately.

UK BEIS/DESNZ official subnational CO₂ inventories

The Department for Energy Security and Net Zero (DESNZ, formerly titled BEIS - Business, Energy and Industrial Strategy) releases annual figures that break the UK's carbon emissions down to a local level^v to help local authorities make decisions. Previously this counted CO₂ only, but **now includes CO₂, methane and nitrous oxide but not F-gases**. It uses data from the National Atmospheric Emissions Inventory and national statistics on local area's energy consumption. It excludes aviation, shipping and military transport because there is no clear basis for how these would be allocated to local areas.



These BEIS/DESNZ CO₂ figures include **only local direct emissions** (including from land use and chemical use as well as fuel use) **and grid energy use**. They are not broken down into ‘scopes’, but would mostly equate to Scope 1 + Scope 2 as they do not include emissions from the local area’s consumption of goods produced elsewhere (except electricity).

The BEIS/DESNZ figures are **broken down into several sectors**: industry, homes, commercial buildings, public buildings, transport, and land use/forestry (‘LULUCF’). Transport emissions are calculated based on traffic flow data on local roads, plus fuel use on inland waterways and trains. Electrical trains are accounted for separately in the ‘industry’ sector.

The BEIS/DESNZ figures show how much carbon is removed by the area’s grassland and woodland. This is positive, but also shows the scale of the challenge: The woodland/ grassland is nowhere near enough to zero-out the area’s emissions even if the green areas were expanded many times over.

The figures also reveal how important it is to plan for reduced car use and enable low-emissions deliveries – as transport is responsible for more than half the area’s emissions.

Tyndall Centre local area carbon dioxide budgets (and SCATTER trajectories)

The Tyndall Centre is a climate change research organisation made up of several UK universities working to get climate science evidence into policy. It created a tool^{vi} that produces municipal-level carbon budgets towards a 2°C global climate pathway that are necessary and fair, taking into account each location’s sectoral base by looking at its historical portion of the country’s emissions.

These trajectories show the UK’s **total CO₂ budget to 2100** if the UK is to pull its weight towards fulfilling the **Paris Agreement** (to **limit global warming to 2 °C**, with **carbon cuts equitably distributed to each country** in proportion to its technological and financial capability, its needs, and its responsibility for historic emissions). This starts with the middle-range global carbon budget likely to limit global climate change to “well below” 2°C, determined by the IPCC. Tyndall derives the CO₂ budget for the UK from this global budget, based on equity principles that account for our existing level of development and sectoral base, and the local budget is derived from the UK one. The resulting totals are split into five-yearly budgets. The Paris-compliant carbon budgets for South Kesteven are as shown here (see Figure 4), and would be used up by the end of 2026 if emissions continue at the 2017 level.

This methodology **only covers CO₂ occurring due to energy use** (whether in transport, buildings, agriculture or other industries). It does not cover the other six greenhouse gases, or releases of CO₂ from activities other than energy use. The reasons are as follows:

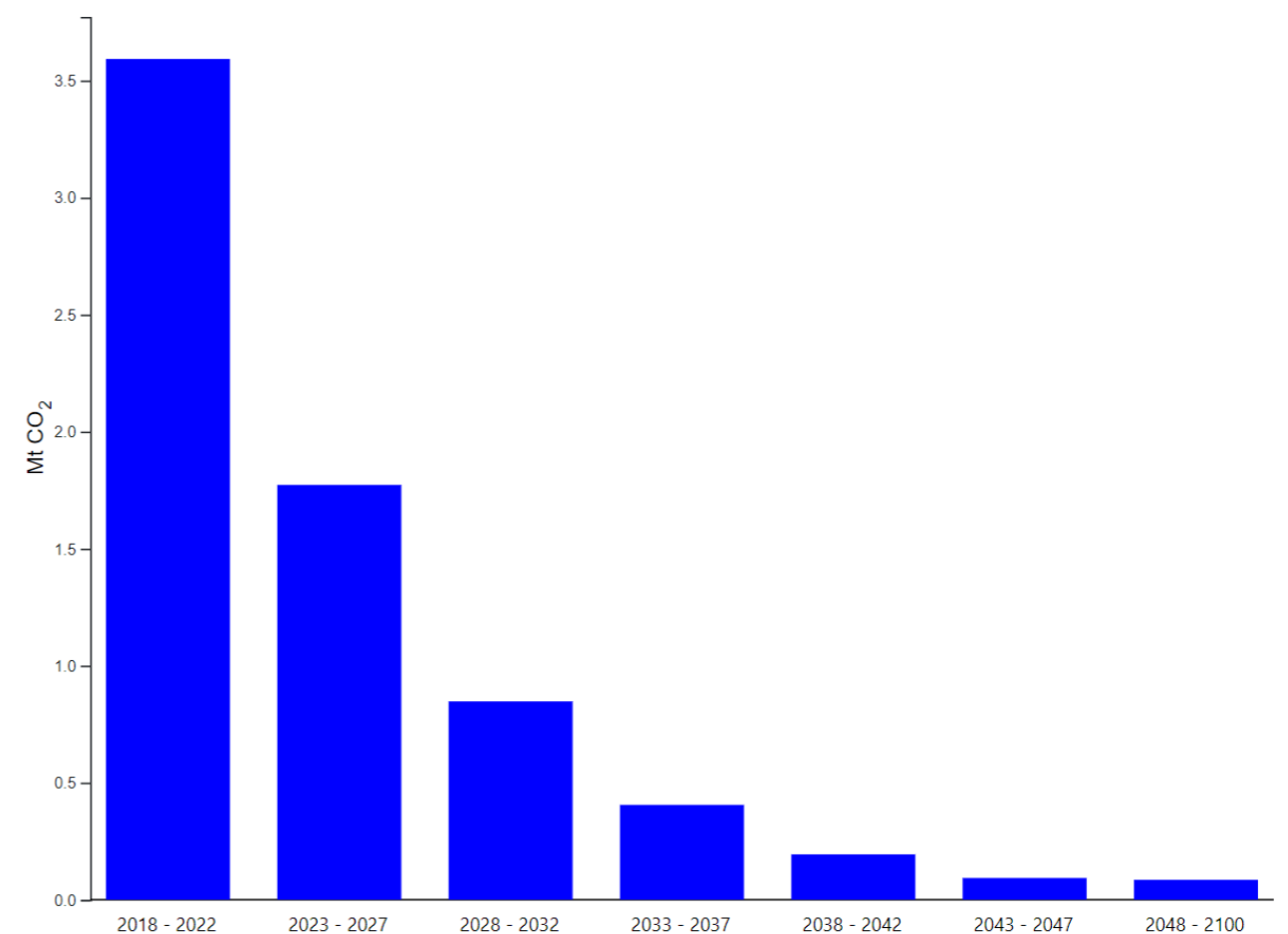
- Other gases are left out because “a cumulative emission budget approach is not appropriate for all non-CO₂ greenhouse gases, as [they have] ... differing atmospheric lifetimes and warming effects”, with more uncertainties around them.
 - There is a parallel methodology named SCATTER¹ that builds on Tyndall carbon budgets to estimate these other gases.
- Other activities are excluded because energy use is the main source of CO₂ emissions and therefore the main activity that needs to be addressed.

- Emissions from cement production (except fuel use) are excluded because cement production is assumed to be unavoidable to some extent, therefore a deduction for cement is made from the global budget before the UK’s budget is allocated.
- Aviation and shipping are excluded from the local budget, because it is considered that those cannot be fairly allocated to local areas – so a deduction is made from the UK budget to make room for aviation and shipping, before the local budget is allocated.

Tyndall Centre assumes that global forest levels do not change between 2020-2100, assuming afforestation in certain areas to counteract deforestation in others. It recommends that GHG removals achieved by further afforestation are monitored separately from this budget and used instead to compensate for unavoidable non-CO₂ emissions, such as agricultural methane.

Unlike the Committee on Climate Change national carbon budgets, **Tyndall does not assume that carbon capture technologies appear in future**, as this would risk over-estimating the budget. If these technologies were to be developed in future, they could expand the size of the available budget.

Offsetting is not part of the budget, because the budget is designed to reveal the actual CO₂ reductions needed locally.



¹ Setting City Area Targets and Trajectories for Emissions Reduction. <https://scattercities.com/>



Figure 4: South Kesteven's carbon budgets to 2100 (energy-only, CO₂ only) compliant with the UK's commitment to the Paris Agreement. Calculated by the Tyndall Centre.^{vii}

South Kesteven's existing carbon accounting methodologies

It is crucial that the level of action required to reach net zero is understood so that suitable programs and policies can be devised, in turn so that emissions reductions are delivered in practice. At a local level, sectors and specific measures should be identified to set out clear pathways that work towards achieving a net zero future. Monitoring emissions reductions is a key element of this and should occur annually to track progress.

Previous years' annual sectoral emissions from national government (DESNZ, as previously explained) are set out below. This is the data set most commonly used by local authority areas to understand their emissions as it is reliably released annually and free of charge. This helps gauge the general progress trajectory to date and may help to identify which sectors are in greatest need of intervention through policy. We note that while certain sectors have been on a better trajectory than others, none of them appear to be on a sufficiently rapid and steep trajectory to achieve the UK's carbon budgets (see separate 'Task 1' report). Transport is particularly problematic. The domestic, industry and commercial sectors have achieved some reduction but still require improvement, especially domestic.

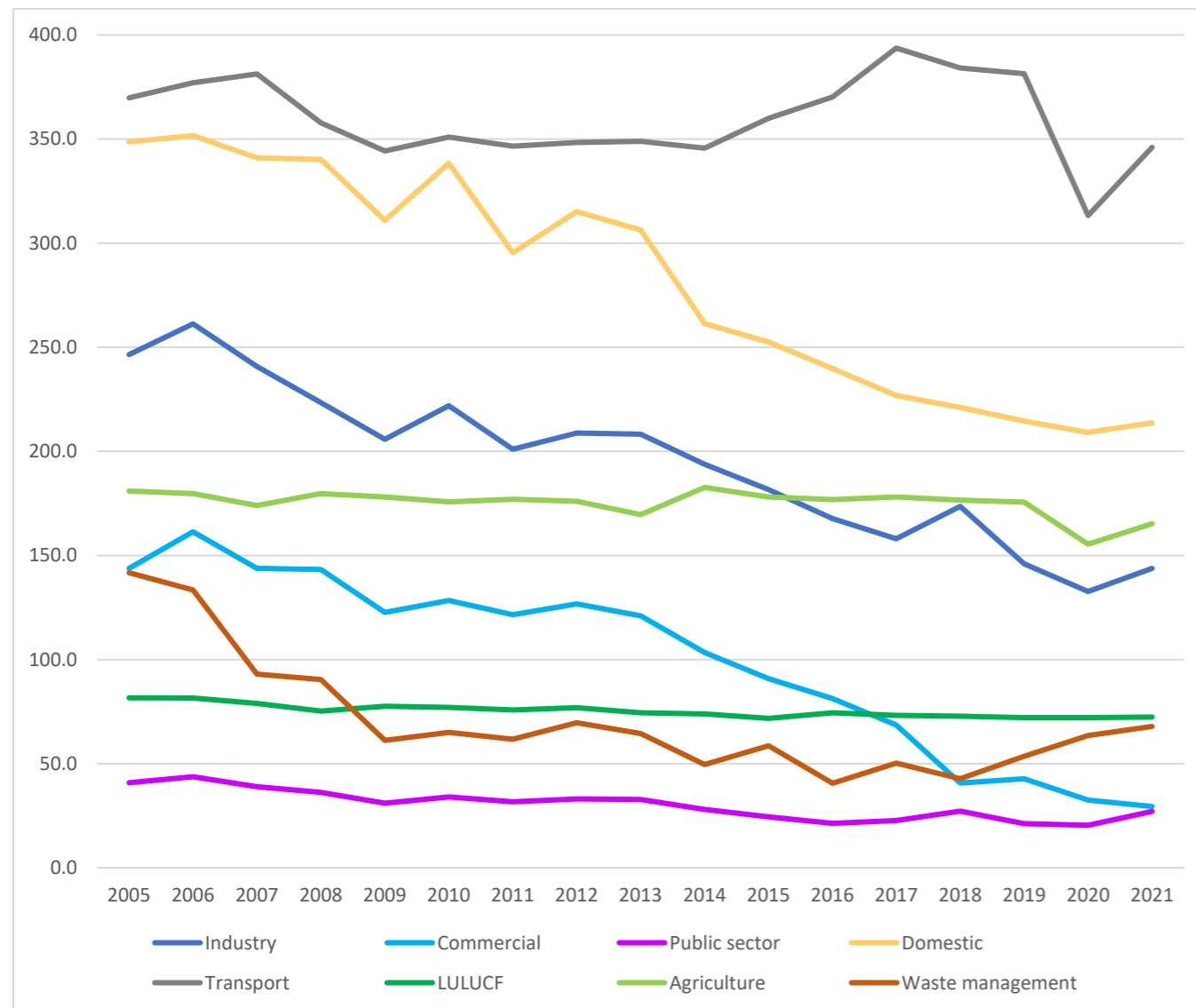


Figure 5: South Kesteven ktCO₂e emissions by sector, 2005-2021. Source: BEIS/DESNZ local authority emissions dataset, 2023.

Although the BEIS data is useful as an overview, an alternative tool – the 'Setting City Area Targets and Trajectories for Emissions Reduction' (SCATTER) tool – improves our knowledge of what *interventions* will most effectively push South Kesteven towards becoming a net zero carbon district. Various degrees of ambitious sectoral change can be set and tested in the SCATTER tool, allowing the user to adjust the predicted degree of emissions reductions for activities in the following sectors:

- Domestic
- Industry and commercial
- Transport
- Agriculture and land use
- Waste

Two different scenarios are explored here for South Kesteven: a high-ambition scenario that significantly exceeds national policy and a business-as-usual scenario.

The table set out below compares different sets of interventions in two scenarios: 'High Ambition' and 'Business-As-Usual'. For the sake of brevity, only the most relevant interventions to South Kesteven and local plan powers are shown here (a wider range is available within the SCATTER tool). Although some of the interventions below are not directly related to policies that could be set in the local plan, they will all be impacted by outcomes of the local plan directly or indirectly. The interventions set out under 'Domestic Buildings' and 'Energy Supply' are those with the greatest scope for influence via the local plan.

		High Ambition	Business-As-Usual
Agriculture and Land Use	Forestry	24% increase in forest cover by 2030	5% increase in forest cover by 2030
	New build	From 2021, 100% new-build properties are built to Passivhaus standard	All new houses are built to 2013 Building Regulations (no change)
Domestic Buildings	Heating technology	By 2050, 7% resistive heating; 60% air-source heat pumps and 30% ground-source heat pumps; 3% district heating	No change to current technology mix for home heating
	Retrofit	By 2050, 10% of current stock is retrofitted to a medium level; 80% deep retrofit	All current households remain at weighted average heat loss
	Lighting and appliances demand	By 2050, domestic lighting and appliance total energy demand has dropped to 27% of current levels.	By 2050, domestic lighting and appliance total energy demand has dropped to 80% of current levels

	<i>Water demand</i>	Hot water demand per household reduces by 8% every 5 years	Hot water demand per household grows 5% every 5 years
Energy Supply	<i>Biomass/coal power stations</i>	Solid biomass generation quadruples in 2025, dropping off after that. Coal phase-out follows trajectories from the National Grid's Two Degrees scenario.	No change in solid fuel power generation
	<i>Small-scale solar PV</i>	Local solar capacity grows, generating equivalent to 2500 kWh per household in 2030; 5200 in 2050 (from a baseline of 400 kWh per household.)	Local solar capacity grows to allow generation equivalent to 750 kWh per household in 2030; 1350 in 2050 (from a baseline of 400 kWh per household.)
	<i>Large-scale solar PV</i>	Large-scale solar generation grows to 200 kWh per hectare in 2030; 400 in 2050 (from a baseline of 50 kWh per hectare.)	No change in large-scale solar generation to 2030; growing to 100 kWh per hectare in 2050 (from a baseline of 50 kWh per hectare.)
	<i>Small-scale wind</i>	Small-scale wind grows to 2.8 MWh per hectare in 2030; 3.3 in 2050 (from a baseline of 1.2 MWh per hectare.)	No change to small-scale onshore wind
	<i>Onshore wind</i>	Large-scale onshore wind generation grows to 1.9 MWh per hectare in 2030; 2.2 MWh in 2050	Large-scale onshore wind generation grows to 1.26 MWh per hectare in 2030; 1.46 MWh in 2050
	Industry and Commercial	<i>Commercial heating and cooling demand</i>	In 2050, commercial heating, cooling and hot water demand is 60% of today's levels
<i>Commercial heating and cooling technology</i>		By 2050, 7% resistive heating; 60% air-source heat pumps and 30% ground-source heat pumps; 3% district heating	No change to current technology mix for commercial heating
<i>Lighting and appliances</i>		Commercial lighting & appliance energy demand decreases 25% by 2050	Commercial lighting & appliance energy demand increases 28% by 2050

	<i>Industrial processes efficiency</i>	Industrial electricity consumption is 50% of total energy consumption by 2035; 65% by 2050. Output falls by 2% every year for non-heavy industry	Industry moves to higher natural gas consumption, with electricity consumption falling before 2035 then remaining constant
Transport	<i>Domestic passenger transport modal shift</i>	Average modal share of cars, vans and motorbikes decreases from current national average 74% total miles to 38% in 2050	No change to current national average modal split by total miles: 74% transportation by cars, vans and motorcycles
	<i>Domestic passenger transport demand</i>	25% reduction in total distance travelled per individual per year by 2030	No change to total travel demand per person
Waste	<i>Recycling</i>	65% recycling, 10% landfill, 25% incineration achieved by 2035, recycling rates increasing to 85% by 2050	65% recycling, 10% landfill, 25% incineration by 2040; remaining constant to 2050
	<i>Waste reduction</i>	Total volume of waste is 61% of 2017 levels by 2040	Total volume of waste is 124% of 2017 levels by 2040

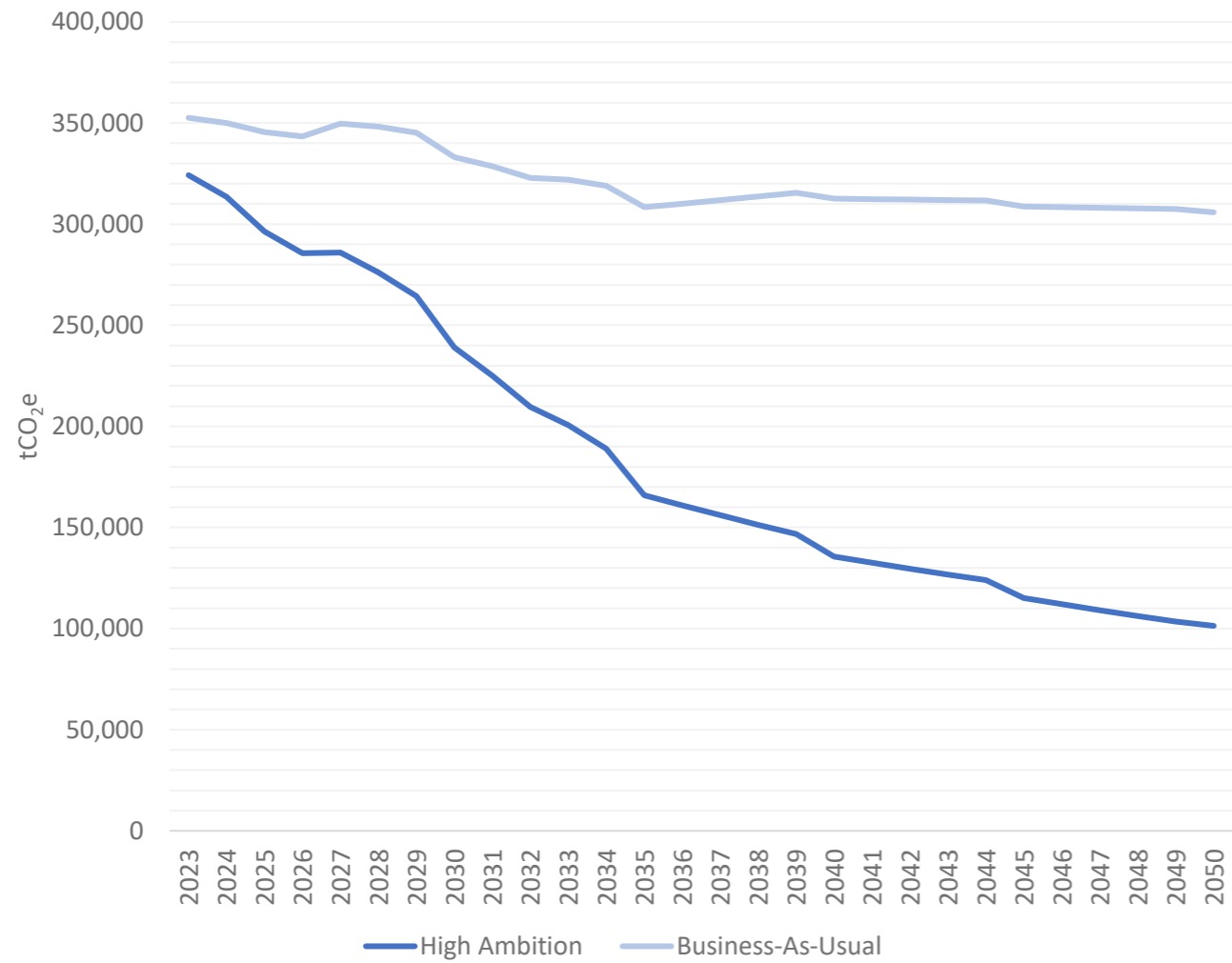


Figure 6: Two SCATTER tool scenarios for South Kesteven.

Figure 6 shows that although the High Ambition scenario expectedly makes progress towards a net zero South Kesteven, it does not achieve this by 2050, despite setting all interventions are to maximum in available in the SCATTER tool. This illustrates the magnitude of action required across all sectors to reach net zero by the 2050 net zero target for the UK and South Kesteven.

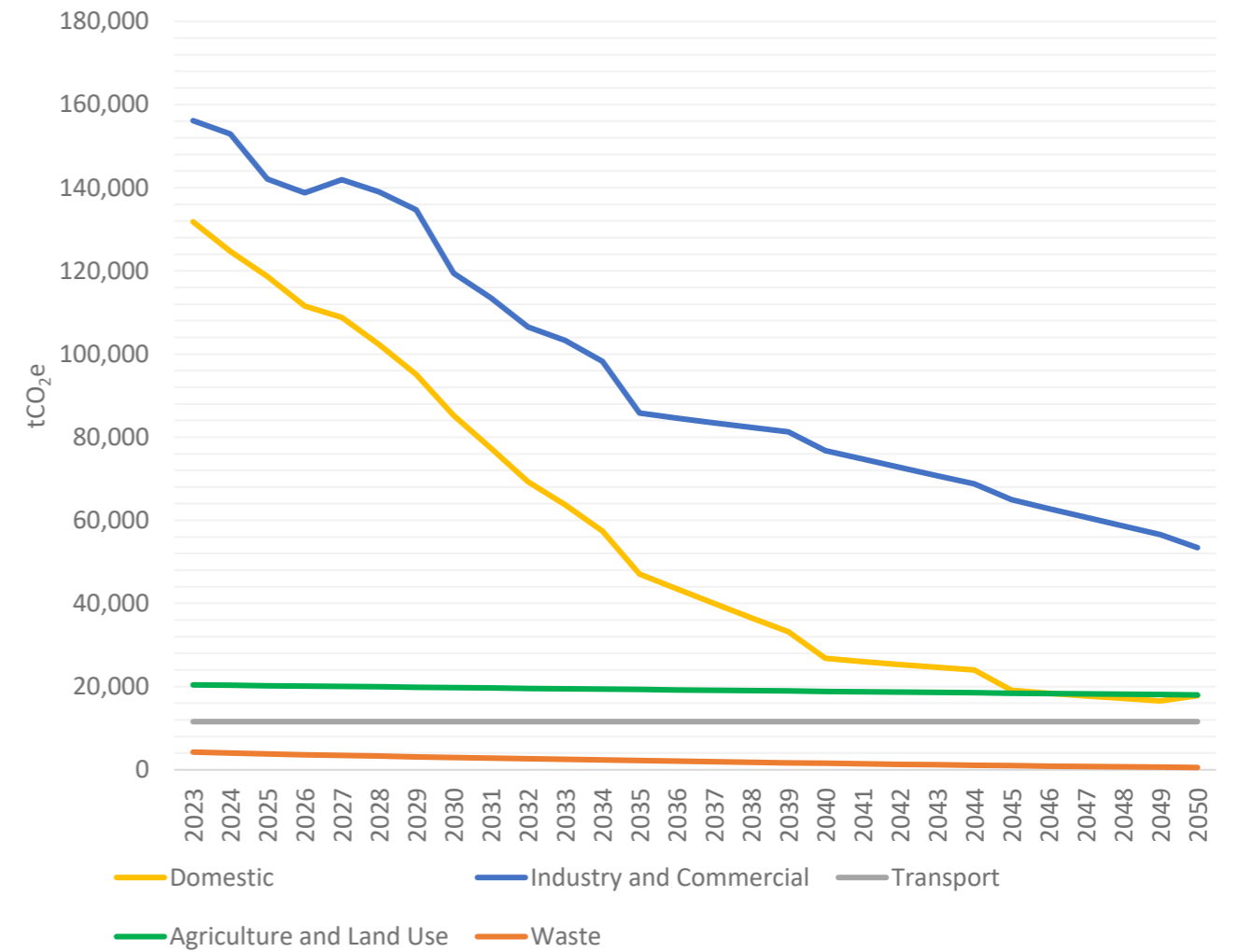


Figure 7: Sectoral breakdown of emissions reductions for the SCATTER High Ambition scenario.

Figure 7 sets out a specific sectoral breakdown of emissions reductions under the High Ambition scenario. This shows that 'Industry and Commercial' and 'Domestic' sectors result in the most significant emissions reductions and in 2023 contribute the most out of all sectors. These emissions reductions to the 'Domestic' sector represent the major impact the local plan can help to deliver to the sector through the implementation of policies that achieve new net zero carbon homes and promote widespread retrofitting of existing buildings. Although the 'Waste' sector represents a small proportion of overall emissions in South Kesteven, the SCATTER High Ambition scenario shows that this sector is able to get to near zero emissions by 2050. The local plan can influence this pathway to near-zero for this sector through the delivery of policies that aim to reduce waste in new buildings, which could include focusing on embodied carbon, circular economy, and material reuse and retention.



In Figure 8 ('Business as usual'), the 'Domestic' sector in fact undergoes no emissions reductions to 2050, and in fact shows a small increase in emissions, even though it is expected that the electricity grid will significantly decarbonise. This failure to achieve reductions is primarily due to the fact that the existing UK housing stock is reliant on gas for heating and therefore will not benefit very greatly from reduced carbon intensity of electricity generation, unless widespread retrofitting occurs to transition existing buildings from gas to electric heating (as per the interventions in the High Ambition scenario). Contrarily, the 'Industry and Commercial' sector experiences notable emissions reductions even in this Business-As-Usual scenario, due mainly to grid decarbonisation.

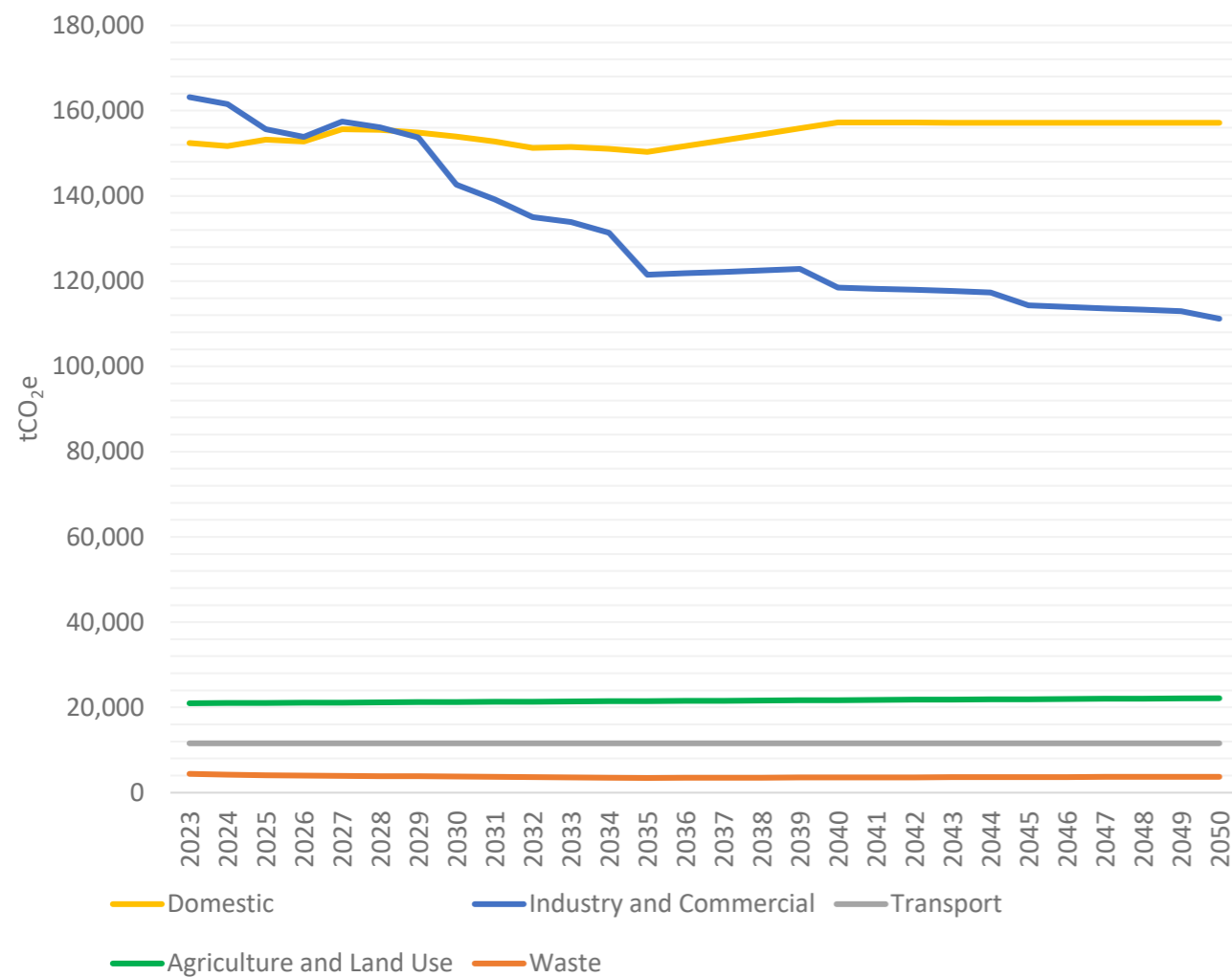


Figure 8: Sectoral breakdown of emissions reductions for the SCATTER Business-As-Usual scenario.

² Differences between the BEIS/DESNZ and SCATTER estimations of the actual and relative amount of emissions by sector are due to differences in the way that these two carbon accounting exercise allocate the UK's carbon emissions to different local authority areas, among other disagreements between the two methodologies. For transport specifically, the BEIS/DESNZ data is more likely to represent the full picture, as BEIS takes into account the traffic flow data (using its access

The results from Figure 7 and Figure 8 show the significant impact that local authority action and policy can have on the 'Domestic' sector. Whilst the High Ambition scenario results in monumental emissions reductions, the Business-As-Usual scenario reveals that a lack of policy action will leave the 'Domestic' sector as the most carbon intensive in South Kesteven and far off-track what it needs to be for this district to pull its fair weight towards the UK's legally binding carbon targets. Therefore, for South Kesteven to become a net zero carbon region as soon as viable before 2050, and to contribute its share towards a net zero UK, ambitious local plan policy must be implemented to deliver truly net zero carbon new buildings, ensure retrofitting of existing buildings, and create an attractive policy landscape for renewable energy development as far as possible within existing planning powers.

Since SCATTER only refers to CO₂ from energy use, the 'Transport' sector does not result in any notable emissions reductions under both SCATTER scenarios. However, as shown in Figure 5, national figures estimate that transport is currently the largest emitting sector in South Kesteven (despite the different picture shown in the SCATTER figures²) and should therefore be simultaneously addressed in the local plan by allocating sites primarily by their scope for reduced car use, requiring development that results in a better mix of homes and services (in both new and existing settlements), and setting development management policies that promote walking, cycling, support public transport and electric vehicle use

It is paramount that the South Kesteven local plan maximises emissions reductions for all sectors. Yet it is clear from the combination of BEIS/DESNZ and SCATTER data that the local plan's greatest potential to potentially influence emissions reductions lies in the sectors of domestic buildings, transport, and industry and commercial buildings (including the growth of renewable energy).

to automatic numberplate recognition) and national fleet breakdown between diesel, petrol and electric vehicles. By contrast, the SCATTER methodology states that for road transport, SCATTER takes the total final energy consumption for transport fuels per local authority area and makes the assumption that this is all diesel.

How could carbon accounting methodologies be logically applied to an individual building and how would this impact the carbon footprint of the local area and UK?

There are two ways in which a new building is responsible for carbon emissions:

- **Operational** carbon: the emissions caused by running of the building, mostly due to energy use.
- **Embodied** carbon: the emissions that were caused in the production and transport of the materials and their assembly into the finished building. This can also include further embodied carbon emissions as parts of the building are maintained, replaced or eventually demolished.

The Global Greenhouse Gas Protocol ‘three scopes’ is helpful to conceptualise how the individual building would contribute to South Kesteven’s overall emissions.

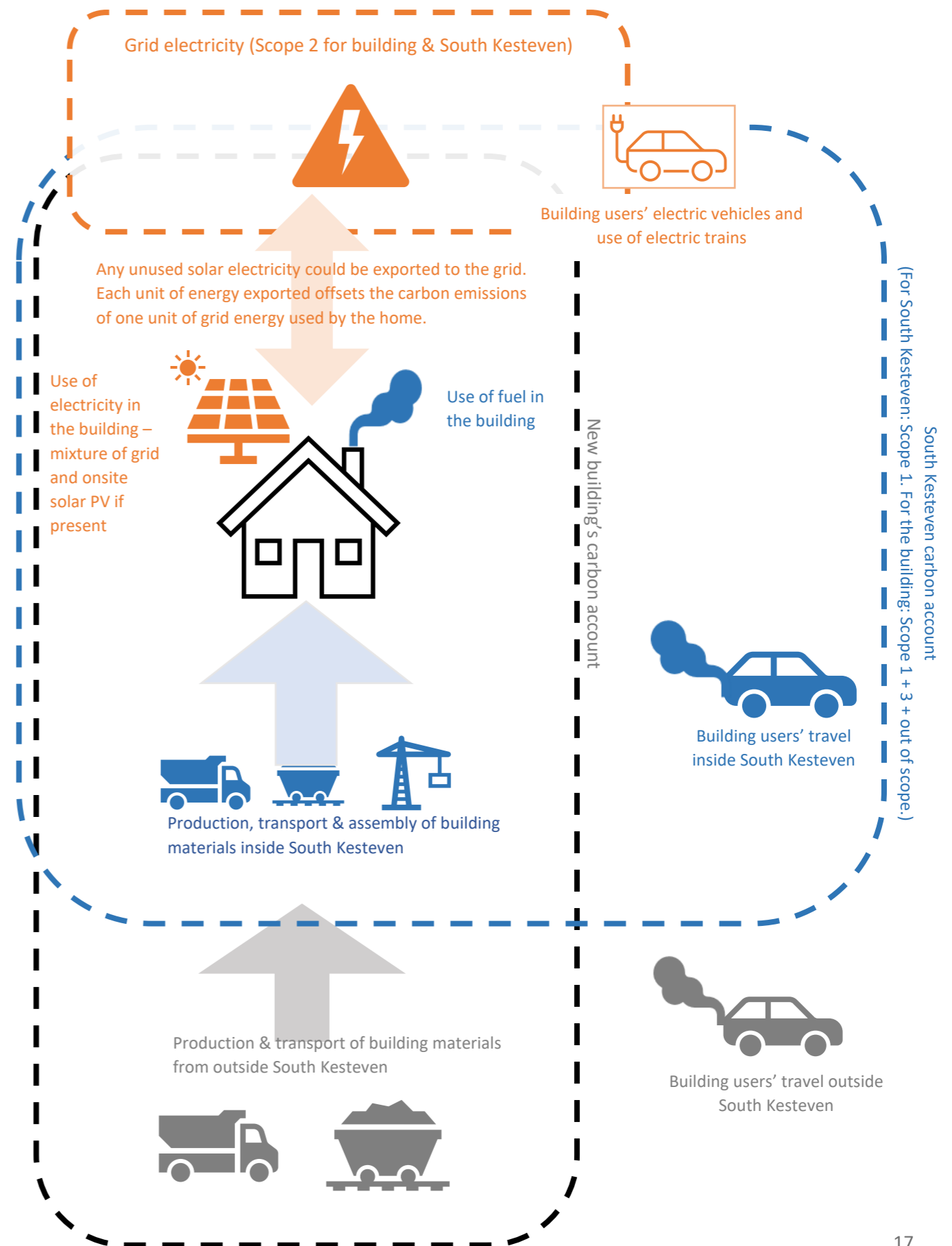
Operational carbon emissions of a building appear almost entirely within Scopes 1 (burning of fuel for energy in the building itself, such as a gas boiler) and 2 (use of electricity from the grid, and use of any energy from a heat network if there is one present).

Embodied carbon would be entirely Scope 3 for the building and mostly Scope 3 for South Kesteven. However, that embodied carbon will also contribute to the Scope 1 and 2 emissions of the UK (and potentially also to a lesser extent the Scope 1 and 2 of South Kesteven), because it includes the transport of materials to site, the use of energy to assemble the building, and potentially the production of the material itself if it is sourced from within the district or the UK. It will also include some Scope 3 if the material was produced overseas.

New development could also cause increased ongoing transport emissions by causing occupants or visitors to drive. This would be part of South Kesteven’s carbon account (Scope 1). However, any increased transport carbon is not counted within the *building’s* carbon account, by any existing methodology to account for a building’s carbon emissions. Thus a ‘net zero carbon building’ does not have to ensure that no transport carbon is emitted by its occupants or visitors. The same is generally true for the use of the term ‘net zero carbon development’ in planning policy and the built environment sector. However, as previously noted, transport is the largest source of carbon emissions in South Kesteven and should be a priority for the local plan to address via the spatial growth allocation strategy and separate policies (other than a ‘net zero carbon buildings’ policy).

To follow the carbon budgets for South Kesteven – and to ensure South Kesteven plays its role in following the carbon budgets for the UK as a whole – emissions from transport and from buildings’ energy use are the key areas that should be targeted by local plan policy. This is because these are the main ways that a new building’s carbon emissions would affect South Kesteven’s carbon account.

Embodied carbon of new buildings’ materials and construction will less strongly affect South Kesteven’s overall carbon account using the methodology currently used by South Kesteven and its consultants (GHG Protocol for Cities) – but a significant proportion of the embodied carbon will appear in the UK’s carbon account. Planning policy should therefore still encourage reductions in this.





'Net zero carbon building' definition in national building regulations and planning

Building Regulations Part L is the legal tool that controls buildings' energy and carbon emissions. Most definitions of 'net zero carbon buildings' in local and government policy are based on Part L and the associated calculation methods.

Building Regulations Part L looks only at *operational* energy and carbon (and does not even address the entirety of this, as explained below). There is currently no regulatory method to consider embodied carbon, nor to hold new development responsible for the carbon emissions of the new occupants' transport.

Part L only controls the 'fixed' energy uses of a building: space heating/ cooling, hot water, fixed lighting, ventilation, fans, pumps. It **ignores plugin appliances**, lifts, escalators, and so on ('unregulated energy'). **This means a 'zero carbon' building using Part L is not truly zero carbon.**

To legally comply with Part L, a proposed development must use an **energy and carbon calculation** named the **Standard Assessment Procedure (SAP)**, for homes) or the **Simplified Buildings Energy Model (SBEM)**, for non-residential buildings). These calculations are submitted to building control regardless of whether a local plan policy sets any requirements about building energy or carbon.

SAP and SBEM set limits on the amount of energy a building uses per square metre per year, and the amount of carbon emissions that associated with the building's energy use. These are the Target Emission Rate (TER) and Target Fabric Energy Efficiency (TFEE). The TFEE relates only to energy used for heating and cooling. The TER is the carbon emissions associated with all 'regulated' energy uses.

These limits are set by modelling a 'notional building' of the same size and shape as the proposed building, with a range of basic energy saving measures applied (insulation, glazing, air tightness, lighting efficiency, heating system efficiency and so on). Part L defines what these measures are. The proposed building must be designed so that it uses no more energy nor emits more carbon than the 'notional building' would. This means the targets vary between buildings, as heat losses are affected not only by the fabric but also the size and shape (more external surface and joins = more heat loss).

Part L is updated periodically, but not often: the previous version was in place from 2013 to 2022. A new version "**Part L 2021**" was implemented from June 2022, and a further version is expected to arrive in **2025 (the Future Homes Standard and Future Buildings Standard)**. These uplifts come with changes to the 'notional building'^{viii}. For Part L 2021 (residential), this has some small improvements to fabric (insulation/glazing) and solar panels applied to the roof, but it still has a gas boiler. Together these will make the home target emission rate about 31% lower than it was in Part L 2013. In Part L 2025 the notional building has a heat pump and much better fabric, but no solar panels. Together these measures will make the target emission rate about 75% lower in 2025 than in 2013 (or about 64% lower than it is with Part L 2021).

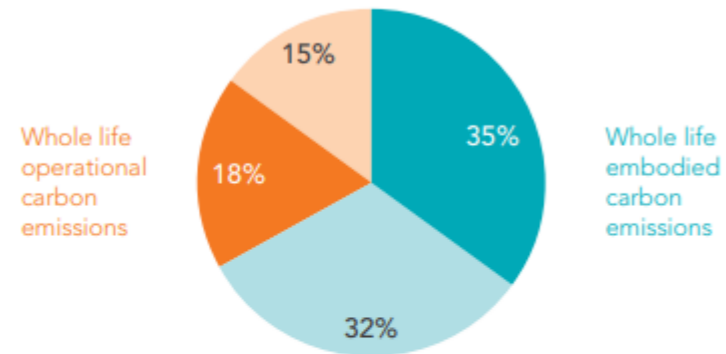
SAP and SBEM methods are also periodically updated to reflect changes in the carbon emissions of grid electricity, and the efficiency of various appliances or fittings such as boilers and hot water taps. Nevertheless, it is widely acknowledged that **these methods are poor at predicting actual energy use** (discussed overleaf) and their periodic **updates tend to lag far behind the real-world changes** to electricity grid carbon or changes to the efficiency of different heating technologies.

The Government's consultation on the Future Homes Standard noted that their intent is that the Part L **2025 target emission rate will be low enough that new homes would not use a gas boiler**. The 75% reduction on Part L 2013 would be almost impossible to achieve in a home that has a gas boiler. Therefore this is likely to prompt

the use of heat pumps in most homes, although some may be able to reach that emissions target using direct electric heating combined with extensive solar panels.

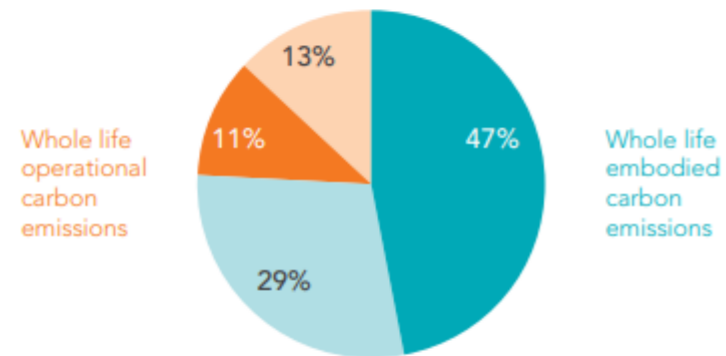
Office

Speculative office building with Cat A fit out; central London



Warehouse

Typical warehouse shed with office space (15% by area); London perimeter, UK



Residential

Residential block with basic internal fit-out; Oxford, UK

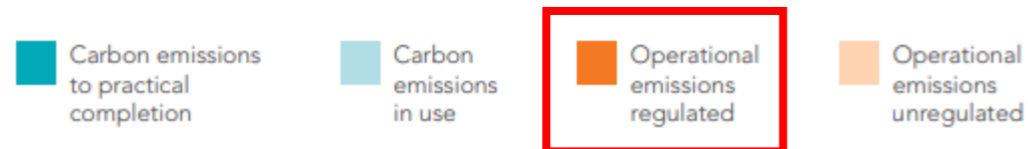
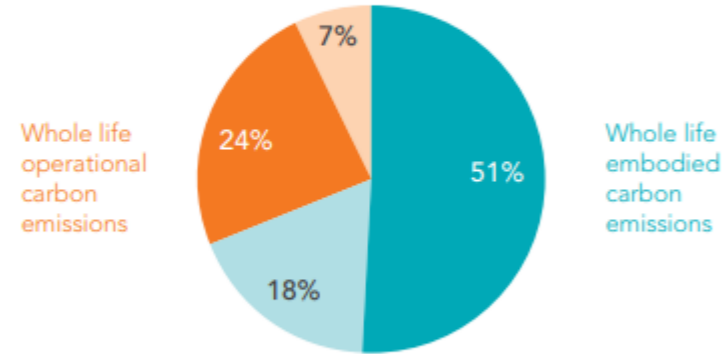


Figure 9: Diagram showing a breakdown of whole-life carbon emissions for four typical building types. Part L of building regulations only looks at the bright orange segments - and even then quite inaccurately. Source: UKGBC.

'Net zero carbon building' – alternative definitions in the construction sector

Green construction experts have recently been developing new approaches to remedy the shortcomings of the national building regulations, SAP and SBEM in defining and delivering net zero carbon buildings. The main weaknesses in Building Regulations identified by the sector are:

- **Failure to account for 'unregulated energy'** – that is, plugin appliances, lifts, escalators, and any other uses not covered by building regulations – which can be 50% of total operational energy use^x (see Figure 9)
- **Poor accuracy at predicting buildings' actual energy use using SAP and SBEM methods** (the 'energy performance gap'), often incorrect by a factor of 200-300% (see Figure 2)
- **Frequently outdated carbon emissions factors** for energy, especially electricity
- **Failure to sufficiently incentivise energy-efficient building design**, due to relatively weak standards for airtightness and not setting absolute targets in kWh/m² that all buildings of a certain type must achieve.
- **Failure to address embodied carbon** (the carbon that was emitted to produce building materials, transport them to site, and assemble them into a finished building; see Figure 9).

For all of the reasons above, an ostensibly 'net zero carbon building' calculated by Part L SAP or SBEM will in fact be very far from being net zero carbon even just in operation^x, before even considering its embodied carbon impacts.

The industry has therefore begun to collaboratively develop new definitions that address not only the end result of net zero carbon, but also inform the design and energy procurement measures that should sensibly be used to achieve it, such as energy efficiency targets and embodied carbon targets.

UK Green Building Council (UKGBC) Framework Definition of Net Zero Carbon, 2019

The UKGBC definition^{xi} of net zero carbon buildings includes twin tracks: operational and embodied. These twin tracks for net zero carbon buildings can be treated separately (see Figure 10). However, buildings seeking 'net zero carbon construction' should also aim to fulfil the operational track too.

- **Net zero carbon in construction** is: "When the amount of carbon emission associated with a building's product and construction stages up to practical completion is zero or negative, through the use of offsets or the net export of on-site renewable energy."
- **Net zero carbon in operation** is: "When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset."

UKGBC does not require the building to hit any specific targets for space heating, operational energy use, or embodied carbon, although it encourages reductions to be prioritised before offsetting.

UKGBC's separate energy procurement guidance^{xii} confirms that off-site renewable energy supply does not have to be via a long-term power purchase agreement, but can be a green tariff so long as that it meets certain criteria on 'additionality' (so the purchase of the energy brings forward additional renewable energy generation capacity, not just buying up existing renewables present in the grid). The guidance notes that at the time of writing (2021) only three such tariffs existed in the UK. It also notes:

- Fossil fuel must not be the primary energy source for heating, hot water and cooking, and
- All new build energy systems should be compatible with being renewably powered.



1. Establish Net Zero Carbon Scope*

1.1 Net zero carbon – **construction**

1.2 Net zero carbon – **operational energy**



2. Reduce Construction Impacts



2.1 A whole life carbon assessment should be undertaken and disclosed for all construction projects to drive carbon reductions



2.2 The embodied carbon impacts from the product and construction stages should be measured and offset at practical completion

3. Reduce Operational Energy Use



3.1 Reductions in energy demand and consumption should be prioritised over all other measures.



3.2 In-use energy consumption should be calculated and publicly disclosed on an annual basis.

4. Increase Renewable Energy Supply



4.1 On-site renewable energy source should be prioritised



4.2 Off-site renewables should demonstrate additionality

5. Offset Any Remaining Carbon



5.1 Any remaining carbon should be offset using a recognised offsetting framework



5.2 The amount of offsets used should be publicly disclosed

D New buildings and major refurbishments targeting net zero carbon for construction should be designed to achieve net zero carbon for operational energy by considering these principles.

Figure 10: UKGBC Net Zero Carbon Buildings Framework Definition - twin track diagram.

London Energy Transformation Initiative (LETI) Net Zero Operational Carbon

LETI is a coalition of industry-leading green building experts, architects and surveyors.

Its definition^{xiii} is that the building achieves a zero carbon 'balance' in its energy use across each year. That means that for each unit of energy it consumes from the grid, it exports at least one unit of zero-carbon energy produced by the building itself (through solar panels). Alternatively, the building's energy demands can be entirely met by additional renewable energy supply from off-site.

LETI's approach is not just about carbon, however – it also incorporates a number of design parameters that will make the net zero carbon achievement possible, and which make the building fit for the UK's wider net zero carbon future by minimising the demands the building will place on limited energy supplies (which already face a huge challenge to decarbonise while meeting existing demand).

LETI's definition therefore also requires that the building fulfil the following targets:

- **Space heat demand:** 15kWh/m₂/year for all building types.
- **Total energy use intensity**, including unregulated as well as regulated: 35kWh/m₂/year in homes, 65kWh/m₂/year in schools, or 70kWh/m₂/year in commercial offices
 - These targets are designed to ensure the use of heat pumps, as these have a ~300% efficiency which translates a 15kWh space heat demand to a 5kWh energy use.
- All space heat and energy demand targets must be fulfilled at the design stage using an **accurate predictive energy modelling methodology**, such as Passivhaus Planning Package³ (not the building regulations methods SAP or SBEM^{xiv})
- **Heating and hot water not to be generated using fossil fuels**
- Onsite renewable energy should be maximised.

These targets – specifically the space heat demand target and fossil-free heating – are in line with the similar targets that apply to the industry certification 'Passivhaus' (although Passivhaus basic certification does not require any level of renewable energy provision or full 'net zero carbon' status). This means the **LETI targets are well-aligned to the recommended SCATTER 'high ambition scenario'** interventions for the new build sector for South Kesteven, outlined previously.

Other sustainable construction frameworks such as the RIBA Climate Challenge^{xv} have adopted similar targets for energy use intensity at similar levels, although not specifically for space heating.

LETI also recommends annual reporting of energy use and renewable energy generation on site for 5 years to verify the net zero carbon status, and that embodied carbon should be separately assessed and reported. It offers separate targets^{xvi} for embodied carbon, but does not expect the embodied carbon to be offset – rather, reduced at source as far as possible.

We note that although UKGBC has not updated its 'framework definition' (discussed in the previous section), it has now endorsed the LETI definition of net zero carbon^{xvii}.

³ Please note the Passivhaus Planning Package (PHPP) is a method to model and predict building's energy use. Although it was developed for use in the Passivhaus certification process, there is no obligation to undergo Passivhaus certification – the PHPP tool can be used in any project without pursuing certification.

Net Zero Operational Carbon

Ten key requirements for new buildings

By 2030 all new buildings must operate at net zero to meet our climate change targets. This means that by 2025 all new buildings will need to be designed to meet these targets. This page sets out the approach to operational carbon that will be necessary to deliver zero carbon buildings. For more information about any of these requirements and how to meet them, please refer to the UKGBC - Net Zero Carbon Buildings Framework; BAP - Design for Performance initiative; RIBA - 2030 Climate Challenge; GHSA - Net Zero Housing Project Map; CIBSE - Climate Action Plan; and, LETI - Climate Emergency Design Guide.

Low energy use

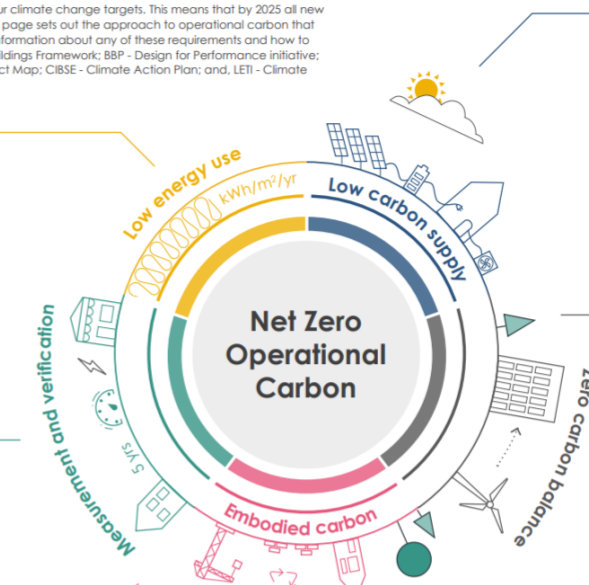
- 1 Total Energy Use Intensity (EUI) - Energy use measured at the meter should be equal to or less than:
 - **35 kWh/m²/yr** (GIA) for residential!
 For non-domestic buildings a minimum DEC B (40) rating should be achieved and/or an EUI equal or less than:
 - **65 kWh/m²/yr** (GIA) for schools!
 - **70 kWh/m²/yr** (NLA) or **55 kWh/m²/yr** (GIA) for commercial offices!²
- 2 Building fabric is very important therefore space heating demand should be less than **15 kWh/m²/yr** for all building types.

Measurement and verification

- 3 Annual energy use and renewable energy generation on-site must be reported and independently verified in-use each year for the first 5 years. This can be done on an aggregated and anonymised basis for residential buildings.

Reducing construction impacts

- 4 Embodied carbon should be assessed, reduced and verified post-construction.³



Low carbon energy supply

- 5 Heating and hot water should not be generated using fossil fuels.
- 6 The average annual carbon content of the heat supplied (gCO₂/kWh) should be reported.
- 7 On-site renewable electricity should be maximised.
- 8 Energy demand response and storage measures should be incorporated and the building annual peak energy demand should be reported.

Zero carbon balance

- 9 A carbon balance calculation (on an annual basis) should be undertaken and it should be demonstrated that the building achieves a net zero carbon balance.
- 10 Any energy use not met by on-site renewables should be met by an investment into additional renewable energy capacity off-site OR a minimum 15 year renewable energy power purchase agreement (PPA). A green tariff is not robust enough and does not provide 'additional' renewables.

Notes:
 Note 1 - Energy use intensity (EUI) targets
 Note 2 - Commercial offices
 Note 3 - Embodied carbon should be assessed, reduced and verified post-construction.

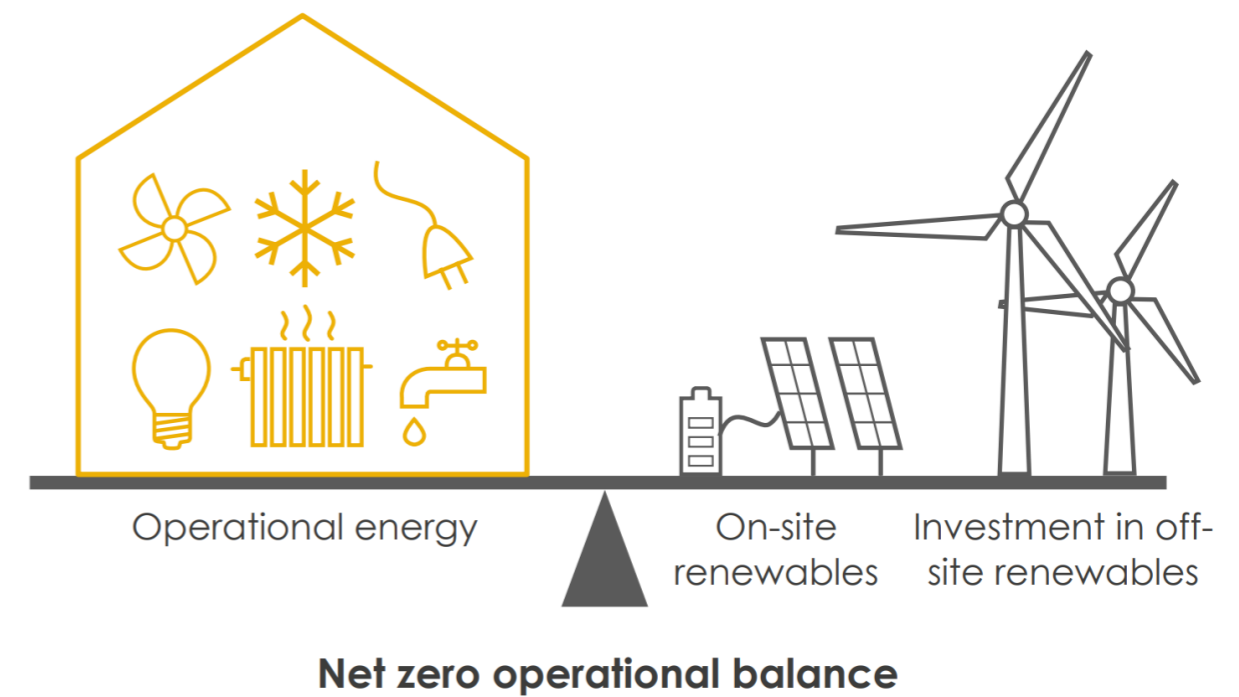


Figure 11: Diagram of LETI net zero operational balance. From LETI Climate Emergency Design Guide.

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