Bioregional & Etude

# Greater Cambridge Net Zero Carbon Evidence Base

Task A: Defining net zero carbon, exploring planning powers towards this, and devising a position statement

December 2020, Revision C

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# Defining and acting on ‘Net Zero Carbon’ in Greater Cambridge and the Local Plan

## Overview

This report explores how to set a meaningful and actionable definition of “net zero carbon” for a local area, and develops a position statement that could be used in the context of the new local plan.  This task aims to support South Cambridgeshire and Cambridge City’s stated commitments to ensuring that all planning decisions are made in line with a shift to zero carbon, as per these Local Authorities’ climate emergency declarations.

A net zero carbon target on which robust and enforceable policies can be built should be based on a recognised greenhouse gas accounting methodology and relate to the emissions reductions shown to be necessary by climate science and national climate commitments. To be effective, these targets and policies need to focus the attention of planners and other stakeholders on issues that are relevant to (and largely achievable in) Greater Cambridge.

The definition of net zero carbon within a local area is explored with a review of existing methodologies for local-level greenhouse gas (GHG) accounting, also relating these to national GHG inventories used to report progress towards international science-based climate commitments. This review also considers which carbon-emitting sectors are likely to be most relevant to the context of local planning, and the relative merit of including these in the local or national carbon inventory. This includes a view of emissions sources and sinks specific to the Greater Cambridge area.

Lastly, this report assesses planning powers that could be deployed to move Greater Cambridge towards net zero carbon status, considering the level of influence that local planning has over different activities and developments. This includes a look at the local planning authority’s legal obligation to address climate change, weighed against other duties and limitations on its powers.

**Please note:** This is a long report as the issues explored are complex. We advise using the navigation pane, which can be viewed in Word by selecting ‘view’ and ticking the box for ‘navigation pane’. We also provide a table of contents and a glossary.

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## Glossary of acronyms and terms

| | |
|---|---|
| ˚C | Degrees Celsius, A measure of temperature. |
| AFOLU | Agriculture, forestry, other land use, grouped as one sector for the purposes of GHG accounting. Also called LULUCF. |
| BEIS | Government department for Business, Energy, Innovation and Skills. |
| Carbon budget | The total amount of carbon that can be emitted over a certain timeframe, if we are to avoid the worst impacts of global warming |
| CCC | Committee on Climate Change. UK independent body appointed by the UK Government to track national progress on climate change. |
| CCS | Carbon capture and storage. New emerging technology for directly capturing and storing carbon from the air. |
| CH4 | Methane, a greenhouse gas that is potent but short-lived and comes mostly from biological processes and decay. |
| CIBSE | Chartered Institute of Building Services Engineers. |
| $CO_2$ | Carbon dioxide, the most common greenhouse gas. Man-made $CO_2$ emissions come mostly from burning fossil fuels. |
| $CO_2e$ | Carbon dioxide equivalent. A way to express the sum of all GHGs in terms of their global warming impact. |
| CUSPE | Cambridge University Science Policy Exchange. An organisation of early-career researchers at the University of Cambridge which runs an annual research program to answer key policy questions with evidence. |
| F-gases | Fluorinated gases. Man-made gases containing fluorine that have a global warming effect. Includes chemicals HFC, $SF_6$, PFC, $NF_3$. |
| GHGs | Greenhouse gases. Gases that trap the sun's heat when they reach the atmosphere of the earth, causing global warming. |
| GPC | Global Protocol for Cities, a methodology to account for the greenhouse gas emissions that a local area is responsible for. |
| IAS | International aviation and shipping |
| IPCC | Intergovernmental Panel on Climate Change, a UN body dedicated to providing objective scientific information on climate change. |
| LDO | Local development order, a legal tool used in planning to encourage certain kinds of development. |
| LETI | London Energy Transformation Initiative, a network of built environment professionals working to support a zero carbon future. |
| LULUCF | Land use, land use change, forestry, grouped as one sector for the purposes of GHG accounting. Also called AFOLU. |
| Mitigation | Reduction of the total amount of greenhouse gas in the earth's atmosphere, either by reducing emissions or increasing removals. |
| $MtCO_2$ ($MtCO_2e$) | Mega-tonnes of carbon dioxide (or carbon dioxide equivalent) |
| Net zero carbon | When removals of GHG from the atmosphere are equal to emissions. Different from 'zero carbon' which is when no GHGs are emitted. |
| $N_2O$ | Nitrous oxide, a greenhouse gas. |
| Offsets | Actions that remove or avoid a certain amount of GHGs, in order to cancel-out the emission of the same amount of GHGs elsewhere |
| Paris Agreement | A UN agreement within the UNFCCC that all countries will take action to reduce emissions sufficiently to limit average global warming to 2˚C above the pre-industrial climate, and pursue a limit of 1.5 ˚C. |
| Part L | Building regulations section on energy use and carbon emissions. |
| Passivhaus | A process and performance standard for designing, building and certifying buildings that have extremely low energy demand. |
| PHPP | Passivhaus Planning Package, a set of virtual tools that are used to accurately model the way a building uses heat and other energy. |
| RIBA | Royal Institute of British Architects. |
| RICS | Royal Institute of Chartered Surveyors. |
| SAP | Standard Assessment Procedure by which a building's energy and carbon are estimated to show compliance with building regulations. |
| SCATTER | An online tool to understand and set policy to reduce local authority areas' overall carbon emissions. Acronym for "Setting City Area Targets and Trajectories for Emissions Reduction'" |
| Scope 1, 2 and 3 | Different parts of an area's GHG account (in descending order of how much influence the area has over them). From GPC, see left. |
| Sequestration | Removal and capture of greenhouse gas from the air. |
| SPD | Supplementary Planning Document (additional to Local Plan) |
| UKGBC | UK Green Building Council |
| UN | United Nations, a global body whose members include almost all countries of the world, aiming to promote international cooperation. |
| UNFCCC | United Nations Framework Convention on Climate Change. A UN agreement to limit GHGs to avoid dangerous climate change. |

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## Executive summary

"Net zero carbon" means that emissions of greenhouse gases (GHGs) are balanced out by removals of GHGs from the atmosphere. The main GHG is carbon dioxide ($CO_2$) which represents about 80% of the UK's climate impact. As $CO_2$ 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 1.5˚C above pre-industrial climate). Six other GHGs are also relevant: methane, nitrous oxide, and four types of fluorinated gas (refrigerants). These other gases are not subject to the 'budget' approach, but should still be reduced as close to zero as possible. At present, green features such as forests, grassland and woodland are the only reliable and scalable means to remove greenhouse gases, as no appropriate and efficient technology has yet been developed.

Depending on the methodology used, a local area would achieve 'net zero carbon' status when:

- The GHG removals achieved within the local area are equal to emissions from directly within the local area plus the emissions associated with production of grid electricity that is consumed within the local area, or
- As a last resort[1], the local area finances GHG removals achieved elsewhere that are equal to any emissions that it cannot avoid. To best support national carbon goals, these removals should be achieved within the UK.

For a higher level of ambition, the local area may also choose to achieve or finance GHG removals equal to some of the GHG emissions outside the area that are driven by activities within it (such as residents' aviation or consumption of goods brought in from elsewhere).

Existing analyses of how the UK could reach net zero carbon show that most sectors must shrink their emissions to zero or near-zero very soon, without simply paying for offsets elsewhere, because the UK's capacity to achieve offsets[2] is limited. New buildings and ground transport are two such sectors; whereas aviation and agriculture will likely need offsets.

Some carbon accounting methodologies exclude certain sources of GHGs from the scope of what the local area is responsible for. Typical examples include aviation, international shipping and cement use (because these usually happen outside the local area even if caused by local residents' spending). Peatlands and refrigerant use are often excluded due to lack of robust data, but this is starting to change. The emissions included or excluded in each methodology are explored in this report and summarised in an appendix.

Local planning does not have the power to make all changes needed for a net zero carbon Greater Cambridge, but it can drive some key changes (new builds; infrastructure; spatial patterns of land use). It can also influence or enable others (transport; renewable energy; afforestation; existing buildings). There are some carbon-emitting activities which local planning cannot influence (agriculture; aviation; shipping). The key entry points for influence are new development and land use changes.

The current national building regulations are insufficient to create, or even identify, true zero-carbon buildings. This is due to the 'energy performance gap' between design and reality, and the fact that the regulations exclude energy used by plug-in appliances. Alternative metrics are therefore needed for the purpose of setting zero carbon buildings policy. The Passivhaus Planning Package leads the way at present by providing more reliably accurate modelling of a particular building's energy use. It is also helpful to set metrics not only about carbon, but about total energy use intensity (per square metre of floor space), so that new builds do not put extra strain on an electricity grid which is already coming under pressure from transitioning vehicles and existing heating to electricity rather than fossil fuels – which are also essential for a net zero carbon Greater Cambridge and a net zero carbon UK.

For this reason, many local authorities are already requiring new builds to achieve higher standards than those of national building regulations, in new builds. Arguably, there are limits to local planning authorities' power to raise the bar for new developments' energy and carbon performance . However, these limits are now beginning to clash with local planning authorities' legal duty[3] to address climate change and to contribute towards the UK's national legally binding net zero carbon target for 2050. The relative weight of these duties and powers has not yet been thoroughly tested in legal terms. What is clear is that there is no time to lose if the UK is to pull its weight towards a safe global level of emissions, so local planning authorities need to take bold steps towards achieving zero emissions buildings immediately, and adopt policies that drive drastic and rapid emissions reductions from transport, energy and land use.

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[1] This is a last resort because the further away the GHG removal projects are, the less visibility and certainty there is over them. Also, local nature-based projects offer local co-benefits like recreation, flood protection and wildlife. These can also help with the planning obligation to *adapt* to climate change as well as mitigate it – such as by shading streets with trees.
[2] At present, nature-based solutions such as forests and wetlands are the only large-scale means to remove GHGs. For years there have been attempts to develop technology for carbon capture and storage (CCS), but these are not yet cost-effective or deployable at scale. Current technology uses a lot of energy, and its manufacture also emits carbon.
[3] Planning and Compulsory Purchase Act 2004, section 19, and National Planning Policy Framework (para 149-150).

An illustration of the activities that emit or remove carbon is given as follows, showing where each of these activities falls within the sphere of influence or responsibility of the local area, the local plan and a new development that happens under the aegis of the local plan. Note that some activities overlap spheres of influence, where they are partly steered or enabled but not entirely delivered by that entity.

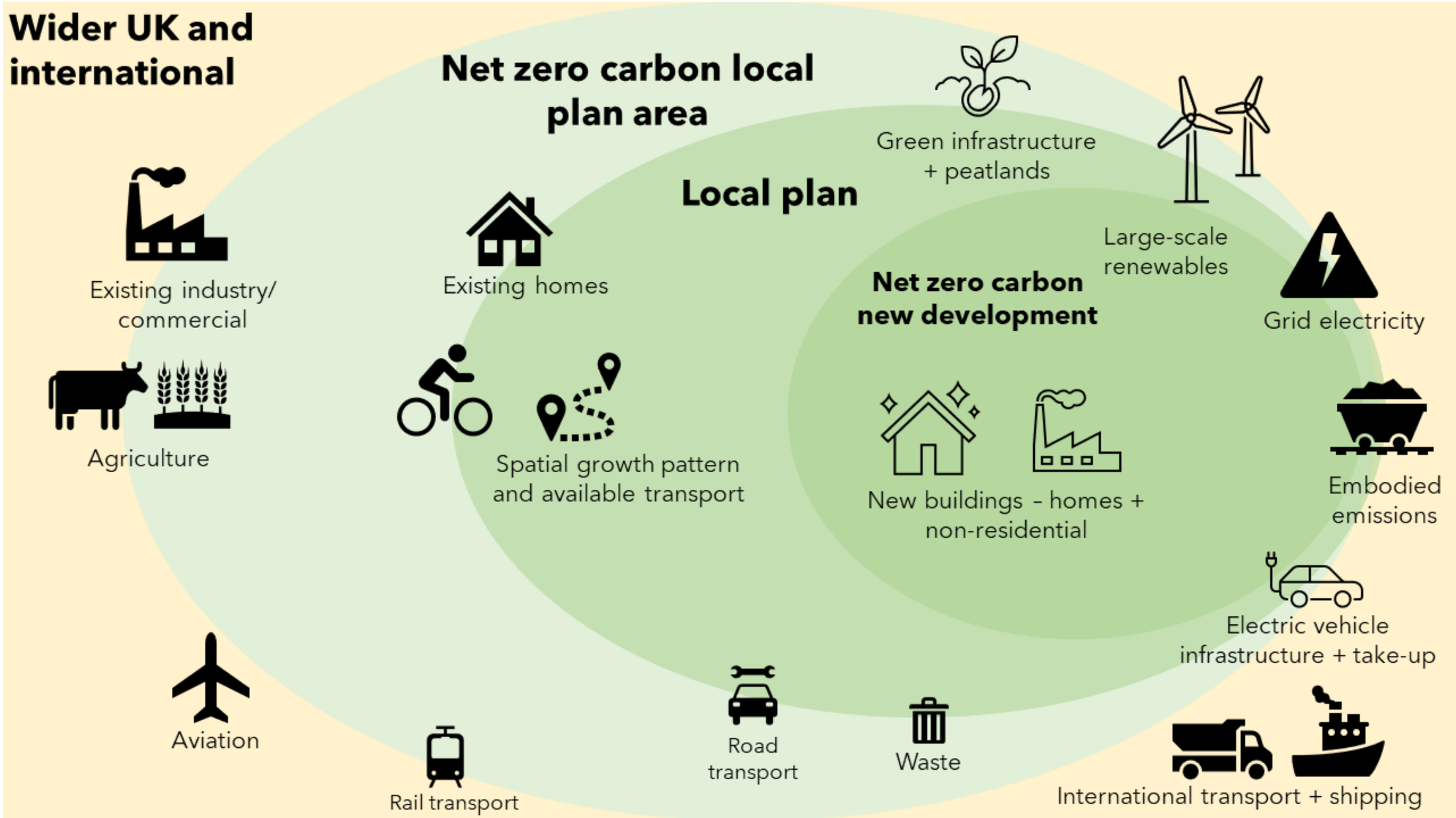


Figure 1: Spheres of influence for activities and sectors causing the emission, avoidance or removal of greenhouse gases between the local plan, the local area, a net zero carbon development within the local plan, and the wider UK/international sphere.

# Contents

# 1. Introduction

## 1.1 A new net zero carbon compatible local plan for Cambridge

In November 2018 South Cambridgeshire District Council declared a climate emergency, pledging that "all strategic decisions, budgets and approaches to planning decisions by the council are in line with a shift to zero carbon". In February 2019 Cambridge City Council followed suit by also declaring a climate emergency, committing to be zero-carbon by 2050. This is in a national context where the UK Government has legally committed to the whole country becoming net zero carbon by 2050, as part of the UK playing its full role in its commitments under the international Paris Agreement (to limit global average climate change to a maximum of 2˚C, with a change of staying below 1.5˚C.

The two councils are jointly working on a new local plan. Acknowledging the local plan's key role in helping to realise the zero carbon ambition, this position statement explores what zero carbon[4] means for Greater Cambridge, and how the local plan can be developed to achieve the target.

## 1.2 Defining what zero carbon means for Greater Cambridge

A zero carbon compliant local plan for Greater Cambridge would enable the area to develop in a way that is consistent with its zero carbon targets, and the UK's legal obligation to achieve net zero carbon emissions by 2050.

There are many different ways in which "net zero carbon" can be defined, depending on different sources of emissions, where those sources are emitted, which greenhouse gases are included, and whether the goal must be achieved by emissions reductions or whether carbon offset credits are part of the equation. Methodologies for accounting for "carbon" vary widely, and the leading ones are reviewed within this position statement. These methodologies are useful and can help to clarify thinking and track progress, but they also have their limitations. The **important end goal to focus on is "ceasing Greater Cambridge's contribution to human-induced global warming**".

Human-induced global warming is caused by the release of greenhouse gases (GHGs) into the earth's atmosphere as a direct result of human activity. Carbon dioxide ($CO_2$) is the "carbon" referred to in "zero carbon", but "zero carbon" is generally taken to encompass the other greenhouse gas emissions too – methane ($CH_4$), oxides of nitrogen (NOx) and fluorinated gases (F-gases).

Our review of the different definitions and methodologies to account for carbon (Appendix 1, and throughout the report) makes clear which greenhouse gas emissions are included.

Our **recommendation is that all greenhouse gases and their sources are included** when considering the ways in which the local plan can help to cease Greater Cambridge's contribution to global warming – i.e. achieve net-zero greenhouse gas emissions. We also **recommend that intermediate targets are set (and action taken) to limit the total amount of carbon dioxide** that is emitted between now and the net zero end date, in order to ensure Greater Cambridge pulls its weight towards a world where global average temperatures do not rise more than 1.5˚C.

We also look at the role of off-setting and carbon sequestration, which needs to be considered with care and only be relied upon to reach net zero carbon in exceptional circumstances. This topic will also be covered in more detail in a separate report.

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[4] "Zero carbon" refers to the end goal of there being no net carbon emissions, e.g. "we need a transition to zero carbon". We also use 'zero-carbon' (with a hyphen) as an adjective, e.g. "zero-carbon homes".

## 2. Defining net zero carbon

**This section will explore how 'carbon' and 'net zero' can be defined for a local area.**

On a global level, achieving **'net zero carbon' means that greenhouse gas emissions are balanced out by removals of greenhouse gases (GHGs) from the atmosphere**. Various gases have a greenhouse effect, although carbon dioxide is the most prevalent.

Emissions of greenhouse gases come from many different human activities, usually in the production of goods and services such as electricity, heating, food, materials, or transport. Some human activities can also remove greenhouse gases, such as tree planting. Because goods and services are often traded between different countries – and between different areas within each country – we need methodologies to account for whose activities are responsible for what amount of greenhouse gas.

This section will therefore review literature on the following:

- **Which gases** have a greenhouse effect, and their relative climate impact
- Which UK **sectors and activities** are driving greenhouse gas emissions
- The leading **methodologies to account for the GHGs** for which the **local area is responsible** (and should therefore be acted upon in the local plan).
- Methodologies to account for GHGs for which a **building or development is responsible**
- What is meant by **'net' zero** – that is, how can greenhouse gas be removed or avoided, and who gets the credit for those removals.

Several area-based greenhouse gas accounting methodologies are available, and are structured according to:

- What the main local activities are, that drive emissions or removals of greenhouse gas
- Which greenhouse gases have the biggest climate impact
- What data is available about local activities and the emissions they cause
- What purpose the greenhouse gas account is being prepared for.

A greenhouse gas account is also sometimes called an 'inventory' or a 'footprint'. An inventory tends to look at emissions coming from directly within an area and its energy use, while a footprint tends to also include emissions happening elsewhere that are caused by spending within the local area (for example, importing goods whose production involved a lot of greenhouse gas emissions).

The available greenhouse gas accounting methodologies do not all agree about which activities and which gases should be included in the local account. Disagreements tend to arise from differences in the purpose of the GHG account. For example, if a methodology is designed to produce a greenhouse gas account that a local authority will act upon, it may ignore emissions over which the local authority has no influence – such as citizens' international flights from airports outside the area. However, some methodologies still include these activities, on the grounds that all emissions must be addressed somehow and so the local area is as good a place as any to assign the responsibility.

A further way in which the methodologies differ is whether they allow the purchasing of carbon offset credits as a way to reduce the local area's account – and whether those can be internationally traded.

**The differences between all reviewed methodologies are summarised in Appendix 1.**

View of neighbouring building from the top of One Brighton development. Shows active travel greenway, rooftop solar, and timber cladding. Credit: Bioregional.

## 2.1 What do we mean by carbon and greenhouse gases?

Carbon dioxide ($CO_2$) is the most prevalent greenhouse gas (GHG). Other GHGs are emitted in smaller amounts yet have significant effects on climate. These other GHGs often have a stronger global warming effect than $CO_2$, but do not always stay in the atmosphere as long as $CO_2$. To account for these gases all together, they are converted into the equivalent amount of carbon dioxide ($CO_2e$) based on the global warming effect each gas would have over a period of 100 years.

Some GHG accounting[i] only looks at $CO_2$ because it is the most prevalent gas and because calculations about the other gases are more uncertain. However, because the other GHGs still have a significant effect on climate change, international protocols[ii] (and the UK's Committee on Climate Change[iii]) advise that **seven greenhouse gases should be accounted for** in national GHG calculations and therefore should be included in a net zero carbon target:

| **Greenhouse gas** | **Proportion of UK's total GHG emissions ($CO_2e$)[iv]** |
|---|---|
| Carbon Dioxide, ($CO_2$) | 81% |
| Methane ($CH_4$) | 11% |
| Nitrous Oxide ($N_2O$) | 4% |
| F-gases (HFC, PFC, $SF_6$, $NF_3$) | 3% |

These percentages do not account for emissions from peatlands, which were not included in international carbon accounting protocols at the time but will be included from 2020 onwards. Intact peatlands can be a net remover of GHGs, but damaged peatlands emit huge amounts[v].

$CO_2$ emissions come mostly from fossil fuel use. Methane emissions come mostly from agriculture and waste. $N_2O$ emissions also mostly come from agriculture, especially fertiliser. F-gases are refrigerants.

## 2.2 The UK's net zero target and carbon budgets

The UK government legislated that the country must achieve net zero carbon by 2050, by updating the Climate Change Act in 2019. This was in response to the latest climate science from the IPCC (Intergovernmental Panel on Climate Change) which showed that the world needs to further limit its carbon emissions in order to limit global temperature increases to under 1.5˚C (rather than 2˚C), to stand an acceptable chance of avoiding the most catastrophic effects of climate change.

As well as setting a target year by which the UK's emissions and removals should be in balance, this Act includes caps on the amount of $CO_2$ that we can afford to emit in each five-yearly period (carbon budgets)[vi], periodically revised according to how much $CO_2$ has been emitted to date. These budgets aim to ensure that our cumulative emissions between now and 2050 are consistent with a less harmful global climate change pathway, acting to guide policymaking towards intermediate targets [vii]. In the updated legislation, the UK permits itself to buy international carbon credits to achieve this goal. This would involve paying an entity in another country so that removals of GHGs by another country's forest or wetlands would be put into the UK's GHG 'account', lowering our emissions total. This runs counter to the advice of the UK's Committee on Climate Change (CCC) and most sectoral advice, discussed in the next section.

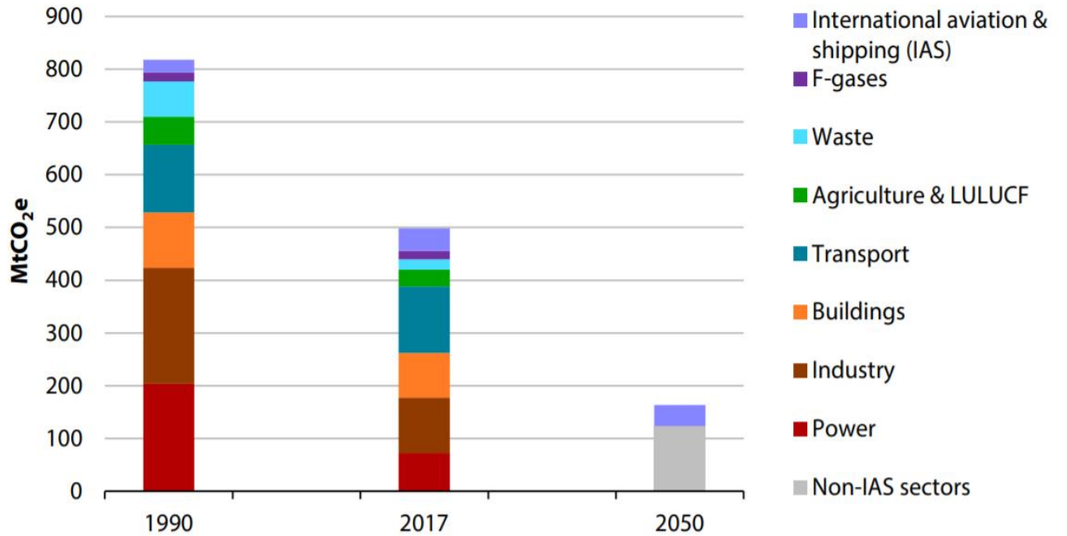


Figure 2: How the UK's emissions have reduced from 1990-2017 by sector, and looking forward to the former 2050 target in the original Climate Change Act 2008. The country now needs to go further, bringing the 2050 figure to net zero. "Non-IAS sectors" means all sectors other than international aviation and shipping. LULUCF is land use, land use change and agriculture. MtCO2e is mega tonnes of greenhouse gas measured in carbon dioxide equivalent. Committee on Climate Change, 2019.

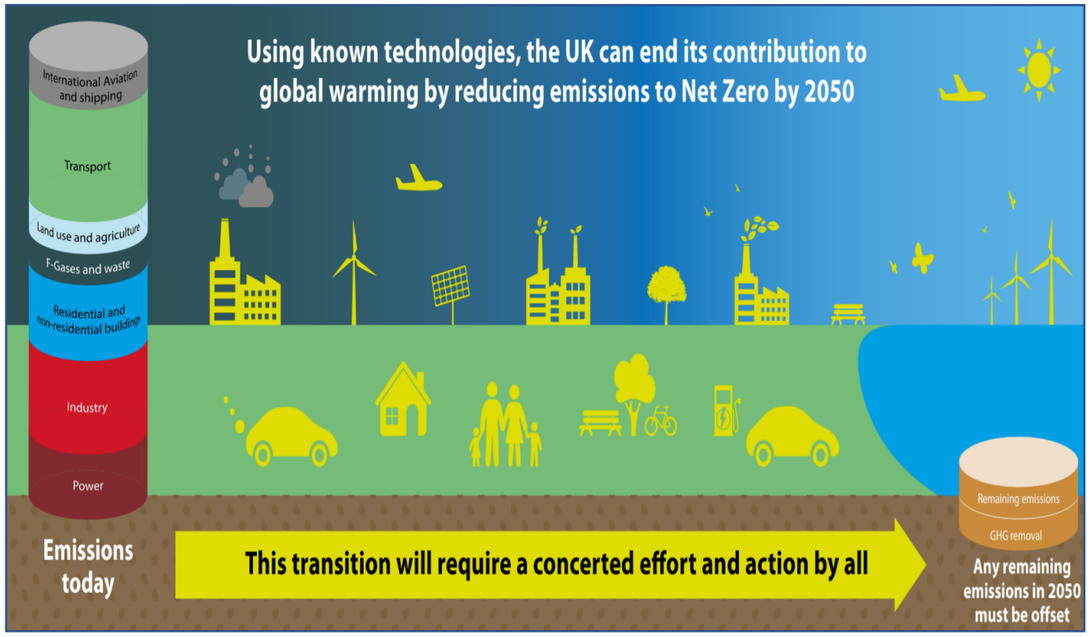


Figure 3: The UK's transition to net zero by 2050. Committee on Climate Change, 2019.

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### 2.3 How GHG emissions and removals are apportioned to places and people

There are two main ways to count the amount of GHGs a location is responsible for:

- **Territorial:** the GHG emissions being generated directly from within that location
- **Consumption-based:** the GHG emissions generated anywhere in the world during the production and transport of goods and services that are *consumed* within that location

Of the two options, territorial GHG accounting offers the clearest and most reliable picture without the risk of double-counting (of emissions or removals) between regions of countries.

**Consumption-based GHG accounting** gives the broadest picture of the emissions that are driven by all activities and spending within a country, city or district. Because the UK consumes far more imported goods and services than we export, our consumption-based carbon footprint is nearly twice as big as our territorial one[viii]. However, consumption-based footprinting involves more estimation about how goods are produced elsewhere, and it is complicated to untangle what proportion of each step of the supply chain should be allocated to each party, risking double-counting. Consumption-based GHG accounts also bring in more elements not under the control of the entity whose footprint it is.

**Territorial GHG accounting** presents a more precise picture, where the emission sources are more firmly under the control of that location. For this reason, national carbon accounting is territorial, not consumption-based, as established in the UNFCCC (United Nations Framework Convention on Climate Change – the internationally agreed structure for national GHG accounts). This avoids double-counting of emissions at the global level and makes sure no emissions go unclaimed (for example, if one country produces goods and another consumes them).

The UK's Climate Change Act follows this territorial structure for emissions, but the Act allows the UK to claim removals of GHGs elsewhere by buying **international offset credits** – paying another country so that the UK's carbon 'account' includes removals of GHGs achieved by the other country's forests or wetlands. This goes against the advice of the UK's Committee on Climate Change (CCC)[ix] and others[x]. Arguably, as national GHG emissions are accounted territorially, then GHG removals should be treated similarly. As well as obscuring a country's actual emissions profile, it is not certain that offset payments bring genuinely 'additional' removals of GHGs (removals that otherwise would not happen, such as by creation or protection of forests)[xi]. This is why international carbon credits run counter to a meaningful national net-zero target that supports a globally safer climate pathway.

**The CCC advises (referenced above) that the 2050 carbon neutral balance should be achieved using removals that happen within the boundaries of the UK,** at least for most sectors. Allowing the use of international offset credits reduces the incentive to make the domestic GHG reductions that are achievable and essential in order for the global aims to be met (further to the aforementioned doubt that hangs over the effectiveness of carbon credit payments). The argument is that international offsets should only be permitted for the sectors which would otherwise be practically impossible to decarbonise internally within the timescale, such as aviation, cement and steel production. The CCC notes that even for these industries, international carbon credits should be used only if the anticipated low- and negative-carbon technologies fail to emerge, such as carbon capture and storage (CCS) or hydrogen fuel.

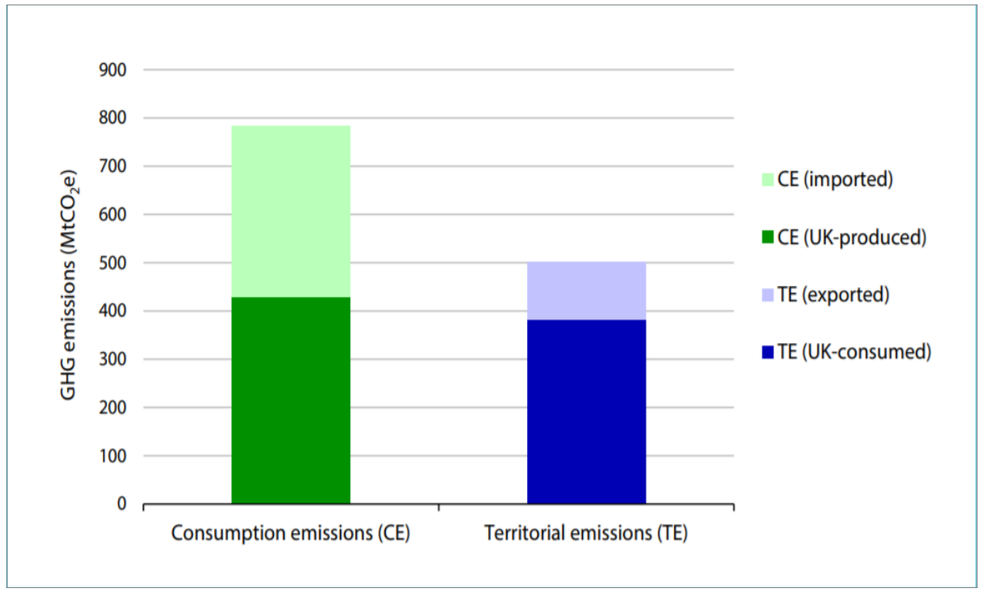



Figure 4: Graphic showing how much larger the UK's consumption-based carbon footprint is, in comparison with its territorial emissions – even accounting for goods and services we export. Credit: Committee on Climate Change 2019 progress report to parliament on reducing UK emissions.

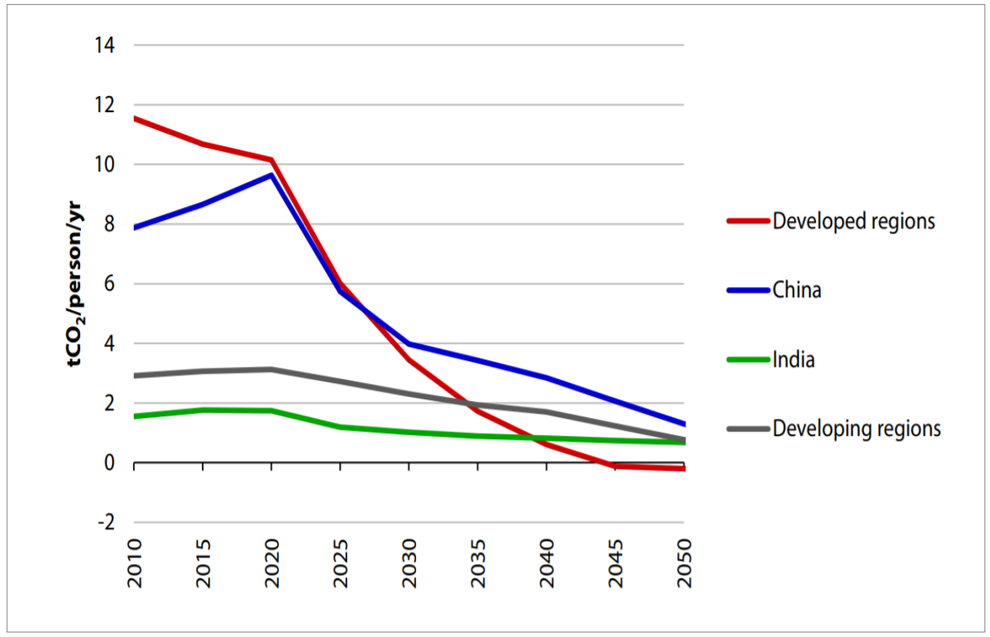



Figure 5: Per capita carbon reductions that would fulfil the Paris Agreement in a 'leadership scenario' where richer countries play their full role. The Paris Agremeement commits to limit climate change to no more than 2°C. Committee on Climate Change, 2019

## 2.4 Translating national inventories into local ones, and using carbon 'scopes'

Territorial carbon neutrality is difficult if the boundary is drawn tightly around the built area[xii,xiii]. This is because a large share of GHGs comes from cities and infrastructure, but removals are currently only achieved by green areas.

GHG accounting 'scopes' are another way to express the responsibility for emissions, so that emissions are reported consistently and not double-counted. The scopes come from the **Greenhouse Gas Protocol**[xiv], the most widely used standard for GHG accounting by organisations. The scopes reflect how much control an entity has:

- Scope 1: Direct emissions from assets controlled by the entity – e.g. fuel in the entity's cars or generators; $N_2O$ escaping from fertiliser on its fields. (For a local area, this matches to 'territorial emissions' as above)
- Scope 2: GHGs that were emitted during the generation of electricity and heat purchased by the entity, generated by another entity (e.g. a power company)
- Scope 3: all other GHGs emitted during the production and use of goods and services purchased by the entity, and in the management of waste produced by the entity[xv].

### 2.4.1 The Greenhouse Gas Protocol for Cities (GPC)

The GPC[xvi] is adapted for the local scale, so that local areas can be compared and aggregated. The scopes are applied as if the area (and all activities within it) were a single entity.

Scope 1 allows aggregation of local inventories up to a regional or national level, consistent with national accounts. Scope 2 (grid energy) may overlap the area boundary but is within the area's influence. Scope 3 is harder for city policy to influence. Compared to national accounts, more of cities' GHGs fall into scopes 2+3, because cities bring in goods and energy from elsewhere in the country, so the GPC notes that scopes 2+3 should not be neglected.

The GPC advises that the city should first define the boundaries of the GHG inventory (geography, sources, gases and timescale). Boundaries may be set according to the **data available**, and the **purpose** of the inventory. That said, the protocol is designed for a 1-year timescale and to cover **all 7 main greenhouse gases**.

The GPC requests that cities report their GHG inventory in two ways (encouraging both to be used):

- Scopes framework: "This totals all emissions by scope 1, 2 and 3". Scope 1 is the most crucial as it forms the territorial footprint that can be aggregated to national level.
- City-induced framework: "This totals GHG emissions attributable to activities taking place within the geographic boundary of the city". This has two levels, 'BASIC' (if data is limited) and 'BASIC+' which takes in additional sources from industry and land use.

The main difference between these is that the city-induced framework excludes the following emissions:

- Energy generated inside the city but exported to the grid
- Waste from outside the city that is managed in the city, other than as an energy source.

Emissions are split into six sectors (see Table 1). Most sectors have emissions in more than one scope.

**Regarding offsets**, the GPC requires that 'offsets purchased from outside the geographic boundary should be separately reported and not deducted from the inventory.' The same is true for offset credits generated in the city but sold externally. This lets the municipality recognise purchased offsets as a positive step without claiming that they are a reduction in the city's own emissions. Still, GPC notes that 'net neutrality' goals often include an *element* of external offsetting and "cities may designate *a portion of* their mitigation goals to be met using … offset credits".

**For an individual development**, there would be changes to which activities fall into each scope, because the area boundary would be reduced to the plot. Some emissions that are scope 1 for the local area – such as cars on local roads – become scope 3 for an individual development, because they occur off-plot. Hence it is less common to apply the scopes to an individual building or development scheme.

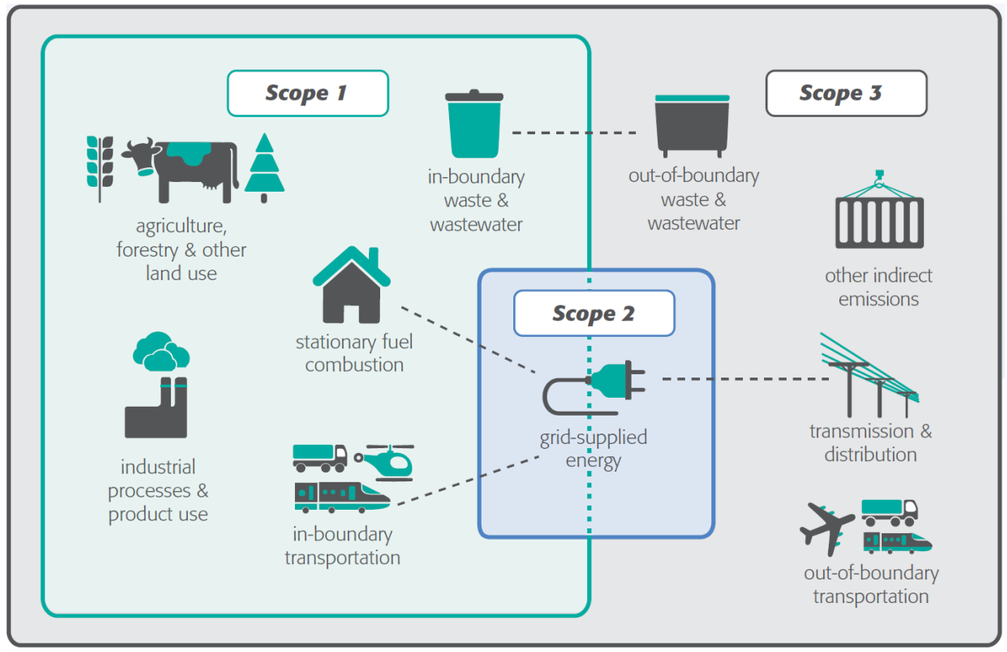



Figure 6: GHG Protocol for Cities diagram of scope 1, 2 and 3 emissions sources for local GHG accounting.

| Sector in GPC inventory | Includes (non-exhaustive list) |
|---|---|
| Stationary energy | Energy and fuel used in buildings, construction, manufacturing, street lighting; energy industries; fugitive gases from fuel production |
| Transport | All journeys by cars, trains, boats, aviation, off-road – including if these are inter-city or international |
| Waste (and wastewater) | Disposal, treatment, incineration |
| Industrial processes and product use (IPPU) | Emissions that occur as a result of chemical or physical change rather than due to energy use. (E.g. aerosols and refrigerants escaping from products; $CO_2$ driven off the raw materials during cement kiln heating) |
| Agriculture, forestry and other land use (AFOLU) | Livestock (digestive system; manure); conversion of forest land resulting in loss of carbon held in soil or trees; decomposition of drained peat soils |
| Any other emissions occurring outside the geographic boundary as a result of city activities | As per sector description. This would only cause emissions under scope 3. Example: embodied carbon (emitted during production) of goods or materials brought in from outside the city. |

Table 1: Greenhouse Gas Protocol for Cities (GPC) emissions classification

### 2.4.2 PAS2070

This document[xvii] aims to define good practice for the assessment of the greenhouse gas emissions of a city'. It is not an official 'standard' but a 'publicly available specification', often produced as a prelude to an ISO or British Standard.

PAS2070 underlines the case for including a full range of different GHGs in the scope of 'net zero carbon', and to further emphasise that externally purchased carbon offsets are a separate element rather than part of a city's overall carbon emissions inventory.

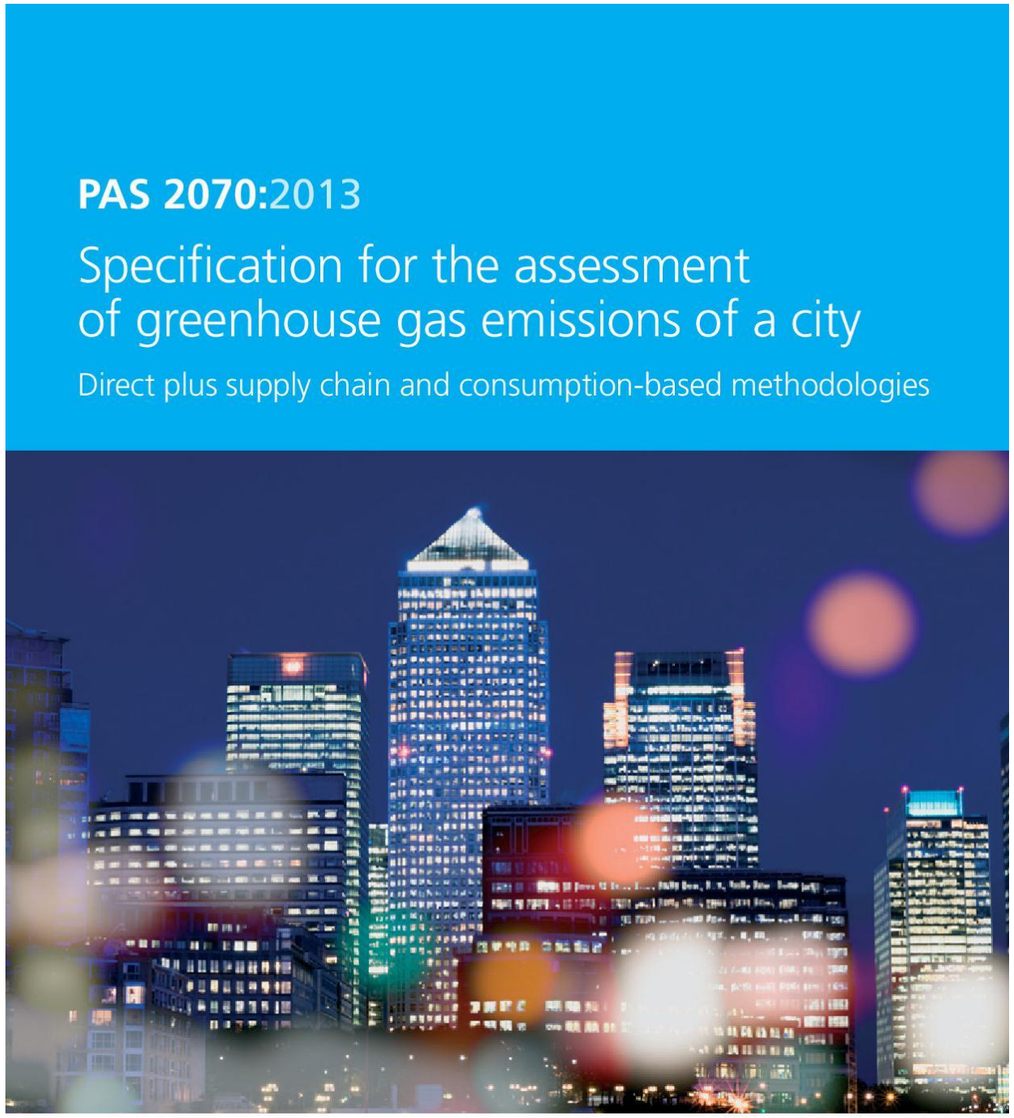
PAS2070 lays out two possible methodologies for greenhouse gas accounting:

- Direct Plus Supply Chain methodology (DPSC). This is consistent with the GHG Protocol for Cities with its three scopes, as laid out previously.
- Consumption-based methodology. This includes direct and whole life-cycle emissions from goods and services consumed within the city and deducts the emissions from goods and services that are produced in the city but exported for consumption elsewhere.

PAS2070 builds on the GHG Protocol for Cities (GPC, as above) to include a **wider range of emissions sources**. It includes **six greenhouse gases**: $CO_2$, methane, $N_2O$ and three F-gases. These are the original six gases named in the first version of the Kyoto Protocol, before a further F-gas ($NF_3$) was added later. The inventory should be set according to the city boundary (typically geopolitical) and are accounted for on a one-year timescale.

Just like the GHG Protocol for Cities, 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, the payments should be **accounted for separately**.

PAS2070 was produced by a coalition of 15 entities (including Bioregional along with major urban climate networks, universities and infrastructure specialists) and sponsored by the Greater London Authority. It was then applied to London as a case study[xviii]. Its aim is to provide a robust and transparent method for consistent, comparable, and relevant GHG inventories for cities or urban areas. This is intended to inform benchmarking and decision-making by the city about carbon reduction actions, changes to urban economies to become less carbon-dependent and creating more resource-efficient supply chains.



### 2.4.3 The Tyndall Centre – city-scale budgeted trajectories to zero carbon dioxide emissions

The Tyndall Centre is a climate change research organisation made up of several UK universities working to get climate science evidence into policy[xix]. It created a tool[xx] that produces municipal-level carbon budgets towards a 1.5˚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 look at the **UK's total $CO_2$ budget to 2050** if the UK is to pull its weight towards a relatively safe global climate pathway considering the equity principle of the Paris Agreement[5]. This is calculated starting with a middle-range global carbon budget for a **pathway to limiting global climate change "well below" a 2˚C** , determined by the IPCC[xxi]. The UK's $CO_2$ budget is then derived from this global budget based on equity principles that account for our existing level of development and sectoral base, compared to other countries which have a more pressing need to develop their economies and infrastructure (and are less responsible for historical emissions than the UK is)[xxii]. The resulting totals are split into five-yearly budgets.  Figure 6 illustrates the size of the budgets for Greater Cambridgeshire.

This methodology **only covers $CO_2$ occuring due to energy use** (whether in transport, buildings, agriculture or other industries). It does not cover the other six greenhouse gases, or releases of $CO_2$ from non-energy-use sources such as waste. Other gases are left out because "a cumulative emission budget approach is not appropriate for all non-$CO_2$ greenhouse gases, as [they have] … differing atmospheric lifetimes and warming effects", with more uncertainties around them. However, it follows the IPCC's assumption that other GHG emissions will also undergo significant reductions.

The methodology **assumes that global forest levels do not change** between 2020-2100, assuming afforestation in certain areas of the world 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 non-$CO_2$ emissions that are unavoidable, such as methane from agriculture. Local authorities would need a separate estimation for these other gases (for example using SCATTER tool, as per next section). Tyndall also declines to assume that carbon capture and storage technologies appear in future, as this would risk over-estimating the budget. **Offsetting is not part of the budget**, because it is designed to reveal the actual $CO_2$ reductions necessary within the UK as part of the global picture, thereby avoiding double-counting global GHG removals.

**Tyndall Centre's trajectory tool excludes certain heavy-emitting sectors from the local authority carbon budgets**. Cement process emissions are assumed to be an unavoidable necessity, so room is made for them before the local budget is set: the world's cement process emissions are deducted from the global carbon budget before the budget for the UK and its local areas are allocated. This deduction is based on a very optimistic view of how the cement industry might decarbonise[xxiii], so all producers and consumers of cement would still need to pursue efficiencies of resources and carbon in order to maintain the global budget. Aviation and shipping are also omitted, and instead dealt with as a 'national overhead' with an assumption that aviation emissions will decline from 2030 and fully decarbonise by 2075[xxiv]. If this condition is not met, then local budgets would be even smaller.

In summary, the Tyndall Centre local carbon budget tool **reveals the extreme pace and scale** of the necessary **science-based, fairly-allocated**, actual carbon emissions reductions required from energy-using activities that can be **directly locally influenced**, their progress tracked, **without relying on offsets** or unproven future carbon removal technologies.

[5] The equity principle acknowledges that richer countries have more responsibility and capability.

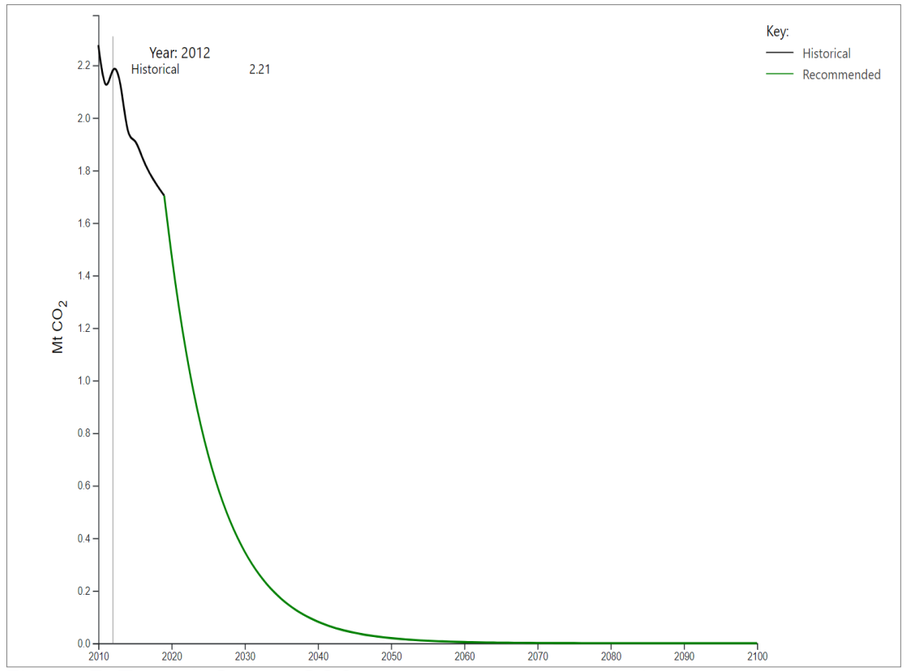



Figure 7: Tyndall Centre CO2-only, energy-only emissions reduction for Greater Cambridge (Cambridge + South Cambridgeshire) to stay within a sub-2˚C climate pathway with a fair share of global emissions based on equity principles of the international Paris Agreement.

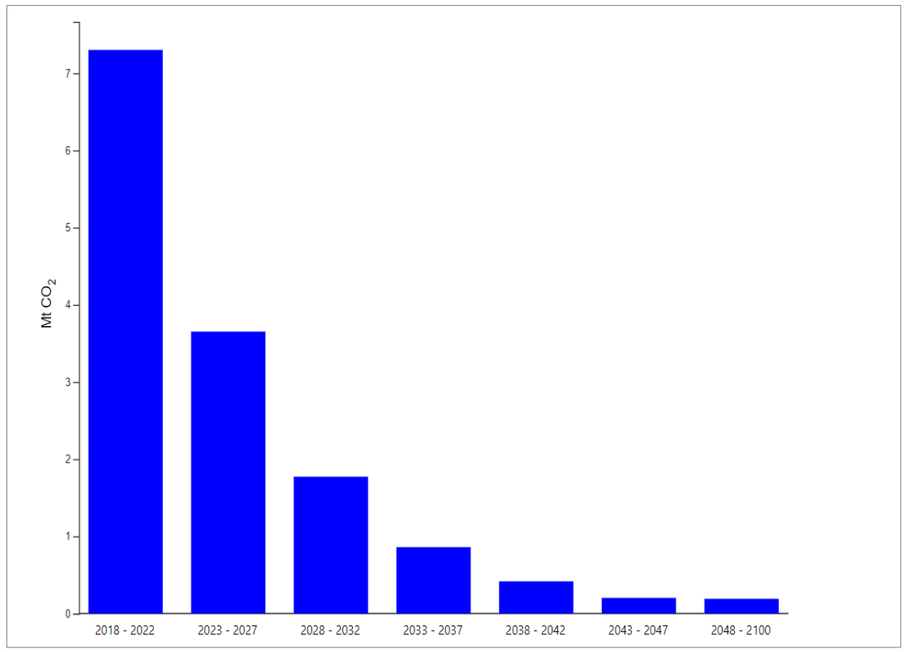



Figure 8: Tyndall Centre 5-yearly budgets for $CO_2$-only, energy-only emissions for Greater Cambridgeshire

### 2.4.4 SCATTER Cities

SCATTER Cities[xxv] is a tool that creates GHG inventories at the scale of the local authority area. It was developed by a collaboration of experts from government departments, academia, local authorities and private sector. Its name stands for 'Setting City Area Targets and Trajectories for Emissions Reduction'. It can be used to report to other GHG inventory frameworks such as the Global Covenant of Mayors Common Reporting Framework, the GHG Protocol for Cities and CDP (Climate Disclosure Project). The energy component of this tool is built on the work of the Tyndall centre as described previously, so these are compatible.

**SCATTER accounts for three gases that together represent 96%** of the UK's current greenhouse gas emissions in terms of global warming impact: carbon dioxide, methane and nitrogen dioxide.

The **missing 4% is the F-gases**, whose global warming impact per kilogram is very high but their emissions are very small and are thought to have decreased since 1990[xxvi]. F-gases are used for refrigeration, aerosols, heat pumps, high-voltage electronics (including some wind turbines and electricity grid equipment[xxvii]), and foamed plastics. As heating and transport **transition to electricity, F-gases therefore may grow to represent a larger proportion** of the UK's climate impact unless alternative substances or systems are developed[xxviii]. Still, the UK's F-gas emissions are predicted to shrink drastically to at least 2030, with regulation[xxix].

**SCATTER includes all sectors and most sources across all three 'scopes'**, including aviation, land use, waterborne navigation, waste and railways as well as residential buildings, industrial processes/product use, and roads. Under scope 3, SCATTER looks at emissions that are caused by energy production and transmission, and aviation. **It does not include embodied carbon in construction materials** or other goods produced outside the city.

In land use, SCATTER can account for both emissions and removals. Livestock is a separate category. Solid waste and wastewater are each covered separately. External offsets are not part of the assessment. Aviation emissions are in two parts:

- Landing and take-off from airports present in the study area (scope 1)
- Cruising-altitude aircraft emissions, allocated based on population size (scope 3).

Waterborne emissions are calculated based on the presence of ports and canals, with inland emissions allocated to the study area based on how many km of canals are present (so, a city could only reduce its canal emissions to zero in SCATTER by getting rid of all its canals).

**SCATTER therefore provides a useful tool that is compatible with cutting-edge carbon budgets in line with the UK's international legal commitments**, recognises land use emissions and removals, and lines up with most international GHG reporting protocols. In order for Greater Cambridge to use SCATTER to set and track progress towards a net zero target within its own means, it might therefore be useful to:

- **Consider whether to include aviation and waterborne transport** in the scope of the net zero target, as these are not influenceable by the planning service – if included, these would need to be offset by removals within Greater Cambridge.
- **Separately calculate the F-gases emissions**, in order to keep sight of the full picture of a transition from fossil fuels to electrical heat and transport. .

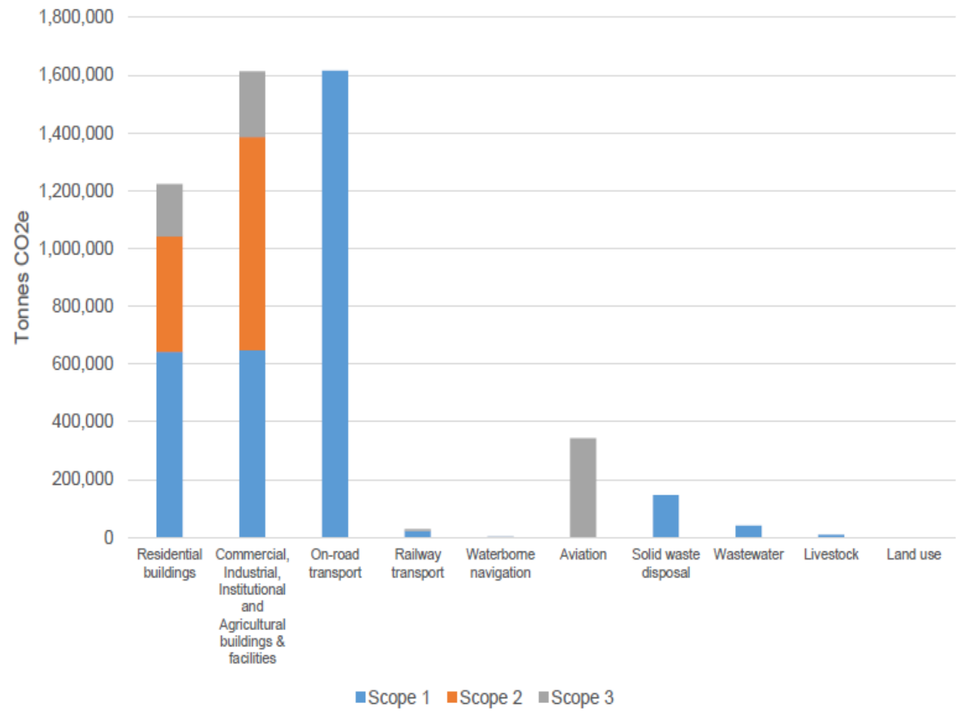



Figure 9: County of Cambridgeshire emissions inventory as generated by SCATTER Cities tool

### 2.4.5 CUSPE (Cambridge University Science and Policy Exchange)

CUSPE is an annual research programme that aims to provide evidence-based recommendations for county policy. In 2019 it produced a GHG inventory (and scenarios for net zero by 2050) for Cambridgeshire[xxx], now part of the County Council's evidence base. It includes most emissions sources and removals under scopes 1 and 2, by sectors: domestic buildings, transport, agriculture, commercial services and industry, afforestation (using the Woodland Carbon Code) and waste. It excludes rail travel in future scenarios (as this is an insignificant source) and peatlands (as these were not part of national inventories in 2019). The baseline inventory is broken down by district for each sector except waste and afforestation, so further analysis would be needed if this method were to be scaled down for Greater Cambridge. It is not clear whether CUSPE intends to update its analysis in future years.

**The GHGs included in the scope are $CO_2$, methane, nitrous oxide, and one of the four F-gases**. CUSPE's baseline is built on combining various data sets. The analysis starts with $CO_2$-only data sets produced by the UK government about local authority areas, and then builds customised assumptions to scale-down other national-level GHG inventory and industry data to make estimates about Cambridgeshire's non-$CO_2$ greenhouse gas emissions, to reflect the county's economic activities and land use. Three future scenarios are then built on national data projections for each sector, plus existing future scenarios analysis from the Committee on Climate Change.

**The figure for F-gas is a proxy**, representing only the HFC emissions declared by one major food producer which CUSPE assumes to be the county's main user of refrigerant gas. CUSPE finds this more realistic than scaling down the national F-gas emissions by population, because the county does not have much heavy industry (where F-gases are often used[xxxi]). It argues that other F-gas sources are likely to be negligible as a proportion of total emissions. In the future scenarios, F-gas emissions are assumed to remain static. This means it **does not take account of possible increased use of F-gases which may occur** as buildings move to electrical heating and cooling (heat pumps), and as the electricity grid is upgraded and moved to renewables (wind turbines, high voltage switches).

**CUSPE adds a clear caveat that peatlands would add 65 -90% to Cambridgeshire's overall emissions** if considered as part of the county's local territorial inventory. Cambridgeshire contains a large portion of the nation's 'wasted' peatlands, heavily degraded as a result of drainage and use for agriculture. This makes them a net emitter of GHGs, but with restoration they could once again become a net remover of GHGs. However, CUSPE observes that because peatland is such an enormous emitter that could become a carbon sink of national importance, it is "inconceivable it could be tackled [in Cambridgeshire] without intervention from national government". This means the burden should not rest solely on the local authority in whose area they lie – although local authorities clearly have an important role to play. CUSPE highlights that **peatlands** should be a key consideration for local authority **land use policies and research initiatives even if they are not part of the net zero target scope**.

**CUSPE's analysis excludes scope 3**, presumably because it is focused to support policymaking that will apply within the boundaries of Cambridgeshire. This means it does not consider shipping or aviation (as there is very little within the county) or the embodied carbon of goods and materials brought into the county. A separate calculation compares the embodied carbon of electric vehicles to that of conventional ones, which is not part of the overall inventory but is used to show that the embodied carbon of electric vehicles does not negate the benefit. Because scope 3 is excluded, this means that no external offsets are considered – only GHG removals achieved locally.

**Development of unproven future technologies plays a significant role** in CUSPE's most ambitious carbon reduction scenarios. This includes hydrogen as part of the solution for buildings and transport, and carbon capture and storage for the waste and industry sectors (including as part of biofuel use in power generation).

**CUSPE also considers the potential to achieve GHG removals by planting new woodland**. To do this, it uses the Woodland Carbon Code and estimates that afforestation could deliver carbon removals at a cost of £15-50 per tonne.  It emphasises that the key metric is total removals between now and 2050, not just annual removals.

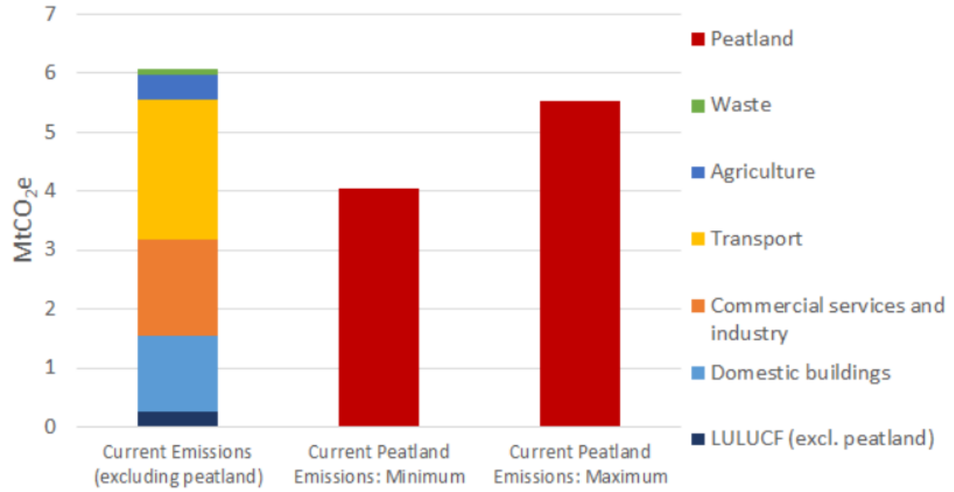



Figure 10: Range of possible peatland emissions for Cambridgeshire, compared to the rest of Cambridgeshire's greenhouse gas inventory for scale. Credit: CUSPE (2019).

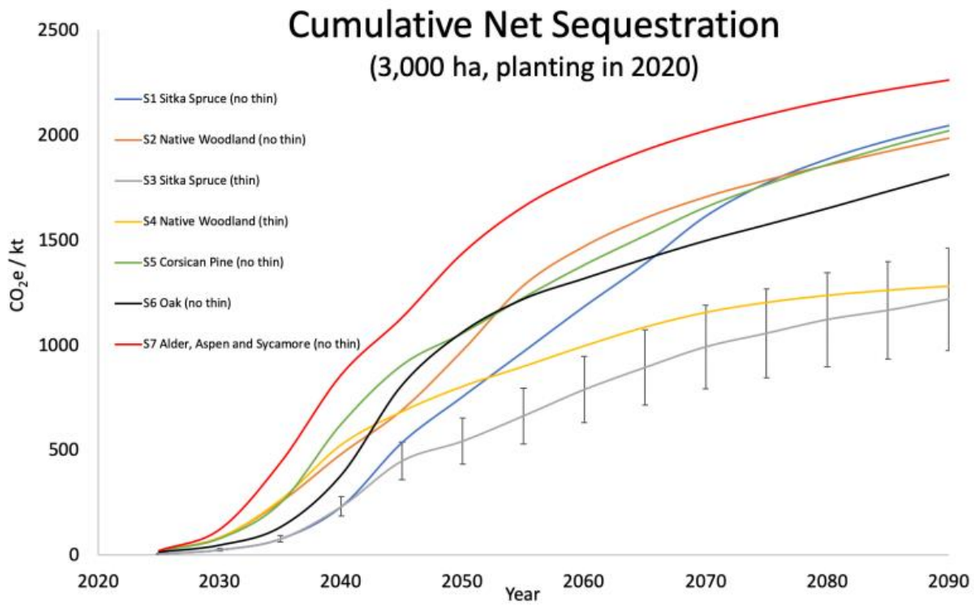



Figure 11: Comparing the total amount of greenhouse gas that could be captured over time by different woodland planting mixes on 1% of Cambridgeshire's total land. Credit: CUSPE (2019) using data from Woodland Carbon Code.

## 2.5 Carbon accounting at the scale of the development plot

**Building Regulations Part L** and the accompanying Standard Assessment Procedure (SAP) are the current legislated means (National Calculation Methodology) to estimate and regulate homes' energy use and carbon emissions. SAP estimates the proposed building's energy efficiency and carbon emissions based on features such as the insulating value of materials, and heating system efficiency. Part L sets the standards that must be achieved, which are in relation to a theoretical building of the same size and shape as the proposed building, rather than universal targets. This means there is no incentive to design the built form to minimise heat loss. It also looks only at the fixed energy-using features (heat, fixed lighting, ventilation,). It does not address the impacts of plug-in appliances, nor embodied carbon, nor the well-documented 'performance gap' between estimated energy use and actual energy use (up to 150% more[xxxii]).

This means that **other methods are needed to define, design and deliver buildings that actually operate with net zero emissions**[xxxiii]. More comprehensive definitions of zero-carbon buildings have been produced by various experts including the London Energy Transformation Initiative (**LETI**), the Royal Institution of British Architects (**RIBA**) and the UK Green Building Council (**UKGBC**). All these experts stress the need to drastically minimise the total energy demand of buildings, and then add renewable energy supply. Most recommend monitoring the building's performance in-use, and some address buildings' embodied carbon too.

There is debate about whether it is reasonable to hold developers accountable for carbon impacts of using plug-in appliances. However, to omit this from policy would miss an opportunity to drive forward the mass deployment of on-site renewable generation that is necessary for the national net zero transition (and reduces the total land demand, as renewables would otherwise have to be built elsewhere).

**Passivhaus Planning Package (PHPP) is widely accepted as a reliable method** to predict and verify energy use. It uses detailed physics models and occupancy data to predict total operational energy use [xxxiv]. Passivhaus buildings must meet a strict limit on the demand for space heating per unit of floor space, and total energy use intensity (**EUI**). More advanced Passivhaus certification levels have tighter EUI limits, and additional renewables.

Another relatively realistic method to model and improve the real performance of buildings is **TM54 guidance**[xxxv] from the **Chartered Institution of Building Services Engineers (CIBSE)**. Other building thermal modelling tools may offer further options to realistically model a building's energy use taking into account orientation, glazing, form, fabric, heating/ventilation technology and future climate. The energy performance gap can also be addressed using methods to quality-assure construction, such as **BEPIT**[xxxvi] which involves a set of checks in construction to avoid the typical errors that harm energy performance. Similarly, the Passivhaus certification process[xxxvii] also has verifications during construction to ensure it is built as designed.

**Drawing on all of the above, an industry consensus on *operational* net zero carbon buildings** has been released by a coalition of industry-leading green building experts, architects and surveyors fronted by **the London Energy Transformation Initiative (LETI)**[xxxviii]. This definition rests on a building achieving a zero carbon 'balance' in its energy exchanges to and from the grid during the year. LETI emphasises that the essential first step is to make the building extremely energy efficient, before adding renewable energy and low carbon heat. This refers to total energy use, including plug-in devices. Total energy use intensity limits are stated, similar to those in RIBA 2030 Climate Challenge[xxxix] which were set according to feasibility findings from the Green Construction Board[xl] and validated in consultation with UK construction bodies.

This takes into account the fact that buildings need to get much more energy efficient in order to make it feasible to shift all buildings and transport to fully renewable energy. The LETI guidance notes that, by 2025, this will need all new buildings to be designed to achieve net zero carbon for all operational energy.

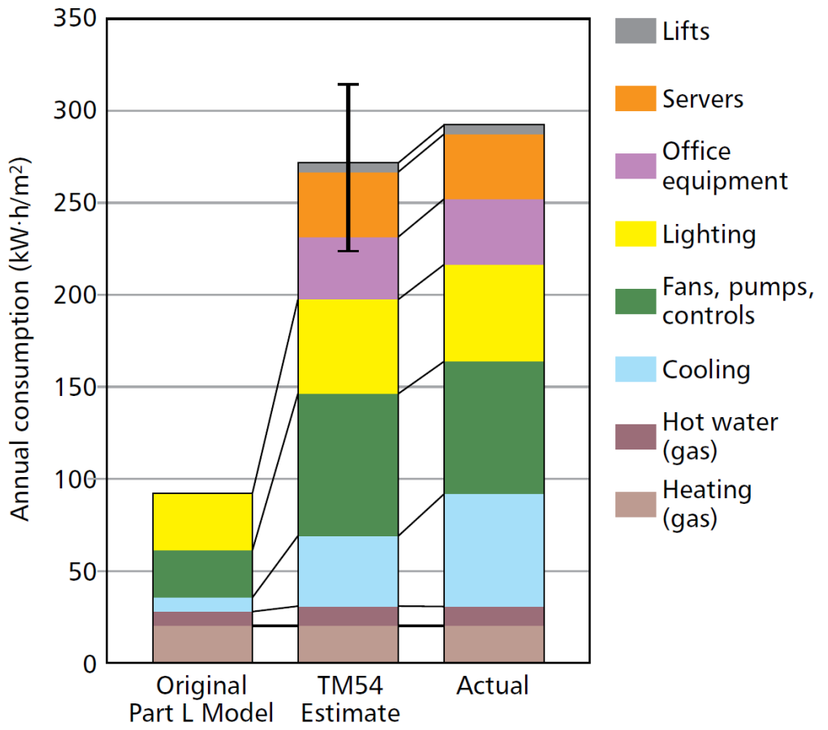



Figure 12: Case study by CIBSE of the difference between an office building's energy use as calculated by current Building Reglations Part L (SAP), versus energy use calculated by CIBSE's TM54 method, versus the building's actual energy use. Credit: CIBSE, 2015.

Bioregional Etude

| Energy use and renewables requirements in various carbon reduction frameworks | Framework |
|---|---|
| **15 kWh / m²/ year** space heating demand<br><br>For homes, total primary energy demand per internal $m^2$ per year is limited to:<br>• **60kWh** (Classic)<br>• **45kWh** (Plus)<br>• **30kWh** (Premium).<br><br>Other buildings have different limits on primary energy demand, for example schools (120kWh).<br><br>Renewable energy generation per $m^2$ of building footprint per year must be at least:<br>• **60kWh** (Plus)<br>• **120kWh** (Premium). | Passivhaus |
| **15kWh / m2 / year** for space heating.<br><br>Total energy demand limited to:<br>• **35 kWh / m2 / year** (homes)<br>• **65 kWh / m2 / year** (schools)<br>• **70 kWh / m2 / year** (commercial)<br><br>All energy must be renewable, (preferably on-site; or 15-year power purchase agreement). | LETI net zero operational carbon |
| Total energy demand limited to:<br><br>**<35 kWh / m2 / year** (homes, 2030)<br>**<55 kWh / m2 / year** (non-domestic, 2030)<br>Intermediate targets are also available for 2025. | RIBA 2030 Climate Challenge |
| Two tracks for zero carbon: construction and operation. Operational energy use must be minimised before renewables are added, and the rest offset. Targets are yet to be developed, but UKGBC collaborated on LETI's definition. | UKGBC framework definition for zero carbon buildings |

**For embodied carbon**, LETI urges that it should be calculated and reported, and offers a separate piece of guidance[xli] containing some 'best practice' target metrics for $CO_2$ per square metre of floor space for different building types, increasing in ambition over time. These are for $CO_2$ emitted from material production through to finished construction, and do not include maintenance, replacement or end of life. The targets are given at two levels: with or without the carbon sequestered by the material (such as carbon absorbed by trees locked up in timber). Sequestration can only be claimed for timber sourced from sustainable forestry (where felled trees are replaced with new ones so that overall sequestration rates are maintained).

**Passivhaus excludes embodied carbon** from its 2019 assessment of zero-carbon buildings. It notes that this is a significant issue, but that there is not yet a mature method to weigh-up trade-offs between embodied carbon in fabric (such as insulation), plant equipment (such as the size of heat pump), and operational $CO_2$[xlii]. It advises that this should not be part of the definition of 'zero-carbon buildings' until methods are mature.

**UKGBC** offers a 'framework definition' for net zero-carbon buildings[xliii], with two scopes: one for embodied carbon, and one for operational carbon. UKGBC highlights that embodied carbon can be 50% of a new building's whole-life carbon footprint (see figure, right). Net zero carbon in the embodied scope is defined as: "When the amount of carbon emissions 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". This assessment should use the method set by the Royal Institute of Chartered Surveyors (RICS)[xliv]. It stops at the completion stage because the lack of data available for the in-use and end of life stages. Offsetting should be via a 'recognised' scheme. The Gold Standard and Clean Development Mechanism are suggested.

**The RIBA 2030 Climate Challenge suggests embodied carbon targets as well as operational energy targets.** This looks at the 'whole life' carbon of the materials, which covers all stages from cradle to grave (material production through to transport, construction, maintenance and end of life).

**There can be a trade-off between upfront (embodied) carbon emissions, and operational carbon emissions**. Cement and concrete, which are carbon-intensive in production, can play a role in improving the thermal dynamics of the building over its lifespan. This can support passive heating approaches by absorbing heat during warm periods and releasing it during cold ones.  If a building will have a very long lifespan, it may justify investment in thermal mass to save operational carbon in the long run.

Using a whole-life embodied carbon assessment gives a full picture of long-term impact. However, the standard methodology[6] assumes that all carbon contained in the material is released at end of life – which may not reflect reality. This obscures the fact that timber locks up carbon sequestered by the tree while intact, and may be reused. Alternatively, assessing **embodied carbon only from cradle to construction (as in the LETI and UKGBC guidance)** may highlight the carbon storage of timber in the first few decades of the building's life – arguably a crucial stage for the world's climate pathway, given the risk of reaching 'tipping points'[xlv].

**Finally, no current zero-carbon buildings framework holds developments directly accountable for the transport emissions that they will induce** in the lifestyles of their occupants due to location, nearby infrastructure and how the building design supports different transport choices (e.g. parking, bike storage, electric vehicle charging). This is therefore outside the scope of the individual development's zero carbon status. However, the government announced in 2019 that it may mandate electric car charging in new builds and possibly also some existing buildings (via the consultation on updates to building regulations[xlvi]). Until electric cars become the majority, the biggest factor shaping transport GHGs induced by a new development will be the location chosen – including walkability to public transport, key services and employment – and perhaps the deployment of high-quality continuous cycle networks.

[6] European standard EN15978.

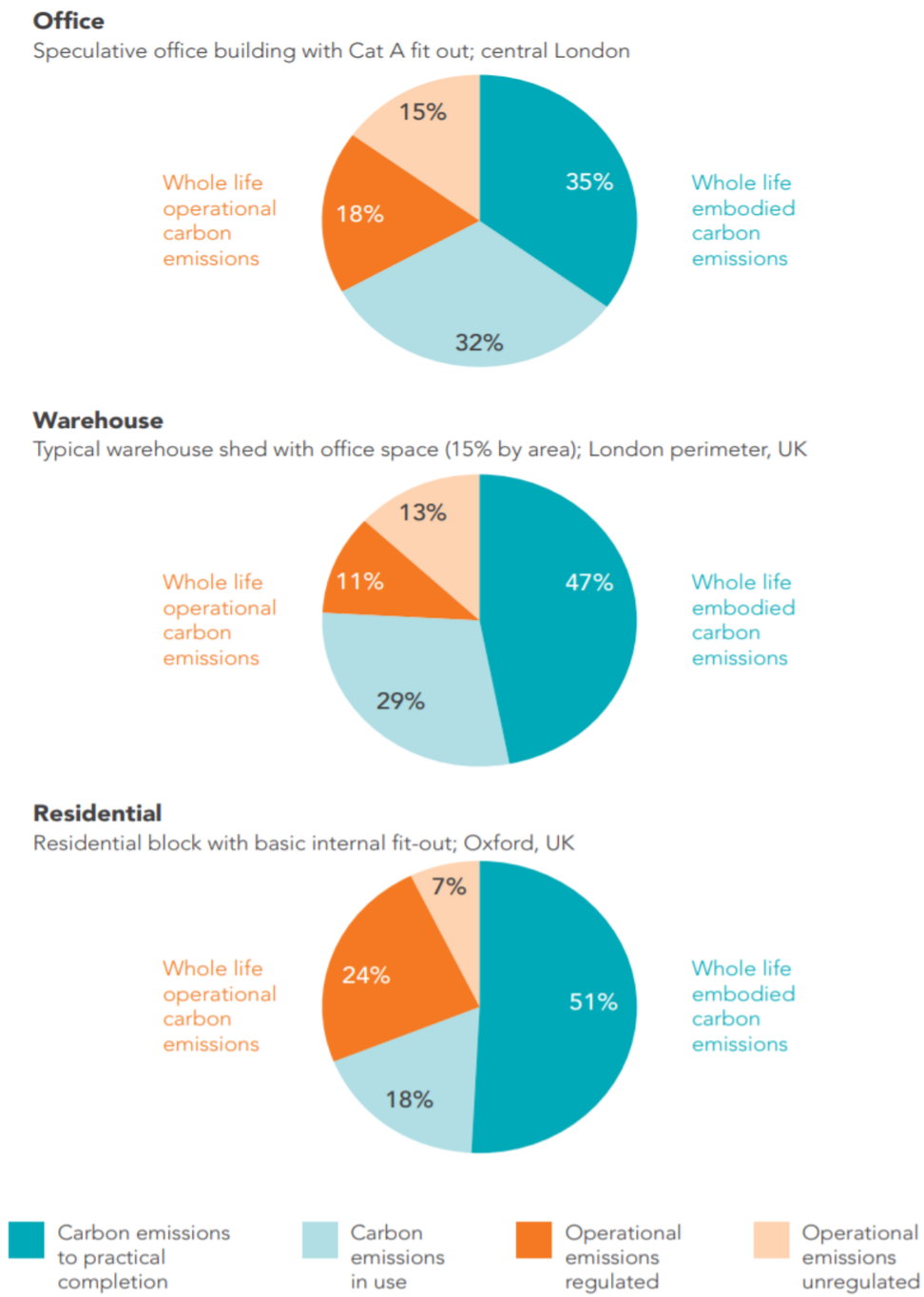



Figure 13: Breakdown of buildings' whole-life carbon emissions. Credit: RICS + Sturgis Carbon Profiling, cited in UKGBC (ibid) (2019).

## 3. What the local plan can and cannot do

Greater Cambridge's emissions come from a variety of sectors and activities. The local plan can influence many of these to a varying extent, but not to the full extent that would ensure a transition to net zero carbon across the whole plan area.

The local plan's influence is largely over new buildings and shaping patterns of living and working that help reduce road traffic. The key leverage points are new development and changes of use – the activities that require planning permission.

The planning system has less influence over other sectors such as agriculture and land use, unless there is new construction or a change of use.

There is also a subset of each of these sectors where planning's influence is more subtle. An example is existing buildings, where the local plan cannot drive the change itself, but can create a permissive policy environment in which the carbon reducing actions are more likely to happen (such as energy efficiency retrofitting, or wider deployment of renewables).

This section will explore the following issues:

- Where does a local plan's legal duty to address climate change come from, and to what extent is this duty expected to drive change when weighed against other concerns?
- What kind of carbon reducing actions can the local plan drive in each sector? (new buildings; existing buildings; renewables; transport; land use)
- What kind of planning tools or mechanisms might be used to drive these actions?
- How can the definition of net zero carbon be adjusted to reflect the available that the local plan can exert, to ensure the definition is relevant for use?

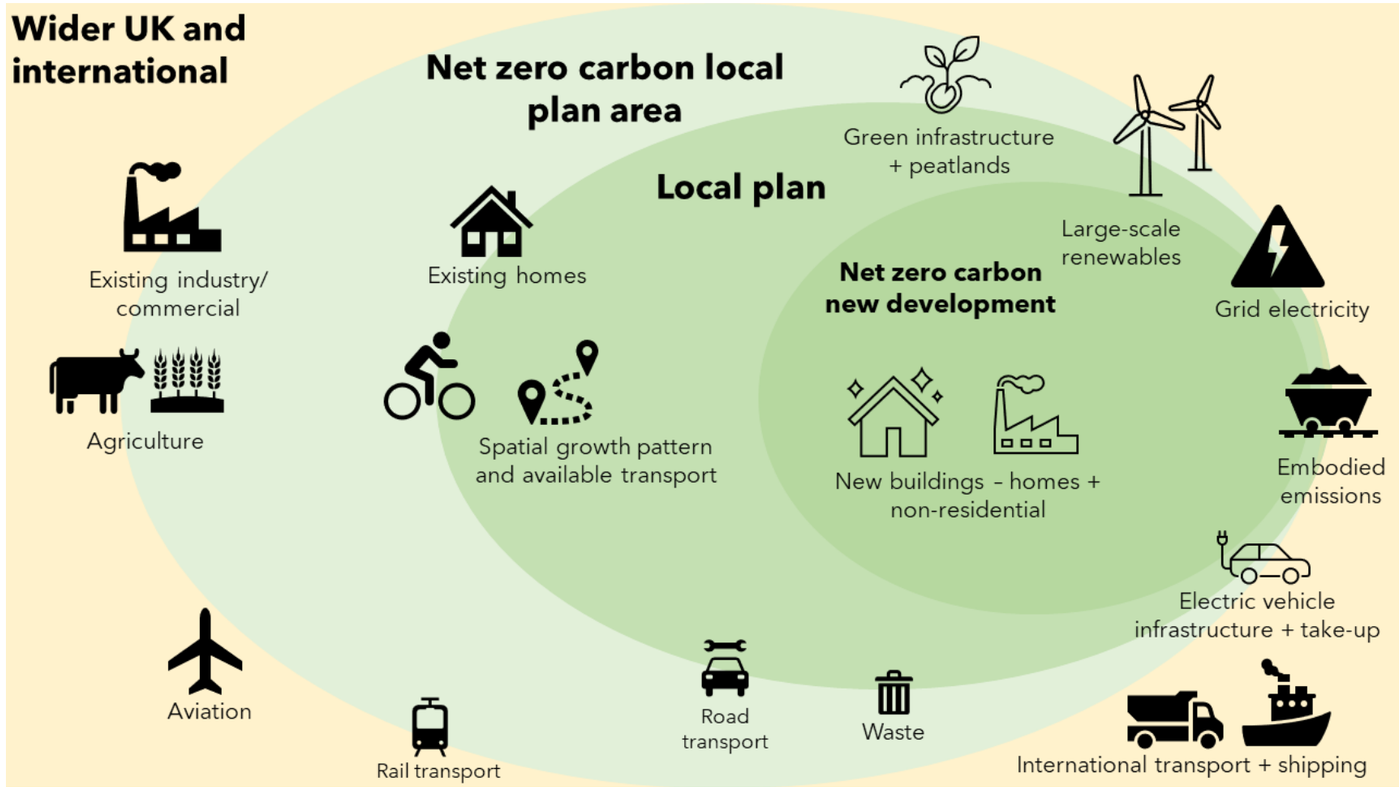



Figure 14: Graphic illustrating how the emissions of each sector are influenced by local policy, local activities, and wider national or international policy and regulation. Credit: Bioregional. For larger version, see executive summary.

Bioregional Etude

### 3.1 The mandate to address climate change in national policy

A local plan's obligation to achieve carbon reductions flows mainly from the following pieces of legislation and national guidance:

- Planning and Compulsory Purchase Act 2004[xlvii]
  - This requires the local plan to ensure that development and use of land contribute to mitigation of climate change
- Climate Change Act 2008 (2019 update)
  - Which sets the national net zero goal
- Planning and Energy Act 2008[xlviii]
  - This permits local plans to set high standards for energy efficiency and renewables in new buildings
- National Planning Policy Framework (2019 update)[xlix].
- National Planning Practice Guidance (NPPG).

Planning and legal expert bodies, the Town and Country Planning Authority (TCPA), the Royal Town Planning Institute (RTPI) and ClientEarth, have together produced guidance on the powers and obligations of local planning to mitigate and adapt to climate change taking into account all of the above sources. This guide[l] stresses that the local plan **must** mitigate climate change, an obligation in the **Planning and Compulsory Purchase Act 2004**.

The **National Planning Policy Framework (2019)** highlights that one of the three objectives of the planning system includes "mitigating and adapting to climate change, including moving to a low carbon economy"[li]. Later[lii], it confirms that the planning system should "shape places in ways that contribute to **radical reductions in greenhouse gas emissions**" and "take a proactive approach" to combat climate change **in line with the Climate Change Act 2008**. New development should be planned to reduce GHG emissions, including through location, orientation and design[liii]. The National Planning Practice Guidance echoes this.

The NPPG section on climate notes that both design and location of new development (for sustainable transport) are appropriate carbon reduction measures in local planning, as is deployment of renewable energy. Local design requirements must be evidence-based and consider viability – but as of 2018, guidance on **viability** has been rebalanced so that the price paid for land no longer justifies failing to comply with local plan policies[liv].

The TCPA/RTPI/ClientEarth guide also notes that if a local plan policy is challenged by objectors or inspectors (for example due to viability), the challenger must clarify how the plan would comply with the legal duty to mitigate climate change without that policy.

The UK's national commitment to the carbon reductions in the **Paris Agreement 2015** (and subsequent **legislation for a net zero-carbon UK by 2050 via the Climate Change Act** 2008, 2019 update) are beginning to make their effects felt in planning[lv]. A key example is the **2020 Heathrow Airport decision** by the Court of Appeal to reject the expansion of airport on the grounds that the **government had failed to take into account the Paris Agreement climate commitments**. Planning experts note that while this precedent mostly applies to major national infrastructure like road and gas projects – many of which are now being challenged on similar grounds – it also gives objectors a strong basis to oppose a local plan or decision on the basis of climate[lvi]. The decision shows that the UK's legally binding climate change commitments should now be taken very seriously within the planning system and may be able to override certain other government planning practice guidance, if there is a conflict. This case consequently had a hearing at the Supreme Court, with a decision due in January 2021. It was notable that the UK Government chose not to seek permission to pursue this appeal, hence it is being pursued solely by the corporate entity Heathrow Airport Ltd[lvii].

# Heathrow third runway ruled illegal over climate change

**Appeal court says decision to give go-ahead not consistent with Paris agreement**


Guardian headline, 27th Feb 2020

Bioregional Etude

### 3.1.b The tools to address climate change in local planning

In addition to the local plan itself, the local planning authority can prepare supporting items that clarify or otherwise help deliver the outcomes that the local plan aims towards. This page provides a brief overview of examples that are relevant to the purpose of a transition to net zero carbon.

- Local plan: the sum of development plan documents[lviii] which are used to make decisions on planning applications. This explains the vision and rationale for the desired outcomes for the local area (including obligatory outcomes such as providing a 5-year land supply and housing delivery, as well as locally-specific outcomes such as sectoral economic growth or conservation of natural and historic environment). For this purpose, it sets out what kind of development can happen within the local area, where it can happen, the scale of development, and the qualities the development is expected to have. It includes:
    - Core strategy: the overall rationale, vision, objectives and strategic policies to achieve this
    - Non-strategic policies: setting out the more detailed and specific requirements for new development, such as water consumption limits, building heights or heritage considerations
    - Area action plans and site-specific allocations– relating to specific smaller areas within the local plan area (this could be strategic or non-strategic depending on scale and importance)
    - Supporting text: providing the rationale for the policies.

  Carbon reductions can be part of all of the above, with a transition to net zero carbon being one of the strategic objectives / policies.

- Infrastructure delivery plan: the means by which infrastructure needs are identified and planned for[lix], which generally includes identifying delivery levers and funding sources to bring them forward. This can apply to just the local plan area or it can be prepared in coordination between local authorities at multiple scales. ‘Infrastructure’ includes not only networks like energy grids and transport, but also community infrastructure such as schools and healthcare facilities, and green infrastructure.

- Green infrastructure strategy: identifying the type, quantity, quality and/or location of natural or seminatural features that are needed to provide certain services for people or wildlife within the local area.

- Developer Contributions Schedule: document setting out the charges to be made to developers via Section 106 Agreements and/or Community Infrastructure Levy (CIL) relating to the local infrastructure or other council actions that will be required as a result of the new development. This will generally refer to the infrastructure delivery plan which will have identified other funding sources before imposing CIL.

- Supplementary planning documents: Wider guidance for developers on how to comply with policies in the local plan. For example, design codes or design guidance on sustainable construction.

- Local development order: A legal tool used by local government to achieve specific identified objectives in the local plan by permitting certain types of development that would otherwise need to go through the planning permission process. See section 3.11.

### 3.2 Requirements for new buildings' carbon and energy performance

#### 3.2.1 Is there a limit to how high can we raise the bar?

Even for new buildings, there is ongoing debate about the extent to which local plans can legally require significant reductions to energy and carbon. A series of conflicting messages from Government over recent years has failed to provide clarity about the relative weight of climate versus other planning imperatives such as viability or housing delivery targets.

The Planning and Energy Act (2008)[lx] empowers local plans to set "reasonable requirements" for new builds to:

- comply with '**energy efficiency standards that exceed** … **building regulations**'[7],
- supply a **proportion of their energy from nearby renewable or low carbon** sources.

There is no obvious guidance on what is deemed 'reasonable'. An 'energy efficiency standard' is defined as one that is referred to or endorsed in regulations, policies or guidance from the Secretary of State. This could mean that the higher standard must still use the same calculation and metrics as building regulations – that is, kWh of energy used on permanent equipment per square metre per year, and the resulting carbon emissions depending on the heating system and size of the building. Also, the plan policies must not be inconsistent with relevant national policies on energy efficiency, low carbon energy and renewables.

A 2015 ministerial statement[lxi] said that local authorities should not set additional 'technical standards' for homes. This was to be applied after updates to the Planning and Energy Act, which have consequently still not happened. The national Code for Sustainable Homes (CfSH) would have required zero-carbon new homes from 2016, but was revoked in 2015.

In 2018, the government made a statement on the revised **National Planning Policy Framework**: "the [NPPF] does not prevent local authorities from using their existing powers … to set higher ambition … **Local authorities are not restricted in their ability to require energy efficiency standards** … The Government [commits] to … the clean growth mission to halve the energy usage of new buildings by 2030."[lxii]

Contradicting this, the 2019 updated **National Planning Practice Guidance (NPPG)** states that for **homes**, local plans can only require energy efficiency up to the equivalent of **CfSH Level 4**[lxiii]. This would be only a **19% cut in regulated carbon emissions** compared to the current Building Regulations[8] (which is generally considered universally viable) and no improvement in carbon emissions from unregulated energy.

However, several local plans with a 35% or even 40% cut have successfully passed inspection between 2015-2020 and are in force. For non-residential new builds, the NPPG confirms that local authorities are not restricted in the energy standards they can require.

The UK Green Building Council[lxiv] urges local plans to at least require the 19% reduction, to be met solely via energy efficiency so that renewables cannot be used to mask poor fabric. It then urges local authorities to indicate an intent for net zero in new builds by 2030, including a space heat demand limit of 20kWh/m2 by 2025.

Also, there is **conflict between the ambiguous restriction on local plan powers, versus the more clearly stated government policy** around the **Paris Agreement** and **Climate Change Act legislation for a net zero carbon UK by 2050**. The Heathrow Airport ruling (as above) provides a precedent for how this may be tested in law. The Climate Change Act obliges the government to set policy that will enable the UK to meet its carbon budgets, a duty that is arguably failed if local planners are prevented from ensuring zero-carbon new builds[lxv].

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[7] This power may be lost, depending on ongoing updates to Building Regulations.
[8] This is already a planning requirement in Cambridge, as in many local planning areas

**Legislation, national guidance and legal decisions supporting ambitious local policy on carbon and energy policy from new buildings**

- Planning and Energy Act 2008
- National Planning Policy Framework
- Government 2018 statement about the National Planning Policy Framework
- **Several** existing adopted local plans (precedents)

Underlined indirectly by:

- Climate Change Act 2008 and carbon budgets
- Heathrow third runway rejection for failing to consider Paris Agreement on climate

**National guidance limiting locally specific carbon and energy policy for new homes**

- Ministerial statement in 2015 relating to legislative changes that have still not happened
- National Planning Practice Guidance: limit for homes is -19% on Part L of Building regulations
- Possible: white paper planning reforms 2020 – final version not yet decided or legislated

### 3.2.2. Going further – and existing policy attempts towards 'zero'-carbon homes

**Despite the aforementioned ministerial statement and NPPG, many local authorities have already adopted local plans that go above and beyond the supposed limit** of a 19% improvement on Part L. This leaves the path open for Greater Cambridge to do the same.

**Some local plans have already set a 'zero-carbon homes' policy.** This approach usually demands a 35-40% carbon reduction compared to the Building Regulations baseline, then charges the developer a fee per tonne of remaining GHGs that will be emitted over 30 years.

This offset payment is collected via Section 106 (S106) and ringfenced for actions elsewhere within the local plan area to reduce carbon, such as insulating existing homes, replacing boilers or adding solar panels to other buildings.

Some examples are provided here, including London and Reading. Both these plans have been through examination and Reading's has been adopted. Going even further, Oxford City Council has an adopted plan with 40% carbon reduction versus 2013 Building Regulations (or future equivalent), increasing to 50% from 31 March 2026[lxix].

By definition, this only addresses the 'regulated' portion of the building's energy use, leaving as much as 50% of the energy and carbon unaddressed (see illustrative graph to right). This would mean only an ~18% reduction in actual onsite emissions (before considering the performance gap as discussed in section 2.5). The 'offset' portion is not displayed as a certain reduction, because offset schemes are not always successful (see section 3.5).

Please note that the proportion of unregulated energy will vary based on a number of factors. The 50% ratio as illustrated in the graph shown here is indicative of the energy use patterns of highly thermally efficient new homes[lxx] but the proportion of unregulated energy can be either lower or higher in non-domestic buildings (ranging from 25% to 65%[lxxi]), or in less efficient homes where the regulated energy use is larger. With more people working and studying from home since COVID-19, the difference between homes and offices may blur.

**Precedent: Zero-carbon buildings definitions in local plans**

**In the emerging London Plan[lxvi], new major residential development must be net-zero carbon.** This starts with at least a 35% carbon reduction against building regulations 2013. An 'energy hierarchy' process must be followed, so that the demand for energy is reduced before clean heat and then renewable electricity are added to improve the carbon figure. Energy efficiency measures must make a 10% reduction in homes, or 15% in other buildings. After this, offsets must be paid into local carbon reduction funds at £95 per tonne of GHGs that will be caused by the building's regulated energy use for 30 years. Energy and carbon must also be monitored for the first five years to verify compliance and help set new benchmarks. This is part of London's overall road to net zero 2050[lxvii].

**In the adopted Reading local plan[lxviii],** all major new-build residential development must be zero-carbon. A separate SPD (supplementary planning document) is being produced to define this. The London definition (as above) is adopted in the interim. All non-major new-build housing must achieve at least a 19% reduction on Part L 2013 target emissions rate (TER). Major non-residential developments must achieve BREEAM 'Excellent' and minor ones must achieve BREAM 'Good'. The 'excellent' level requires some improvements in energy and carbon beyond national building regulations. If there is existing centralised energy provision present locally, new developments of 10+ dwellings (or ≥1,000m$^2$ non-residential) must connect to this network unless unfeasible. A development of 20+ dwellings (or 1,000m2 non-residential) must show how it has considered decentralised energy provision on site, unless unviable/unfeasible.

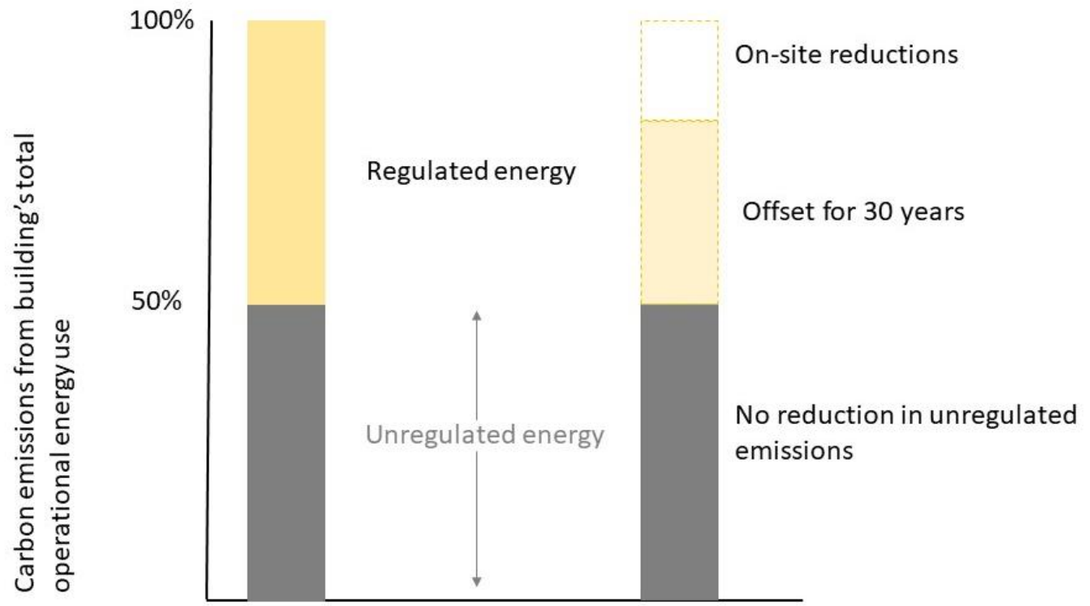



Figure 15: Illustration of a new building's total carbon emissions due to energy use (left), and the carbon reductions achieved by typical 'zero carbon buildings' plan policies as found in London, Reading, Milton Keynes and Oxford (right). Bioregional, 2020.

Bioregional Etude

### 3.2.3 Where next for building regulations, planning powers, and 'best practice' in calculating building energy and carbon performance?

Clearly, there has been significant ambiguity in government policy on this area for some time. This remains the case at present, as acknowledged by the government in the 2020 Future Homes Standard consultation . At the time of writing, the government is still analysing feedback. This included a direct question about whether or not the government should "restrict local planning authorities from setting higher energy efficiency standards for dwellings". Until the government responds, uncertainty remains.

Even if a local authority were to require a 100% reduction in carbon emissions against building regulations standards, it is widely acknowledged that a building's total emissions are not fully captured by the 'SAP' calculation used in building regulations[9]. As previously mentioned, a house designed using the current Part L/SAP to have 'zero' emissions might still emit more carbon than could be offset using solar panels on its own roof[lxxvi]. This shortfall in onsite space for renewables would loom even larger for the taller, denser urban building typologies that are needed to reduce transport carbon.

Additionally, the energy performance gap (as previously mentioned) can result in large differences between SAP-calculated emissions, and actual emissions – while the Passivhaus Planning Package is much more effective at accurately predicting emissions and ensuring a construction standard that performs as designed.

A total departure from the National Calculation Methodologies metrics (SAP) for energy performance might need to come as part of a national reform, but there is precedent for additional energy reporting requirements, for example the Greater London Authority's Energy Assessment Guidance 2018[lxxvii], that encourages the use of SAP 10 reporting (which is a future version of the existing SAP calculation methodology which will come into force next time Part L of the building regulations is officially revised). Until the Part L calculation methodology is amended to be suitable to deliver net zero-carbon buildings, taking into account a building's actual total energy use and making accurate predictions, **PHPP is the only identified alternative that can deliver net zero-carbon buildings given the urgency of the challenge and the 2020 commencement date of the local plan**.

**Precedent: policies to address the energy performance gap**

Various Local Authorities have set local plan policy to help new builds perform as designed:

- **Milton Keynes**[lxxii]: All proposals of 11+ dwellings or non-residential space over 1,000m$^2$ must "implement a recognised quality regime, which assures that 'as built' performance (energy use, carbon emissions, indoor air quality, and overheating risk) matches the calculated design performance of dwellings". They should also undertake post-construction testing and submit data to the council.
    - This is in addition to a 19% reduction on Building Regulations 2013 carbon emissions, and a further 20% reduction through renewables (onsite or a local network), compounding to a 35% reduction on building regulations carbon emissions. They must then pay to offset remaining emissions.
- **Newcastle**: "Development will be required to … Reduce its whole-life **$CO_2$** equivalent emissions impact"[lxxiii] (achieved partly through demonstrating that the performance gap between design and as-built is minimised[lxxiv]).
- **Brent, City of London and Enfield**[lxxv]: carbon offset payments (as part of the requirement to achieve net-zero carbon homes) must be recalculated at completion of the build, rather than solely during the planning application or detailed design.

[9] Building regulations only look at 'fixed' energy uses like permanent heating, lighting and ventilation. They do not capture plug-in devices installed by the user. Where monitoring has taken place, sometimes more than twice as much energy is actually used than was calculated during building design and energy statements submitted to planning. This 'energy performance gap' can have large impacts on emissions, as well as bills.

### 3.3 Mandating more renewables in new builds

In addition to energy efficiency, a transition to zero carbon will need a great deal of new renewable generation, grid capacity and storage. This applies to both electricity and heat. In the Spring Statement 2019, the government already indicated that new homes will not be permitted gas heating from 2025 onwards, in the emerging Future Homes Standard[lxxx].

As previously noted, the Planning and Energy Act 2008 allows local plans to require a 'reasonable' proportion of a new development's energy use to be met with renewable sources 'in the locality of the development'. The Planning Practice Guidance confirms this. Our review has not identified examples of the term 'reasonable' being legally tested.

To grow renewables, many plans use a 'Merton rule'. The original Merton Rule required a new build to include renewable electricity generation capacity sufficient to meet 10% of its own demand. In today's world this is arguably a low proportion, as renewables are now more efficient and affordable, and construction can now achieve higher energy efficiency. The most efficient new builds can produce more energy than they consume in the year [lxxxi].

It must be noted that in a high-rise or overshadowed building, there is proportionally less potential for renewable energy generation compared to in a low-rise building with a lot of clear roof space to capture solar energy or available land for ground-source heat pumps.

Local plans might therefore consider a Merton-style rule that is flexible to the form and function of development, in order not to discourage the urban densification that is also needed in order to prevent increased transport carbon emissions.

Modifications to a Merton rule might therefore include:

- A sliding scale of % demand to be met by renewables depending on density or use
- Specifying a certain kWh of renewable heat or electricity generation capacity that should be designed-in per $m^2$ of plot footprint[lxxxii]
- To allow high-density / high-rise developments to meet the renewables requirement through an Energy Services Company (ESCo) supplying appropriately certified renewable electricity, biogas or renewable heat – which could include heat networks.
- To specify the methodology with which total energy use should be predicted.

As a further option, Passivhaus Plus and Passivhaus Premium certifications require an amount of renewable energy generation capacity per square metre of plot area per year (60kWh and 120kWh respectively). At Premium level, which has a lower limit on primary energy use (30kWh/m2 internal area), a building up to 3 floors is likely to be a net exporter of zero-carbon energy. If connected to the grid, this would help to decarbonise the energy used in existing buildings.

Recent RTPI guidance[lxxxiii] suggests that plans should proactively encourage 'smart energy' features, such as smart meters, controls, and vehicle-to-grid EV links. This can support more use of green electricity by making sure it is used when and where it is generated, or stored.

Many local authorities already require new builds to connect to heat networks if they are present. These networks are often gas-fed, making them higher-carbon compared to today's most efficient on-site heat pumps. The network itself would need to switch to a zero-carbon compatible heat source (solar thermal; heat pumps) to meet the 2050 goal.

Another way that local planning authorities can advance the deployment of renewables is through Local Development Orders. See section below for more detail.

**Precedents for minimum renewables requirements**

**Spelthorne**

Under policy CC1 of Spelthorne's Development Plan **Document (2009)[lxxviii]:**

- 10% of the energy needs of a building must be met by on-site renewables.
- This applies to **total energy demand**, not just 'regulated' energy.
- This applies to any dwelling, and any other development of 100$m^2$+
- This is in addition to requiring the developer to first optimise fabric, layout and orientation to minimise energy demand for heat and light (the energy hierarchy).

The 10% renewables requirement is waived if it is shown to "seriously threaten the viability of the development". This makes sense if a high-rise development may be created within an existing tight urban fabric **where there** is not enough space or light for certain renewable technologies , e.g. large-scale p**hotovoltaics**, ground-source or solar thermal heating. However, low-density new developments should be able to build in space for renewables from the start, and take this cost into account when buying land.

**Milton Keynes**

In major new developments, Milton Keynes requires that after carbon emissions have already been reduced by 19% over building regulations, developers must then deploy renewables to achieve a further 20% reduction. This can be on-site renewables, or connection to an existing community renewables scheme.

Also, in plan policy SC2, "Proposals for over 100 homes and non-residential developments of over 1,000 sq.m. will be expected to consider the integration of community energy networks in the development. This consideration should form part of development proposals and take into account the site's characteristics and the existing cooling, heat and power demands on adjacent sites". This appears to be viewed as general renewable energy generation for the grid or nearby settlements, not a feature that would specifically supply the development itself, so it is not a Merton Rule.

**South Cambridgeshire**

The Local Plan 2018[lxxix] requires that all proposals of 1000$m^2$ or more must use renewable energy to achieve a 10% reduction on the building's regulated carbon emissions (Policy CC3). This therefore does not cover unregulated energy, such as plug-in appliances.

Policy CC3 also includes a requirement that "for growth areas and new settlements, site wide renewable and low carbon energy solutions that maximise on-site generation from these sources will be sought, such as renewable and low carbon district heating systems". The term 'maximise' is much stronger and could be used to achieve far greater carbon reductions if implemented to the full technically feasible extent.

### 3.4 Existing buildings and retrofitting

As changes to existing buildings do not always require planning permission, this is one of the most challenging issues to address in a local plan. This is a major hurdle in the nation's progress towards net zero, given that more than 75% of the building stock that we will use in 2050 has likely already been built[10]. The Committee on Climate Change estimates[lxxxiv] that to get to net zero by 2050, "by 2035 almost all replacement heating systems for existing homes must be low-carbon or ready for hydrogen, such that the share of low-carbon heating increases from 4.5% today [2019] to 90% in 2050".

In addition to carbon emissions from operating the building, bringing existing buildings up to date and making them fit for use is a means to reduce the need to build elsewhere. This reduces embodied carbon from the use of materials for new builds and saves land for other climate-friendly uses (for example, green infrastructure with carbon sequestration potential, or local food production to reduce food miles).

Cambridge Local Plan 2018[lxxxv] Policy 30 already requires energy efficiency improvements in existing buildings where there is a conversion or extension that needs planning permission. While this is a positive step, local officers report that this has not driven enough change. This is because the improvements can only be required for the works that need permission, not the whole home. Many refurbishments do not need permission in the first place.

The role of the local plan may therefore need to be permissive rather than restrictive:

- Plan policies to support the large-scale deployment of renewable energy capacity (generation and storage) feeding into the electricity grid, gas network or heat networks, so that existing homes' grid energy use is made cleaner over time
- Plan policies that explicitly encourage, guide and permit effective energy retrofitting measures
    - especially where building owners might assume this would be discouraged by planning, e.g. external solid wall insulation, improved windows or solar panels that have to be visible from the street in conservation areas.
- Plan policies that help fund retrofitting that otherwise would be prohibitive, by raising money from new development.

Clearly, such permissive policies would need to be carefully designed to only support retrofitting that will reliably reduce carbon, and to ensure that retrofitting in heritage settings is done sensitively. This might be achieved by providing detailed guidance that emphasises what would be welcomed and what has worked in other cases.

For planning instruments that take a 'permissive' approach to the deployment of renewables and energy retrofitting, see section on Local Development Orders.

For examples of how developer contributions can and have been used to create carbon reductions in existing buildings and might be used to support carbon reductions in the wider community, see section on developer contributions.

[10] Taking the figure of 70% in 2008 and calculating that roughly 1.8 million homes have since been built in the UK from 2008-2019 representing about 6% of homes now existing in the UK.

**Precedent: local plan policies for retrofitting**

In **Milton Keynes** local plan adopted 2019, sustainable construction policy SC1 (part N) states that:

> "Proposals which would result in considerable improvements to the energy efficiency, carbon emissions and/or general suitability, condition and longevity of existing buildings **will be supported, with significant weight attributed** to those benefits."

The supporting text to this policy acknowledges that some retrofit measures will require planning permission where the alter the building's external appearance, but emphasises that:

> "The Council will encourage retrofit improvements to existing buildings in the Borough, on an individual and area-wide basis. Where appropriate the Council may employ Local Development Orders to support area-wide schemes".

Milton Keynes also offers a carbon offset fund for local energy retrofit measures, supplied by S106 payments by developers of new homes that cannot reduce their carbon emissions to zero on site.

**London Borough of Camden** local plan[lxxxvi] encourages developers to retain and retrofit existing buildings (where feasible) instead of demolishing and rebuilding, due to the embodied carbon impacts.

The local plan is also supported by detailed retrofitting planning guidance[lxxxvii]. While somewhat out of date now (as it was written when the Green Deal was active), it included helpful information such as:

- Which typical retrofitting measures count as permitted development and with which conditions.
- Guidance separated by context – that is, homes which have no heritage designations; homes in a conservation area; homes in a conservation area with an article 4 direction, and Grade II Listed buildings.
- Guidance on the energy and carbon savings that could typically be achieved using different retrofit measures.

### 3.5 Using developer contributions towards carbon reduction or offsetting

Charges can be made to developers to address the impacts of their development on the community and its infrastructure. These can incentivise better climate impacts on site at a development, and fund actions to reduce the local area's wider emissions.

**Section 106 (S106) agreements** are intended to make a development acceptable in cases where it otherwise would not be. This can be a payment, but can also include non-financial conditions such as a certain proportion of affordable housing. These payments can only be required if they are necessary to make the development acceptable, are directly related and proportionate in scale to the development,[xcv]. They should only be used if a planning condition cannot solve the problem. S106 payments have been used by several local authorities to make a development 'acceptable' if it cannot otherwise fulfil a carbon policy.

**The Community Infrastructure Levy (CIL)** can be imposed[xcvi] on all developments of at least 100m$^2$ or one dwelling to fund infrastructure additions, maintenance or upgrades necessary to support development[xcvii]. It can be spent on a wide range of projects including but not limited to transport, district heating, green space, flood defences, schools or healthcare.

To charge CIL, local authorities must prepare a schedule of charges per home or per m$^2$. This is subject to examination like the rest of the local plan (so viability is key). The authority must show how CIL helps implement their plan and supports development across the area. CIL can be waived in exceptional circumstances. Some developments are exempt, such as affordable housing and non-building structures like wind turbines. Different rates can be set according to viability considerations based on location, type, use or scale of development.

Two-tier authorities like Greater Cambridge are expected to coordinate on their needs. A total infrastructure cost must be identified, and other funding sources considered, then CIL can fill gaps. As of 2019, local authorities are permitted to pool many developer contributions towards the same piece of infrastructure (previously there was a limit of 5)[xcviii].

CIL might therefore be used to reduce carbon emissions in many ways:

- Funding infrastructure that will directly reduce the carbon emissions that would result from a particular development, for example:
    - Low-carbon transport infrastructure in areas with poor public transport
    - Creating heat networks, or converting existing ones to zero-carbon energy
    - Creating infrastructure to increase the proportion of biogas in the gas grid.
- Funding the deployment of infrastructure that will remove GHGs – such as forest. This could be part of other green space provision (e.g. flood; air quality; recreation)

The Infrastructure Delivery Plan would need to focus on designing infrastructure that would expedite a transition to zero carbon – and avoid works that increase emissions, like highways.

**It must be noted that local authorities' control over both mechanisms (S106 payments and CIL) may be removed** under the government's 2020 Planning White Paper. Developer payment amounts would be unified across the country as a single 'infrastructure levy' charged at point of occupancy[xcix]. It would apply to changes of use as well as new builds[c]. Spending of levy funds remains in the hands of the local authority level (possibly with more flexibility than now[ci]), so it could still be put towards a range of actions to reduce carbon.

**Developer contributions as an 'offset' as part of zero-carbon homes policies**

**Milton Keynes** carbon offset fund has been running since 2008[lxxxviii]. It is funded by S106 payments from developers, and is intended to achieve carbon savings equivalent to the predicted carbon emissions of the new development.

The amount of carbon to be offset is calculated using the building regulations Part L methodology, plus an allowance for appliances using the BRE Domestic Energy Model[lxxxix]..

Until early 2020, management of the fund was delegated to a third party specialist, the National Energy Foundation (NEF) as an external expert. NEF devised schemes through which the fund will be spent, and reports back to the Council. These have included:

- Grants for residents to upgrade to modern, efficient boilers
- Loft and cavity wall insulation installations
- Purchasing data sets for further analysis and planning for emissions reduction
- Open bids for whole-house energy efficiency retrofitting
- Schools energy saving scheme, including lighting and boiler upgrades.

Initially, grants under this fund could not exceed a certain limit on cost per tonne of carbon and must have at least a 20-year lifespan, but flexibility has been added after some important interventions (like solid wall insulation) had trouble meeting these criteria[xc]. NEF states that the fund has saved over 6,600 tonnes of carbon since 2006, although no date is given for this progress and it is unclear whether this is $CO_2$ or includes other GHGs.

**Pitfalls of Section 106 carbon offsets in London**

Homes in London must achieve at least 35% reduction in $CO_2$ (versus Building Regulations Part L 2013) and then pay to offset the rest via Section 106. Other buildings must achieve the 35% cut, and will pay offsets when the new London Plan is adopted[xci].

NEF **produced a comprehensive report[xcii]** looking at the successes and challenges of implementing the 'zero carbon buildings' policy used in most London boroughs. While the London offset scheme is successfully raising funds and some Boroughs are requiring an even larger improvement than the basic 35%, some pitfalls have arisen:

- A lot of funds remain unspent due to a lack of defined, structured projects available, or lack of internal departmental awareness of the available fund
- Some funds had not reached a size where they could be spent on useful projects, often due to delays in developments reaching the 'trigger point' for payment
- If funds remain unspent for too long, they must be handed back to developers
- Carbon emissions of the building are often calculated only at planning application stage, not recalculated at building completion (which may not match design**s)**
- Viability arguments mean that offset prices do not always reflect the cost of implementing carbon reduction actions
- **Reductions and offsets on Part L only deal with the 'regulated' energy use. They miss out plug-in appliances, which can be half of the total energy used[xciii,xciv]**

NEF notes that **Islington charges a higher price to reflect unregulated emissions** too.

### 3.6 Addressing scope 3 emissions in local planning

As per the previous section about translating national carbon targets into local ones, scope 3 emissions are GHGs emitted from activities outside the area, but driven by consumption or spending within the district (other than grid energy which is scope 2). Examples include:

- GHGs emitted during the production of building materials brought into the district (and transport up to the district edge) – known as **'embodied carbon'**
- GHGs emitted by external aviation where the district's residents are passengers
- External management of waste produced within the district.

**Of the above, only the embodied carbon of building materials is strongly influenceable** by local planning and therefore the other two are not considered further here.

As new builds become more and more energy-efficient, the embodied carbon becomes proportionally more significant in the building's whole-life emissions. The embodied carbon of building materials (from production to end of life) can represent 50% or more of a new building's whole-life carbon emissions[cii]. Cement alone is thought to be responsible for 8% of global GHG emissions[ciii] (mostly because of the chemical reaction in the kiln), while steel, glass and aluminium are also carbon-heavy because of the energy used in their production.

Some common principles for the measurement of embodied carbon of construction projects are established by the European Standard EN 15978: 2011. This has been applied in a variety of ways, with the effect that results are differing and hard to compare. For this reason, the standard has been further refined into a methodology for whole-life carbon assessment for the built environment, produced in 2017 by the RICS (Royal Institution of Chartered Surveyors)[civ]. This is backed up by the RICS Building Carbon Database, which allows a degree of benchmarking and comparison with other projects. There is also a widely adopted and freely available data set called the Inventory of Carbon and Energy[cv], most recently updated in 2019.

However, there is still a degree of subjectivity in undertaking embodied carbon analysis, and the quality of input data still varies to a greater degree than that for operational carbon analysis. Hence it is less reliable and less justifiable to set absolute policy targets, without specifying a great degree of detail as to methodology and assumptions required.

Nonetheless, given the urgency of climate change and the significance of embodied carbon in overall built environment emissions, RIBA has provided some benchmark target values for embodied carbon in its 2030 Climate Challenge [cvi] with guidance to define the scope and boundaries.

The London Energy Transformation Initiative (LETI) has also produced an 'Embodied Carbon Primer document'[cvii], with helpful detailed guidance on the definitions, measurement and reduction of embodied carbon. This also includes benchmark targets for embodied carbon, using the same underlying methodology as RIBA, but different scope boundaries.

UKGBC's aforementioned 'Framework Definition on Net Zero Carbon Buildings' offers a separate 'scope' for assessing embodied carbon. It advises that this scope should cover only the stages from production through to building completion, because reliable data on embodied carbon emissions due to maintenance and end of life is even scarcer.

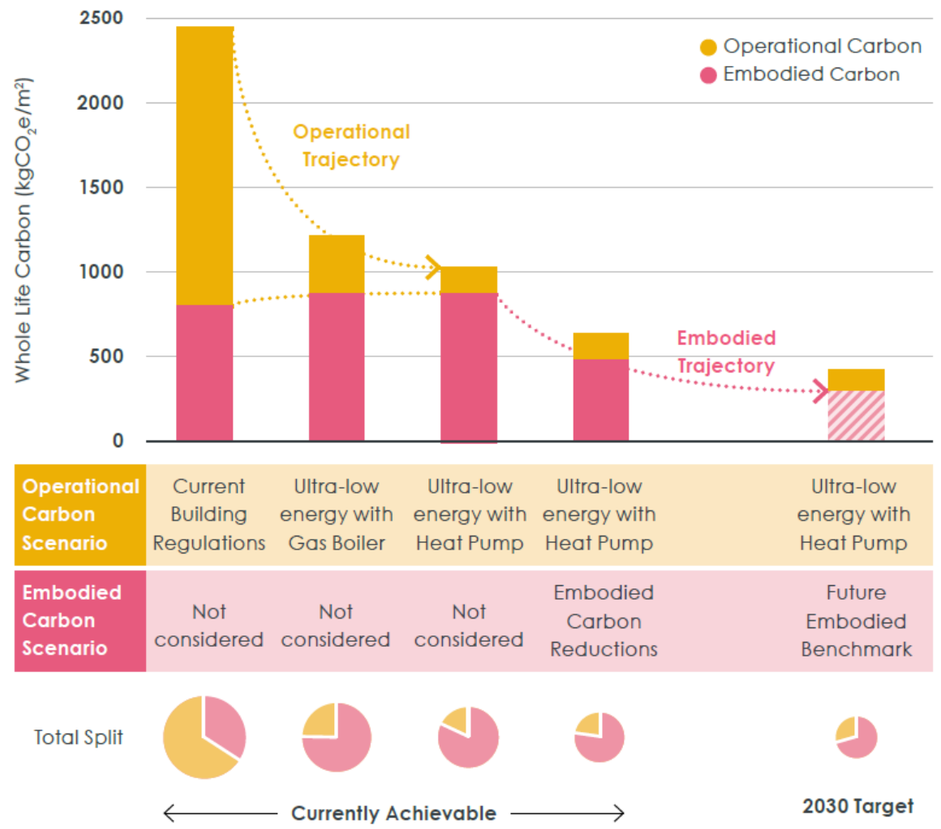



Figure 16: Extract from LETI Embodied Carbon Primer – Diagram showing operational and embodied carbon trajectories

**The power to influence the wider range of activities causing Greater Cambridge's scope 3 emissions** is divided between building regulations, national legislation in other sectors, and local planning powers. Scope 3 emissions are largely due to the construction supply chain and building users' own spending, therefore mostly fall outside the impacts that a developer can be held responsible for. For this reason, a local plan generally has less power to set direct requirements for developers to demonstrate scope 3 emissions reduction, compared to scopes 1 and 2 (which include buildings' energy and transport impacts). Many local GHG inventories and zero-carbon building frameworks exclude scope 3 emissions from their calculations entirely (as outlined in previous sections 2.4 and 2.5).

Despite this, some local planning authorities are taking action to reduce embodied carbon. Even where they are considered not to be fully avoidable, science-based carbon budgeting shows that this kind of action will be necessary to remain on a climate path consistent with the Paris Agreement ('global warming well under 2˚C'). The following sections outline planning powers that might be used for this, and examples of local plans that have done so.

### 3.7 Making low-carbon credentials into a 'material consideration' and giving guidance

A 'material consideration' is an issue to be given weight during planning decisions. This is not the same as a stricter 'requirement'. There is general guidance available on what can count as a material consideration (see right) although there is no definitive list. A material consideration must serve a planning purpose – it must relate specifically to the use of the land, and it must be fair and reasonable.

For issues in which the planning authority is not empowered to *require* certain interventions for reasons of viability or a clash with national regulation, planning may still encourage better carbon performance by stating that this is a material consideration and providing guidance. Developers may then attempt to do better in the hope that this will count in their favour during the planning permissions process. In the table to the right, the issues most relevant to a zero-carbon transition are shown in bold.

Material considerations might, for example, make reference to the national government policy for a net-zero UK by 2050 and signature to the Paris Agreement. This would make it clear from the outset that new developments are expected to be consistent with the carbon budgets and trajectories that would keep the world on track to limit global warming to well below 2˚C, making reference to analysis such as by the Tyndall Centre and World Green Building Council which lay out the drastic changes required for buildings and transport.

This may also be one of the ways to address embodied carbon, given that building design and materials can be taken into account. This could be supported by creating a carbon-focussed materials hierarchy in a design guide and/or Supplementary Planning Document. This approach is taken by the London Borough of Camden (see precedent, right). If developers can show that they have taken steps to limit this – such as by using recycled materials, using cross-laminated timber instead of steel, or reduced-carbon cement – this could count in their favour. For major developments that can support greater investment, the developer could be asked to produce an embodied carbon assessment (such as a cradle to gate[11] boundary, using a relevant methodology such as RICS[cxi] or EN15978[cxii]).

Given that not all developers will be willing or able to produce consistent embodied carbon calculations, it may not be possible to use this to reliably quantify the changes in embodied carbon across Greater Cambridge to 2050 to the point where it would be meaningful to include it in the wider GHG inventory. However, it would be a signal to the construction industry towards reducing embodied carbon, until a more harmonised metric has been developed to the point where it could legitimately be required. Hence a policy reference could be made that is subsequently updated to reflect improvements to the practice of measuring and reporting embodied carbon.

Overshadowing could be relevant to the zero-carbon agenda in that it could affect the ability of a building (or its neighbours) to produce solar electricity or heat in the form of solar gain or solar thermal heat systems.

| Issues that can be considered 'material' (non-exhaustive list)[cviii]. Bold text = most relevant to carbon reductions. | Issues that cannot be considered 'material' |
|---|---|
| • Overlooking/loss of privacy<br>• **Loss of light or overshadowing**<br>• Parking<br>• Highway safety<br>• **Traffic**<br>• Noise<br>• Effect on listed building and conservation area<br>• **Layout and density of building**<br>• **Design, appearance and materials**<br>• **Government policy**<br>• Disabled persons' access<br>• **Development Plan (including neighbourhood plans) and Supplementary Planning Documents**<br>• Previous planning decisions (including appeal decisions)<br>• **Nature conservation** | • Loss of view<br>• Negative effect on the value of properties<br>• Payments promised by the developer to the community resulting from the use of the land |

**London Borough of Camden local plan and supplementary guidance**

Camden's local plan[cix] adopted in July 2017 includes a policy to mitigate climate change (Policy CC1). As well as setting requirements for buildings' operational GHGs, this policy also takes steps to address transport emissions caused by development, and embodied carbon of the development's construction.

Policy CC1 addresses embodied carbon by:

- Encouraging energy efficiency improvements to existing buildings
- Requiring all proposals that involve substantial demolition to demonstrate that it is not possible to retain and improve the existing building
- Requiring all developments to 'optimise resource efficiency'. This is supported by a Supplementary Planning Document (SPD) on energy, climate adaptation and resource efficiency[cx] which includes commentary on embodied carbon.

The accompanying SPD forms a material consideration during planning decisions. In this SPD, developers are provided with guidance on how to assess and reduce embodied carbon. Applicants are advised that they should compare the carbon impacts of a new development versus a refurbished scheme.

Policy CC1 also addresses transport emissions by committing to ensure that the location of development and mix of land uses minimise the need to travel by car.

[11] Cradle to gate means assessing all GHGs emitted from production of the material through to transport and delivery on site. An alternative is whole-life carbon emissions, where the emissions during construction, maintenance and end of life would also be assessed.

### 3.8 Greening the grid with renewable energy generation, storage and use

The Committee on Climate Change has stated[cxiv] that the UK must quadruple its low-carbon electricity by 2050, to get to net zero carbon. Expediting a transition to a clean electricity grid (and/or clean heat networks) is one of the few ways a local plan can decarbonise existing buildings and electric vehicles at scale. The RTPI offers guidance[cxv] on how local planning can help drive this change, and advises creating a strategic Local Area Energy Plan based on geography, demography and building stock[cxvi].

A vital role the local plan can play is to **identify and allocate suitable sites** for wind, solar, and renewable heat – not only **generation**, but also **distribution** and **storage**. This may include heat demand mapping (to assess scope for heat networks) or a call for sites for wind or solar. Biogas may also play a small role[cxvii]. For equipment with deep foundations (like wind turbines), this should be compared against any loss of soil carbon – both on site, and due to changes to hydrology affecting nearby areas[cxviii].

With more renewables, which fluctuate with weather and time of day, we must adapt our energy system. Developing **a 'smart' energy system**, which uses digital technology to maximise efficiency and match demand with generation, will be key – especially as it can make better use of existing infrastructure. Smart energy system features include smart controls in buildings and the grid, energy storage (including electric vehicles), and demand side response (appliances that use less energy during peak demand[cxix]).

RTPI (2019[cxx]) observes that there are few examples of local plans bringing forward smart energy, as it is an emerging area. However, it stresses that it is helpful to have policies and SPDs that generally encourage development of smart energy system elements, and that plan periods are too long to reflect the fast pace of technological change, so flexible policies are best (perhaps a five-year updateable SPD).

**Energy storage** can range from batteries to hydrogen production, insulated heated tanks, or pumping water uphill and using it later for hydroelectricity. For batteries, the suitability of locations relates to other grid infrastructure, like substations, as well as where storage is needed (where there is renewable generation not time-matched to demand). Strategic placement of storage helps avoid costly grid upgrades[cxxi]. RTPI advises local planners to work with the local distribution network operator, national grid and the storage industry to identify locations. Some energy storage does not need permission (as permitted development or existing use class), but local planning will soon be responsible for decisions on larger energy storage projects that until now have been subject to central government scrutiny[cxxii].

**Renewable energy and smart energy features** can be encouraged with plan policies that clarify the general supportive treatment of such developments, along with guidance on what is acceptable in terms of noise, visual impact, safety, ecology, soil carbon loss, and so on. RTPI notes that it is helpful to **train members and officers on the issues likely to arise** when determining planning applications for energy generation and storage. The Energy Institute has helpful resources[cxxiii]. Planning may also encourage developers to deploy 'vehicle-to-grid'-enabled electric charge points that enable vehicles to act as storage.

Planners can also conduct **proactive public engagement** to ensure citizens understand the potential benefits, can articulate what conditions and ownership structures they would find acceptable, and are not plagued by unjustified concerns, such as noise (when in fact there is not much evidence and the technology is constantly evolving). Justified citizen and stakeholder preferences could be incorporated into **supplementary guidance on how to make such developments acceptable**, as above.

Local planners can also use Local Development Orders to bring forward renewables and smart energy.

**Existing local plans addressing smart energy and renewables (all from RTPI reports)**

**City of York draft local plan (2018), Policy CC1.**

"Renewable and Low Carbon Energy Generation and Storage: Proposals for renewable and **low carbon energy storage developments will be supported and encouraged**. Developments should be sited a suitable distance from major residential areas and have suitable fire suppression procedures".

The policy **also explains why storage is crucial, acknowledges that this is an emerging field and commits the council to work with experts to** understand what the options are and develop an SPD which will include safety considerations. This plan is still with the inspector, but this **stance already formed the basis of a 2019 planning approval** for a 50MW battery storage development in greenbelt, due to its location (near a substation) and its contribution to sustainable development, innovation, and energy resilience.

**Milton Keynes local plan, Policy SC2** "Community energy networks and large scale renewable energy schemes" notes that "Low carbon and renewable energy schemes will be attributed significant weight in their favour, [so long as there are not] any significant negative social, economic, or environmental impacts associated with them".

Additionally, "Proposals for over 100 homes and non-residential developments of over 1,000 sq.m. will be expected to consider the integration of community energy networks in the development". This appears to be viewed as general renewable energy generation for the grid, not a feature that would specifically supply the development itself.

**Policy, SC3** (Low carbon and renewable energy generation) makes it clear that the council "will encourage proposals for low carbon and renewable energy generation developments that are led by, or meet the needs of local communities", subject to caveats about amenity, wildlife, landscape appearance, heritage or air quality. Wind turbines are specifically subject to more conditions about site suitability, with an SPD to guide them.

**Policy SC1** also requires new development proposals to "review the opportunities for energy storage and demand management so as to tie in with local and national energy security priorities". This would support a smart energy agenda.

**Swindon Borough Council** has used LDOs to promote the growth of renewable energy generation and use[cxiii], both on specific sites and in borough-wide terms. Examples include:

- A borough-wide LDO for non-domestic air source heat pumps and district heating
- Hydrogen and electric vehicle charging stations (specific sites)
- Identifying specific sites for solar photovoltaic arrays including solar farms.

The LDO on solar farms has been particularly successful, by de-risking the process. It was created by issuing a 'call for sites' and then assessing these sites against various criteria.

### 3.9 Transport

Transport is now the largest source of $CO_2$ emissions in the UK[cxxvi]. This is mostly due to road transport, where small increases in fuel efficiency have been cancelled out by an increase in the number of miles driven, so that the total amount of transport emissions have remained fairly similar in recent years, in contrast to other sectors which have shrunk their emissions. Until the COVID-19 crisis there were sharp increases in traffic, with total mileage up 7% in the past 10 years (14% in the last 20 years[cxxvii]).

Presently, the biggest factor is the spatial pattern of where people live, work and study. Where it is quick and enjoyable to walk or cycle, people will do so. Access to public transport is also key. At present[cxxviii], transport emits 4.2 tonnes of $CO_2$ per capita in South Cambridge (52% of the area's total) but only 0.8 in Cambridge City (20% of the area's total). If we exclude motorways and railways in order to focus only on local travel, the figures are 3.3 and 0.7 tonnes respectively. The urban-rural contrast is significant. National Planning Practice Guidance observes that the distribution of new development and the potential to service this through sustainable transport are appropriate climate mitigation measures in plan-making[cxxix].

A switch to electric vehicles is underway but has been slower than expected (and may be hurt by Brexit[cxxx]). The national ban on new diesel and petrol cars from 2030 will help, but existing cars will remain in use long after that (an average of 14 years[cxxxi]).

Therefore, the **most crucial thing that the local plan can do is to choose spatial growth options that reduce car dependence**, putting growth in locations where most trips are realistically likely to be made by foot, bike or public transport. This includes encouraging growth and regeneration to be mixed-use so that homes, schools and jobs are close together.

Beyond the new growth itself, the local plan can also make spatial choices to support the strengthening of sustainable modes. It could safeguard land for the expansion of public transport (as has per South Cambridgeshire's 2018 local plan) or cycling.

The raising and spending of funds for public infrastructure can also help sustainable transport. As in South Cambridgeshire, local plans can require developer payments to mitigate the development's transport impacts. If the government's proposed planning reforms go ahead, the local authority will still receive a universal 'infrastructure levy'. The transport portion of this could be reserved for sustainable actions only – such as direct funding of public transport, public bike storage, or electric vehicle charging. It might also involve putting highways budgets towards changes that make it easier to cycle or make buses faster and more reliable.

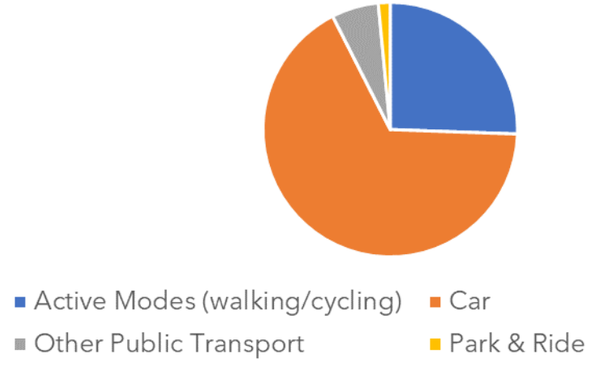
Where car transport is unavoidable, a zero-carbon local plan must ensure zero-emissions vehicles are realistic for all, such as:

- Require a minimum number of EV charging points per parking place (this may soon also be put into national building regulations[cxxxii]), ideally which have vehicle-to-grid capacity so that EVs can act as energy storage
- Reserved EV charging bays in public parking – as investment will be wasted if they are blocked by fossil fuel vehicles (national analysis[cxxxiii] of net zero carbon scenarios notes a need for special support for those who lack off-street parking).
- Logistics and trade bays: as the mileage of light duty vehicles (such as delivery trucks) rose 23% in the past decade[cxxxiv], it is essential that planning delivers infrastructure that would support their transition to zero emissions. This could include reserved 'trade bays' with rapid EV charging, or encouraging development of dedicated zero-emissions logistics hubs.
- Consider infrastructure and fuel production: For heavy vehicles, hydrogen infrastructure is cheaper than other zero-emissions options[cxxxv], but hydrogen production is so energy-intensive that it takes three times as much energy input to power a hydrogen vehicle compared to an electric vehicle[cxxxvi]. An emerging alternative is electric road systems (ERS).

In addition to the local plan, the planning team could create design codes for new settlements that include nudges towards walking and cycling, and away from car use. Such nudges can also improve the street scene – such as added permeability for active modes, and requiring that parking should be at the back of buildings, not on street (aside from trade vehicle bays).

| | |
|---|---|
| 0.7 tonnes of $CO_2$ (18% of city's total territorial $CO_2$ footprint, 2018) | Local transport annual emissions per capita, City of Cambridge[cxxiv], an urban area |
| 3.3 tonnes of $CO_2$ (48% of district's total territorial $CO_2$ footprint, 2018) | Local transport annual emissions per capita, South Cambridgeshire, a rural area |
| Less than 1% | Proportion of UK vehicle fleet that is now electric[cxxv] |
| 2030 | Year of national ban on *new* petrol and diesel vehicles |
| 14 years | Average length of time a car stays in use from first sale (delaying the switch to clean vehicles) |

Figure 17: Share of all trips by transport mode Greater Cambridge (Cambridge Sub-Regional Transport Model, produced by Atkins Global)




Bioregional Etude

### 3.10 Land use and carbon sequestration

Agriculture, forestry and other land use can have a significant impact on emissions of methane and nitrous oxide, and sequestration (removal) of carbon dioxide. Methane and nitrous oxide are largely related to biological waste, ruminant digestion, and fertiliser application. Some carbon is also emitted during soil disturbance such as ploughing or tilling, especially of peaty soils. The Committee on Climate Change states[cxxxvii] that to achieve net zero, one-fifth of our agricultural land must be converted to woodland, biomass production or peatland restoration.

**In agriculture** without land use change, planning does not have much influence. However, the local plan could support proposals for **carbon-reducing crop/manure waste facilities**, such as anaerobic digestion with biogas injection to the grid[cxxxviii]. As with other renewables, success hinges on early community consultation, and well-informed planning officers[cxxxix].

**Forests and grassland** are shown to remove carbon in the government's annual subnational $CO_2$ figures[cxl]. UK-wide, these capture 7% of emissions, but Greater Cambridge's ones only capture 2.3% of the area's emissions. Wetlands are currently a small net emitter at regional and national level, but can remove GHGs if they stay wet[cxli] and are a major carbon store.

Planning's biggest influence here is to choose **spatial options** that steer development away from existing carbon pools and sinks (see maps). New development could also be assessed to see if it may cause changes to hydrology that might dry-out carbon-heavy soils nearby.

Planning can encourage **creation of woodlands** and **wetland restoration**. This should be part of a green infrastructure strategy that focusses on ecosystem services – including carbon removal. This could begin with a 'call for sites'[cxlii] to be assessed against criteria on the site's existing use and potential to provide other services (recreation; food; water quality; climate adaptation[cxliii]). Most new woodland does not need planning permission, but may need an environmental impact assessment and benefit from support from landscape or tree officers.

Sources of **funds** should be considered for creation of green carbon sinks. This might use **developer payments** towards amenity green space or the new requirement for biodiversity net gain in the draft environment bill[cxliv]. The **Woodland Carbon Code** can be used to model how much carbon would be captured by a forest of a certain size, tree mix and management. Registered new woodland then generates **carbon credits** which the government guarantees to buy if another buyer is not found. Other funding[cxlv] is available, such as the Woodland Carbon Fund which supports upfront costs and pays a lump sum 5 years after planting[cxlvi].

Finally, the local authority can **act as a broker for projects that reduce or remove greenhouse gases**. A local authority is in a unique position to convene interested parties or administer funds. Possible foci could include woodland creation, wetland restoration, or low-impact agriculture (nutrient management and paludiculture[cxlvii] – also known as wet farming). Paludiculture needs more pilots in the UK[cxlviii]; and some are underway nearby[cxlix].

**The government's draft planning reforms** (2020) propose to categorise all land as either 'grow', 'renew' or 'protect'. If this goes ahead, green carbon sinks should be prioritised for protection. A strong argument is that these often co-occur with high biodiversity, like wetland.

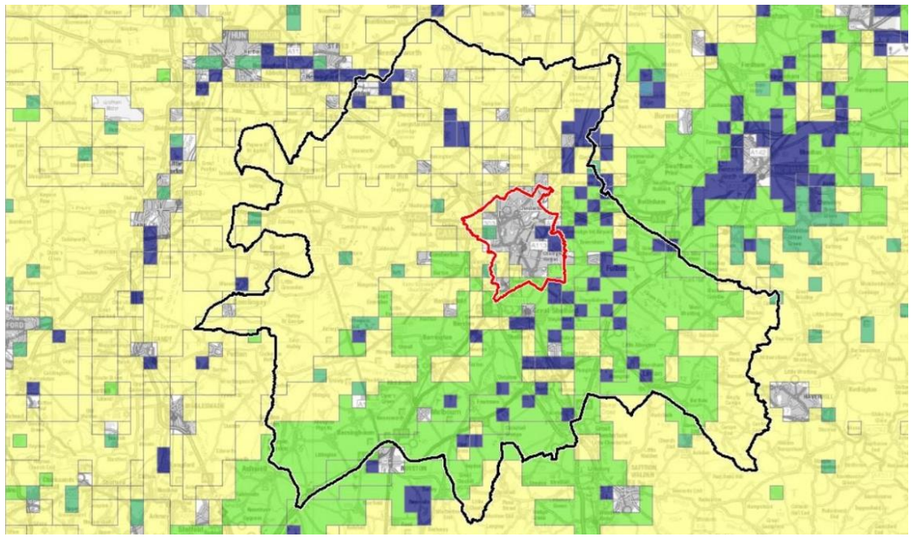


Figure 18: Carbon density in topsoil (tonnes per hectare. Yellow = 45 to 49 tonnes. Green = 49 to 64 tonnes. Dark blue = 72 to 75 tonnes). Centre for Ecology & Hydrology (CEH), kindly provided by Land Use Consultants (LUC)

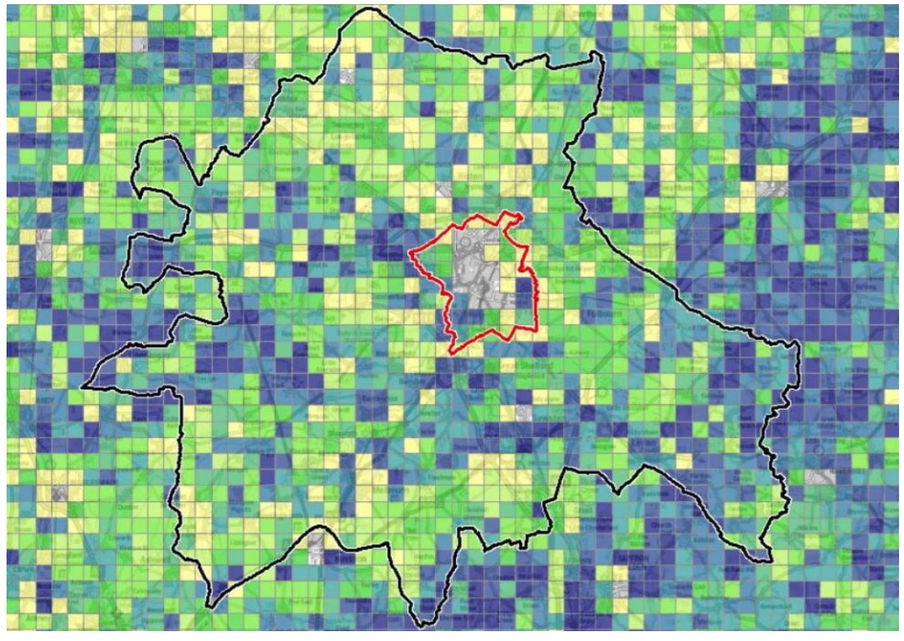


Figure 19: Carbon density in vegetation (tonnes per hectare. Yellow = 0.5 to 0.7t. Light greens = 0.7 to 1.4t. Dark green/teal = 1.4 to 2.7t. Dark blues: 2.7 to 6.8t. Purple = 6.8 to 43 t). CEH, via LUC, as above.

### 3.11 Local Development Orders (LDOs)

Local Development Orders[cliv] are a tool that local planning authorities can use to bring forward specific kinds of development in order to fulfil specific objectives whether environmental, social or economic. They are not always strictly part of the local plan, but the two can mutually refer to each other – or LDOs can be made solely to implement policies within the local plan[clv].

LDOs grant default planning permission to specified types of development. This removes the need to go through a lengthy and complex planning application process, and adds clarity to what is expected, thus improving certainty for developers which helps them access investment and reduce lead times. It also frees up planning officers' time to focus on other applications.

LDOs can:

- Relate to specific sites, or cover the whole local planning area
- Come with conditions (e.g. by referring to specific design codes) or be unconditional
- Be time-bound, or apply indefinitely, or be revoked or edited at any time
- Be deployed without a supporting policy in the local plan (but will be stronger with one)
- Be used in combination with existing S106 or CIL obligations

LDOs should:

- Lay out a clear logic covering the objectives pursued and how the permitted development is thought to bring about those objectives
- Be developed in consultation with a wide array of stakeholders, to increase their robustness, deliverability and legitimacy
- Be reconsidered if the site gains legal conservation status at a later date

LDOs cannot:

- Prevent other planning applications, supersede existing permissions or rights
- Permit development that would harm a listed building or European conservation site
- Remove the obligation to comply with other regulations (e.g. building regulations)
- Add additional Section 106 or CIL obligations (although the developer can offer S106 payments as a way to fulfil LDO conditions, if there are any)

The Secretary of State can require that an LDO in development is submitted for their scrutiny, and may approve it, reject it, or require modifications to it[clvi].

Existing LDOs across the country have been made relating to a great diversity of issues and types of development[clvii], ranging from energy through to town centre diversification, commercial developments and farms. An interactive map[clviii] of England's LDOs produced by the UK government Planning Advisory Service currently shows none in Cambridgeshire.

LDOs have successfully supported renewable energy (capacity and manufacturing), retrofit, and clean transport. Milton Keynes local plan 2019 indicates a willingness to use LDOs to encourage wide scale energy retrofit[clix]. They are also used to promote brownfield development and growth of mixed-use neighbourhood regeneration, so could help to spatially support trip reduction and the use of sustainable transport by expediting the growth of homes and employment sites on public transport corridors, urban densification, or growth of amenities in existing settlements.

This makes LDOs a promising tool to reduce carbon not only in new builds but also existing settlements, by greening the grid and making neighbourhoods conducive to less car use.

**Precedents: using LDOs to promote a transition to renewable energy and reduce transport carbon**

**Swindon Borough Council** has used LDOs to promote the growth of renewable energy generation and use[cl], both on specific sites and in borough-wide terms. Examples include:

- A borough-wide LDO for non-domestic air source heat pumps and district heating
- Hydrogen and electric vehicle charging stations (specific sites)
- Identifying specific sites for solar photovoltaic arrays including solar farms.

The LDO on solar farms has been particularly successful, by de-risking the process. It was created by issuing a 'call for sites' and then assessing these sites against various criteria.

**Across several London Boroughs**, an LDO was created to make it easier to deliver heating and cooling networks[cli]. By removing the need to make a separate application for each new network section, this makes the network more flexible for new connections and reduces the costs of expansion. It also creates a common standard for new heat networks.

**In Hull**, an LDO formed part of a strategy[clii] to bring forward a site for the manufacturing of renewable energy generation equipment (Siemens offshore turbines). Along with other interventions such as a Harbour Order, pre-application advice and wider engagement, this allowed the development to come forward in time to secure necessary investment (and to take advantage of UK government investment in sectoral skills).

**Teignbridge District Council in Devon**[cliii] used an LDO to achieve brownfield regeneration and town centre vitality. Brunswick Street in Teignmouth was occupied by garages and an off-street car park. The local plan allocated the site for a range of development including 40 homes. Supporting this, an LDO was created to expedite a balanced and enticing mixture of new uses, also including community and recreational uses. Much technical work went into the preparation of the LDO, including on flood risk, feasibility, and a heritage-sensitive design guide. Consultation was also extensive, via a working group for the LDO that included representatives from the community, council, chamber of trade and others. This allowed a collaborative vision and genuine community consent. While significant time was invested in the LDO creation, this work helped offices understand the context, and later supported a local plan review.

A similar approach could conceivably be used to reduce carbon by reducing the need or desire to travel, by diversifying neighbourhoods to include more community use, essential facilities, shops, recreation and working spaces. This would have most impact in locations without good public transport and where such amenities are currently not walkable for most. Alternatively, an LDO could specifically promote development along public transport corridors, making these more competitive than car-dependent locations.

It is important to note that the government's draft planning reforms (the White Paper 2020) propose to categorise all land as either 'growth', 'renew' or 'protect'. In 'growth' land, outline planning permission would be granted by default. This may make some LDOs obsolete in this kind of area. However, there may still be a role for LDOs in 'renew' or 'protect' areas and to encourage energy retrofitting of buildings.

### 3.12 Setting a scope that is relevant to Greater Cambridge and its local planning powers

A net zero carbon target on which robust and enforceable policies can be built should be based on a recognised GHG accounting methodology and relate to the emissions reductions shown to be necessary by climate science and national climate commitments. To be effective, these targets and policies need to focus the attention of planners and other stakeholders on issues that are relevant to (and achievable by) Greater Cambridge. The review of greenhouse gas accounting methodologies in the preceding sections shows that it is appropriate to set a target scope boundary according to the purpose for which the greenhouse gas inventory is being used – in this case the local plan – and that some emissions are more appropriately dealt with as a national overhead rather than at a local level. (See executive summary, figure 1).

The review shows that $CO_2$ suits a 'carbon budget' approach to year 2100, while other greenhouse gases do not (Tyndall Centre; IPCC; CCC). This budgeting is essential if Greater Cambridge and the UK are to pull their weight towards a global emissions pathway that avoids the worst impacts of climate change while following the equity principle of the Paris Agreement. Although $CO_2$ makes up 81% of the UK's GHG emissions, other gases will grow in importance once peatlands are included (methane; $N_2O$) and as the energy system moves to electricity (F-gases). The net zero scope should therefore take in all seven gases covered by international protocols ($CO_2$, CH4, $N_2O$ and four F-gases) – but build in a $CO_2$ budget within this.

Along with the review of planning powers, this perspective helps to decide whether the net zero scope should include certain emissions that pose challenges for accounting and action:

- **Peatland** should be included in the net zero scope for Greater Cambridge, to drive action and make sensible land use decisions. This important regional issue requires leadership in research and action to transform it from a carbon emitter to a carbon sink. To solve the whole regional problem may be expensive and difficult, so will require national support – but maps show[clx] that only a small part of the regional peatlands fall within Greater Cambridge, so the burden is proportionally lower here.
- **Aviation** is clearly a serious problem for climate at global level. However, local carbon accounting methodologies either require complex estimations about how Greater Cambridge might cause a proportion of flights elsewhere that may not reflect reality, or make blunt assumptions based on national per-capita aviation that could never be reduced to zero while the UK still has any fossil fuel aviation, or exclude this sector completely. One small private airport operates within Greater Cambridge, and the influence of the Councils and local plan on an individuals' flight choices from airports elsewhere is negligible. It therefore may be sensible to treat aviation separately from the net zero target scope, but prevent expansion of aviation in the district, and strengthen the provision of alternatives. If aviation is included, offsets will be needed (and can be sourced from outside the area).
- **International shipping** may reasonably be excluded, as this is not influenceable by a region without any ports and in any case this emissions source is excluded from all national inventories and from two out of the five local inventory methodologies reviewed.
- **Embodied carbon of consumed goods and materials** is largely not influenceable by the local plan and so may be excluded from the target scope. An exception is building materials, but the methods for assessing this are not yet mature enough to fully account for trade-offs between embodied and operational carbon. It therefore makes sense to refrain from setting numerical targets on this for now, but include policy hooks (such as requiring reporting of embodied carbon, and looking positively on steps taken to reduce it) to add in more specific conditions later.

## 4. Position statement

The following section proposes a 'nested' position statement for net zero carbon for the local plan based on the preceding literature review.

### 4.1 A Net Zero-Carbon Greater Cambridge is one that:

- Contributes no more GHG emissions in scopes 1 and 2 (including all 7 gases named in the Kyoto Protocol) on an annual basis than are removed from the atmosphere by the area's carbon sinks:
    - Including all energy and refrigerant use by buildings and transport,
    - Including peatlands' emissions and removals along with other land use,
    - Including all sectors and emissions sources except aviation and shipping
    - Without relying on offset schemes delivered outside the UK, and minimising the use of UK carbon offset credits too.
- Stays within $CO_2$ emissions budgets for energy use (including transport) that are consistent with a 1.5°C climate change pathway to 2100 (as calculated by the Tyndall Centre to be a proportional contribution by Greater Cambridge as part of a globally fair contribution by the UK to the Paris Agreement)
- Keeps track[12] of its scope 3 emissions (aviation, shipping and embodied carbon of goods, especially building materials), and takes steps to reduce these through resource efficiency, land use, exerting influence over its supply chain, and finds effective means for the appropriate offsetting of the remainder within the UK.

### 4.2 A local plan consistent with a Net Zero-Carbon Greater Cambridge:

- Allocates development sites, densities and mix of uses so as to minimise the potential carbon emissions for built environment and transport:
    - In terms of modal shift to active travel and public transport
    - In terms of availability of grid infrastructure to support both electrification of vehicles, and renewable generation on buildings linked to the grid
    - Using a cautious estimation of the rate of shift towards electric vehicles
    - Avoiding the expansion of existing airports or the development of new ones
- Requires the maximum feasible reduction (typically 100%) in scope 1 + 2 energy use and carbon emissions from any new development's operation
    - Including both regulated and unregulated energy at the development
    - Calculated using a proven methodology to reliably predict the building's energy use and minimise the energy performance gap
    - To be achieved on site using an energy hierarchy considering passive design, fabric efficiency and zero-carbon heating and disallowing fossil fuel energy use
    - Adopting space heating and energy use intensity targets from relevant green building frameworks
    - Taking into account exchanges of energy over the course of a year (with exports of zero-carbon energy counting as negative emissions),
    - With the energy strategy for major developments to include monitoring of energy and carbon emissions for the first 5 years to help create benchmarks
- Uses a Merton-style rule to require developments to renewably generate the maximum feasible total energy on site,
    - adopting a metric of renewable energy capacity per square metre of building footprint (to acknowledge that the key factor is roof space for solar panels),
    - expecting that plots below a certain height should be able to become net exporters of zero-carbon energy across the course of a year
- Requires developer contributions to offset the development's remaining lifetime operational emissions, only as a last resort where these are shown to be unavoidable, and define the 'allowable solutions' for offsetting:
    - Either through direct action, or at a price per tonne that reflects the actual cost of emissions reduction, only in the UK and ideally in Greater Cambridge
    - Prepare structured schemes to deliver these offsets in a measurable and time-bound way (for example, to retrofit existing buildings with insulation or zero-carbon heating, to invest in renewable energy in the local area, or to transition existing heat networks to zero-carbon sources)

[12] This record could be kept by the local authorities, local academics, or a local climate commission set up for the purpose, made up of suitable specialists.

- Requires developments over a certain size or value to calculate their embodied carbon emissions up to the stage of building completion (RICS methodology stages A1 to A5) and specify steps taken to reduce this through resource efficiency, construction practices and materials selection, making this a material issue in planning
    - Include a policy hook to add specific numeric targets for buildings' embodied carbon future, when methodologies and trade-offs are better understood
- Is supported by an infrastructure development plan that explicitly prioritises carbon-reducing infrastructure – and avoids spending on infrastructure that would be likely to lead to increased emissions (such as highways upgrades other than bus routes, cycle routes, and features that support zero-emissions vehicles only)
- Explicitly encourages and supports renewal and refurbishment that includes significant retrofit and improvements to existing building stock, both through policy wording and other planning mechanisms available, such as Local Development Orders.
- Identifies and allocates sufficient and suitable space for large scale generation, storage and transmission of renewable energy to support the transition of all buildings and vehicles away from fossil fuels, again identifying suitable sites and using permissive tools such as Local Development Orders
- Identifies and protects sites in the combined authority area that are or could feasibly become carbon sinks (i.e. peatlands and areas suitable for biodiverse native afforestation),and supports the restoration of these, ideally of sufficient size to offset the remainder of unavoidable emissions from sectors[clxi] that cannot reach zero emissions by 2050

### 4.3 A Net Zero-Carbon Development in Greater Cambridge:

- Contributes net zero GHG emissions in operation in scopes 1 and 2 for *all*[13] its energy use (netting-off any zero-carbon energy it exports over the year), and consumes only renewable energy, preferably from on-site generation
    - To be achieved using an energy hierarchy process in the design that considers orientation, form, fabric, renewable heat supply, renewable generation, and adopts targets for fabric efficiency and space heating demand taken from recognised industry frameworks[14] (RIBA; LETI; Passivhaus)
    - To be assessed using a proven methodology that accurately forecasts and minimises actual total energy use of the building, including the performance gap
    - To be monitored for 5 years from first occupation for major developments (with a method built into the energy strategy)
    - Including a minimum kWh of renewable generation on site per square metre of building footprint[15]
    - Where scope 2 emissions (grid energy) cannot be reduced to net zero on site, and where it cannot be ensured that the building operators will use a long-term renewable power purchase agreement, the remaining grid electricity emissions over the course of the building's full lifetime (~60 years, with grid decarbonisation[16]) should be offset with payments into a defined 'allowable solutions' scheme
        - This offset payment should go into a structured fund held by the Council to be spent on local schemes with direct and measurable carbon reductions that would otherwise not occur, or invested directly in *additional* off-site renewable generation (ideally on the roofs of other new builds that have excess space, so as to save land elsewhere and decarbonise the new build growth as a whole).
- Calculates and takes steps to reduce the embodied carbon from construction (major developments only, stages from production through to completion)
- Does not hinder the site's ability to be an existing carbon sink, or feasibly be converted to a significant carbon sink, if good potential is identified
- Is sited and equipped to support a pathway towards zero-emissions transport: active travel, public transport or electric vehicles (in that order of preference).

[13] Regulated and unregulated
[14] Frameworks that specify metrics for fabric energy efficiency include RIBA Climate Challenge, LETI Net Zero Operational Carbon, and Passivhaus Plus or Premium.
[15] To be defined in the local plan based on the feasibility and cost study which are being produced as subsequent sections of this net zero carbon study
[16] Given that the grid is expected to reach near-zero carbon by 2050, the 30-year emissions should not be much different from the 60-year emissions.

## Appendix 1a: summary comparison of place-based and global greenhouse gas inventory frameworks

| Methodology | Tyndall Centre | CUSPE | SCATTER | Global GHG Protocol for Cities | PAS 2070 | UK Committee on Climate Change | IPCC (2019 update) |
|---|---|---|---|---|---|---|---|
| **Scale** | Local authority area | Cambridgeshire | Local authority area | Any local scale | Any local scale | National | Global |
| **Purpose** | To produce local carbon dioxide trajectories consistent with the United Nations Paris Agreement (that is, a global carbon budget consistent with climate change of less than 2˚C, fairly allocated between countries based on development level, sectoral base and historic emissions) | To help Cambridgeshire reach a net zero carbon emissions target by 2050 in line with the national UK goal, and to understand what reductions are necessary in each sector | To let UK local authorities report consistently on local area emissions to carbon reporting frameworks, set reduction targets and understand pathways to national and international goals. Uses carbon budgeting as per Tyndall Centre. | To allow comprehensive and consistent GHG inventories to be produced that allow comparison between different locations and aggregation of data up to larger scales | To define good practice for producing local GHG inventories, so these can be thorough, transparent and consistent, for benchmarking and decision-making. | To advise the UK on setting and achieving carbon reductions in line with the Paris Agreement (to limit global climate change | Internationally consistent national carbon reporting and global budgeting, in line with latest climate science for a sub-2˚ global temperature rise (aiming for 1.5˚C) |
| **Gases included** | $CO_2$ only (represents 81% of UK's carbon emissions) | $CO_2$, $N_2O$, CH4, and one major source of HFC.<br>Excludes other F-gases and other sources of HFC. | $CO_2$, $N_2O$ and CH4 | All 7 Kyoto Protocol gases, plus optional other F-gases | 6 gases (excludes $NF_3$) | All 7 current Kyoto Protocol gases ($CO_2$, $N_2O$, $CH_4$ and four F-gases); also defines 5-yearly $CO_2$ budgets | All known GHGs; defines a global cumulative budget for $CO_2$ only that gives a chance of remaining below 2˚C |
| **Categories or sectors** | Not differentiated, but includes all $CO_2$ emissions from the energy system (that is: fossil fuel combustion within the geographic boundary for any purpose, plus grid electricity usage). | Homes (operational emissions), transport, commercial services/ industry, agriculture, waste, land use/land use change/forestry | Residential buildings, non-residential buildings (commercial, industrial, institutional and agricultural), road transport, rail transport, water transport, aviation, solid waste, wastewater, livestock, land use | Stationary energy (buildings, energy industries, agriculture/forestry/fishing, fugitive emissions), transport (road, rail, water, aviation, off-road), waste (solid and wastewater), industrial processes and product use, agriculture/forestry/other land use, and 'other scope 3' (supply chain emissions) | Stationary energy, mobile fuel (transport), industrial processes and produce use, agriculture, forestry/land use/land use change, waste/wastewater, goods and services (including water, food, drink, construction materials) | Surface transport, industry, buildings, power sector, aviation, shipping, agriculture, other land use/ change/forestry, | All, defined as: Energy (including buildings), industrial processes (including product use), land use (including forestry and agriculture), waste. Emissions are accounted for in the sector where they directly occur. Transport is dealt with inside other sectors. |
| **Scope 1 / territorial?** | Energy use only (transport as well as stationary energy).<br>Excludes any emissions not from energy use (e.g. | Yes, most.<br>Excludes rail travel (not thought significant). Will | Yes. | Yes.<br>Through-traffic can be excluded. | Yes, as part of 'direct plus supply chain' methodology. | Yes. | Yes (but not named as such) |

| Methodology | Tyndall Centre | CUSPE | SCATTER | Global GHG Protocol for Cities | PAS 2070 | UK Committee on Climate Change | IPCC (2019 update) |
|---|---|---|---|---|---|---|---|
| | waste, soils, cement other than kiln fuel) | include peatlands from 2020. | | | Through-traffic reported separately or excluded. | | |
| **Scope 2?** | Yes | Yes | Yes | Yes | Yes.<br><br>Generation of grid-supplied electricity, district heating or cooling at combined heat and power facilities within the city is treated separately to avoid double counting. | Yes (but not in those terms as this is national level – most of the UK's electricity is generated inside the UK so appears under 'power sector'). | Not applicable. Electricity, heat and steam produced inside the country would fall into the scope 1/territorial emissions of the energy sector. Does not account for transfers of grid electricity between countries. |
| **Scope 3?** | No | No – although a separate calculation is made about vehicles' embodied emissions (electric and conventional) in order to confirm that there is still a major benefit in moving to electric vehicles. | Some – aviation, road transport, buildings, and electricity generation.<br><br>For electricity generation, this is presumably well-to-tank emissions and transmission / distribution losses.<br><br>For buildings and roads, it is not clear what the scope 3 emissions are. They may be embodied emissions of construction materials, but no pathway is given to reduce these.<br><br>Excludes embodied carbon of other imported goods. | Some: energy transmission / distribution losses; waste sent out of boundary; transboundary transport. Cities can exclude journeys that do not begin or end within the city.<br><br>Optional: embodied emissions of food, water, construction materials; fugitive emissions from fuel. No specific methodology provided. | Yes, comprehensive across full lifecycle of goods and services consumed within city, in both methodologies. | No – does not consider emissions caused by production of goods and services imported into UK. | Not applicable – guidance is for national territorial inventories only.<br><br>IPCC's own global climate reports do contain some analysis of how material flows between countries affect overall carbon emissions. |
| **Position on aviation and shipping** | Shipping and aviation do not need to be accounted for locally, even if originating from within the area, because they are counted as a national | Aviation is excluded because it's scope 3 | Included. Landing and take-off emissions are scope 1 if there is an airport. Aircraft cruise emissions are scope 3 and based on population | Shipping: included if occurring to/from/within a city's own waterways or ports.<br><br>Aviation: included as scope 3, departures only, | Included, even when the port or airport is outside the city, so long as it serves the city. Outbound journeys only. Calculated by fuel used, distance | The Committee on Climate Change recommended including these, both domestic and international. | International shipping and aviation is excluded from national inventories and dealt with separately. |

| Methodology | Tyndall Centre | CUSPE | SCATTER | Global GHG Protocol for Cities | PAS 2070 | UK Committee on Climate Change | IPCC (2019 update) |
|---|---|---|---|---|---|---|---|
| | overhead (not considered influenceable at local level) | | (assumes flying is equal per capita across UK).<br><br>Inland water transport emissions based on a proxy of km canal length, therefore will not display actual changes in canal traffic or fuel used within the local authority. Coastal water transport only if a coastal port is present. | from any airports that serve the city whether in or out of boundary. City can estimate by scaling down national aviation data by population or GDP, or only report on passengers travelling from the city. Domestic and international flights must be disaggregated. | travelled, or other. Allocated to the city in proportion to surface transport to/from these ports or airports. | (However, in the eventual Climate Change Act, only domestic flights and shipping are considered a UK source[clxii].) | |
| **Position on embodied carbon of construction** | No need to account for cement, for which room has already been made at global level. However, this is based on an optimistic future scenario in which the industry achieves heavy reductions. Local cement use should therefore pursue resource efficiency and lower carbon options. Other materials not considered.<br><br>Local energy use in goods production or construction must be fitted within Tyndall budgets. | Scope 3 excluded. But: any emissions caused by local production of materials, and any construction-related transport inside the area, is included in scope 1. | Excluded. But: any emissions caused by local production of materials, and any construction-related transport inside the area, is included in scope 1. | Optional; no specific methodology provided for materials' embodied carbon. "To support cities in measuring these and other scope 3 emissions … the GPC authors anticipate providing additional guidance on estimating emissions from key goods and services produced outside the city boundary". Materials produced within the geographic boundary would appear in scope 1 as an industrial process / stationary energy. | Included under 'goods and services' sector (separate from buildings or industrial processes). Covers the cradle-to-gate emissions from cement and steel used. Other materials included if they are thought to contribute >2% to total Direct Plus Supply Chain footprint. Can be calculated by weight, volume or spend on materials. | | Not separately considered. Embodied carbon of materials produced within the country would be captured under the Energy and Industrial Processes category. Imported goods are not part of the national inventory. |
| **Position on land use and land use change (emissions and removals)** | Not part of the assessment, other than energy used to convert or use land in the locale. However, carbon budgets are set with an assumption that there is no net deforestation between 2020-2100 which would require action in all countries. | Included. Gives calculations about type and extent of forest needed to offset remainder of GHGs after reductions are made<br><br>Excludes peatland but acknowledges its significance. Will include next year, | Includes: forestry, grasslands, livestock management and tree-planting. Tree-planting counts towards removing GHGs.<br><br>Peatland and wetland not mentioned separately, but should be part of the land use category[clxiii]. | Included as per IPCC. Emissions from land use change are counted if the conversion of land happened within the last 20 years.<br><br>Refers to IPCC wetlands chapter for methodology. | Included as per IPCC. Emissions from land use change are counted if the conversion of land happened within the last 20 years.<br><br>Emissions from land use for food production should be calculated separately and | Will include peatland from 2020 | Included<br><br>Peatlands optional (under 'wetlands'); methodology provided. |

| Methodology | Tyndall Centre | CUSPE | SCATTER | Global GHG Protocol for Cities | PAS 2070 | UK Committee on Climate Change | IPCC (2019 update) |
|---|---|---|---|---|---|---|---|
| | Any further sequestrations achieved by land use should be used to balance out non-$CO_2$ emissions e.g. agricultural methane, rather than to increase $CO_2$ budget. | and explains how much this might change the footprint. | | | subtracted from the total footprint, so that they are not double counted along with emissions from food supply chain (see assumptions) | | |
| **Position on carbon credits for offsetting** | Not permitted; not included.<br><br>Does not assume that carbon capture and storage technologies will be developed in coming years. | Not included. All 'offsets' for remaining gases in 2050 (after maximum reductions achieved) appear to be based on sequestration within the territorial boundary. | Purchased credits are not part of the calculation; the tool looks only at what is "feasible using only emissions reduction measures and natural sequestration". Tree planting within boundary counts as GHG removal. | Cities are encouraged to align their mitigation goal boundary with the inventory boundary. Purchased offsets from outside the geographic boundary are reported separately, not deducted from the total footprint. | Purchased offsets from outside the geographic boundary are reported separately, not as part of the footprint. | Recommends not to use international offsetting, other than final resort if key technologies do not develop (e.g. hydrogen; carbon capture / storage) | Not included – national territorial inventory only. |
| **Compatible with:** | SCATTER Cities<br>IPCC 1.5˚C report | Committee on Climate Change | GHG Protocol for Cities; Tyndall Centre | IPCC guidelines (mostly); PAS2070 ('direct plus supply chain' method – not consumption-based) | Global GHG Protocol for Cities;<br>IPCC | | Global Protocol for Cities; PAS2070 |

| Methodology | Tyndall Centre | CUSPE | SCATTER | Global GHG Protocol for Cities | PAS 2070 | UK Committee on Climate Change | IPCC (2019 update) |
|---|---|---|---|---|---|---|---|
| **Assumptions that may obscure true emissions or result in unreliable carbon budgets** | No net deforestation worldwide between 2020 – 2100. If there is net deforestation, this would decrease the permissible budget.<br><br>National aviation emissions to remain static to 2030 and then achieve a linear decline to zero by 2075. Similar assumption for shipping.<br><br>No assumption that carbon capture and storage technologies will be developed in future. If these do appear, this could increase the permissible budget. | Net zero scenario assumes development of carbon capture and storage technology at a 90% capture rate by 2050, and deployment of hydrogen for a part of both heating and transport. At present, these options do not exist. Net zero scenario also assumes extensive energy retrofitting of existing homes. | 1% of total on-road fuel consumption is assumed as off-road land transport. Inland shipping emissions are allocated by proxy of km canal length. Excludes F-gases, which may become more significant with more wind turbines, grid capacity, air conditioning and heat pumps.<br><br>Based on publicly available data generally published at national level not always with local verification, whose assumptions or algorithms may obscure the actual status on the ground (e.g. if a building's energy use is over a certain threshold, it must be non-residential). | | Assumes that fuel sold within the city boundary and used outside it, is balanced by fuel bought outside the city boundary and used within it.<br><br>Assumes that food produced within the boundary is consumed entirely within the boundary (as cities are net food importers). | Assumes development and widespread deployment of carbon capture and storage (CCS) for future ambitious scenarios and long-term carbon budgets. If these CCS technologies do not appear in time, we risk emitting more carbon than we can abate by other means. | The most optimistic scenarios would need development and widespread deployment of carbon capture and storage |

## Appendix 1b: Summary of accounting approaches for difficult emissions: aviation, cement, metals, shipping, peatlands

As described above, some local GHG inventory frameworks exclude sources like aviation, shipping and cement from local inventories and leave these as national overheads. At an even smaller scale, even some of the most stringent green building frameworks (Passivhaus) omit embodied carbon of materials in their net zero scope. The GPC and PAS2070 request that these are all included, to be counted under scope 3. The CUSPE report on net zero carbon scenarios for Cambridgeshire[clxiv] chooses to exclude all scope 3 (aviation, shipping and embodied emissions).

It should be noted that for the methodologies which exclude embodied carbon of goods and materials, this only applies to goods brought in from outside the area. Local production of goods would be part of the emissions of the industry sector.

### Aviation and shipping

GPC gives cities the option to only report the portion of flight emissions due to travellers departing the city. It separates domestic flights from international flights, to allow summing of local data up to national level, as a national territorial inventory includes all domestic flights. PAS2070 follows a similar approach.

The Tyndall Centre local area carbon budget makes assumptions about how the UK's aviation and shipping emissions will fall from now to 2075, then makes a national allowance for these before dividing the remaining carbon budget between local areas. These emissions therefore do not need to be included in the local inventory.

SCATTER assumes that every person in the UK flies the same amount. Each city is therefore allocated aviation emissions in scope 3 according to population size, in addition to landing and take-off emissions from airports present within the city in scope 1. Shipping emissions (scope 1) are based on presence of ports and canals.

### Cement, steel, iron

PAS2070 requires that cradle to gate GHG emissions from use of cement and steel materials within the city boundary shall be reported. In GPC, this (and other embodied carbon of goods) is optional to report.

The Tyndall Centre local area carbon budgeting tool makes room for cement *process* emissions (from the kiln's chemical reaction, not energy use) at a global level before setting national and local carbon budgets. They therefore do not need to be accounted for locally. However, the cement allowance is based on a very optimistic view of how the industry might decarbonise[clxv]. This means that all producers and consumers of cement will need to pursue efficiencies of resources and carbon in order to keep room for their energy-only carbon budgets.

SCATTER does not include embodied emissions of materials or goods.

### Land use

Tyndall Centre does not look at land use emissions or removals, because this is not 'energy use'. However, the carbon budget is premised on an assumption that there is no net deforestation globally, therefore the methodology states that efforts must be made to achieve afforestation at least at a rate that balances out deforestation. Any additional afforestation beyond this rate is recommended to be used to balance out GHG emissions that are impossible to reduce to zero, such as methane from farming.

PAS2070 requires reporting of emissions due to land use change within the past 20 years with the option to include removals as per IPCC guidelines. Emissions from land used for food production is reported separately. SCATTER and GPC also both include emissions and removals from land use.

## Appendix 2: Further council action outside the Local Plan itself to support a transition to a net zero carbon Greater Cambridge

As previously explained, the local plan itself would mostly steer changes in new growth, building renovations involving external works, and transport arising from new growth. However, the local authorities of South Cambridgeshire and the City of Cambridge (plus the County Council) are able to act in many other ways to shape the overall emissions profile of the whole area, in addition to that of new growth. This is not part of the original scope of this report, but we came across a few possible actions that may be useful to pass on.

As such, the councils may wish to consider the following courses of action in their wider activities:

- Consider saving administration costs by combining the new buildings offsetting scheme as part of a larger offsetting master scheme to address the existing emissions profile of the district, city and county.
- Waste management designed to minimise GHG emissions, especially eliminating the sending of green waste and food waste to landfill
- Ongoing community engagement project to build knowledge and support for large-scale renewables schemes, including to find suitable sites and build in community benefit
- Policies and support programmes to encourage land management consistent with a net zero-carbon UK[clxvi], collaborating with the wider County, landowners and relevant agencies, to identify and deliver afforestation, peatland restoration and wetland-friendly agriculture (paludiculture)
    - Consider raising and administering funds to deliver this
- Low-carbon procurement for goods and services used by the council(s), including a whole-life zero-carbon buildings policy for any council-commissioned buildings, and sourcing the council(s)' own energy via long-term renewable power purchase agreements (to stimulate the growth of renewable energy generation rather than just buying renewable energy that is already present in the grid)
- Working with the Highway Authority and other local governments to ensure that transport improvement spending (perhaps unlocked by development within the local plan area) is put towards low- and zero-carbon modes, only spending on highways if these support the viability of buses, cycling and electric vehicles
- Parking policy that promotes electric vehicle charging, such as protected charging bays and/or discounted rates for electric vehicles
- Encourage bus, taxi and private hire transport operators to use zero emissions vehicles, using licensing conditions and offering charging installations and/or grants

## Appendix 3: Stakeholder engagement

Our wider study for Greater Cambridge emerging local plan includes the following elements:

- Task A: Defining what net zero means for the local plan area (this report)
- Task B: Spatial analysis, creating a tool that can model the different carbon emissions that will occur depending on where and how we build
- Task C: Defining carbon reduction targets and policies for the local plan
- Task D: Modelling the feasibility of building to the specified 'net zero carbon' standard
- Task E: Exploring the difference in costs for net zero carbon buildings
- Task F: Exploring the potential role of offsetting
- Task G: Stakeholder engagement on the findings of tasks A, C, D and F.

Task G is to refine our findings with individuals and small focus groups of people with particular expertise in the topics we are addressing. Three stakeholder workshops and various other interviews have been held. As this is a complex topic with a lot to cover, these sessions have been invite-only.

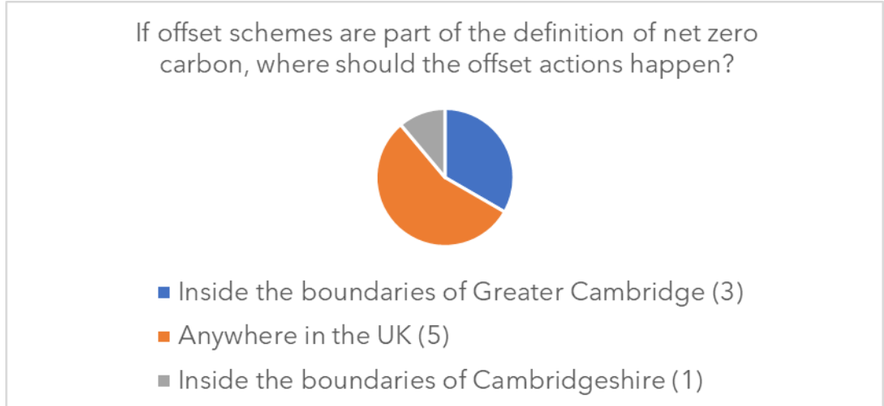
For Tasks A and C, a two-hour virtual stakeholder workshop was held in August 2020. Attendees included Greater Cambridge Shared Planning (GCSP) team members, county council representatives experienced in climate and carbon, planning experts from the RTPI, local non-profit interest groups in carbon and transport, a PhD researcher from the University of Cambridge, and a guest from another local authority planning team. Prior to the workshop, we also consulted informally with environmental law experts ClientEarth, the RTPI and an embodied carbon expert from the ICE database[clxvii].

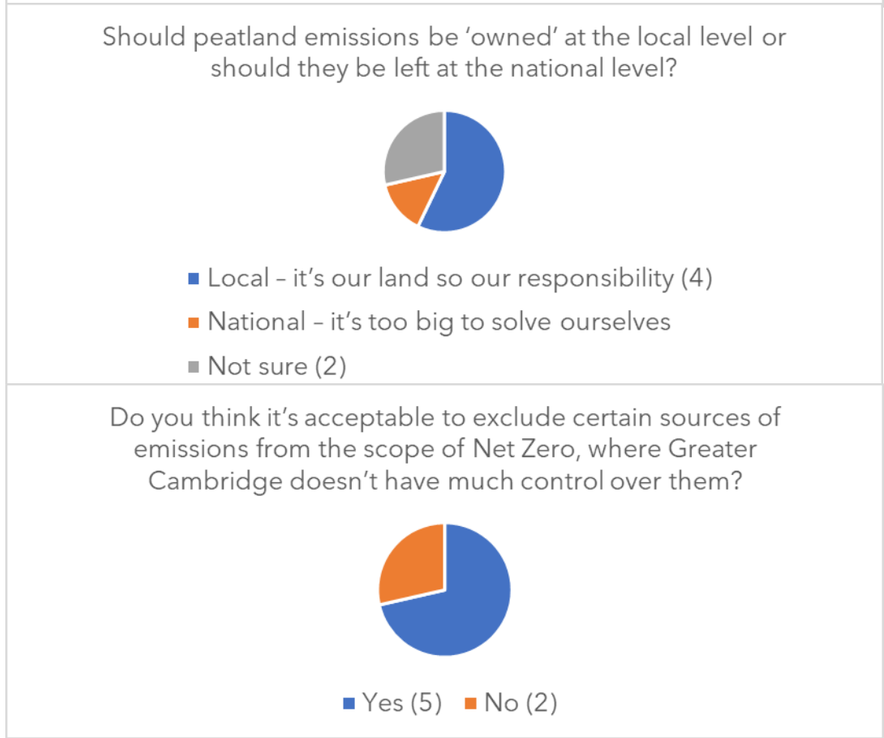
In the workshop, we outlined our findings, offered discussion sessions, and posed poll questions to participants. Participants could also leave further comments after the session on a virtual whiteboard. This helped us gauge whether our work to date was relevant to the local context, whether our participants knew of anything that would contradict our work or could highlight any issues that we had missed, and whether we needed to explain our findings more clearly. For issues where we had not yet settled on a firm conclusion, participants' input helped indicate the direction we could take.

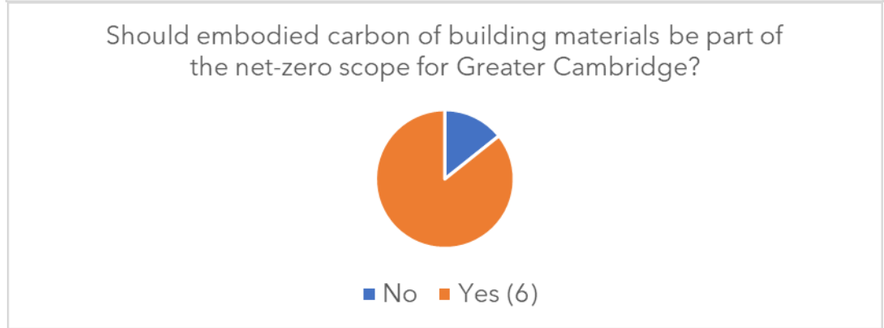
Members of GCSP team also kindly provided extensive and constructive commentary on early report drafts.

### How the stakeholder engagement influenced this piece

- Confirming that it makes sense to set $CO_2$ reduction targets in line with the Tyndall Centre work
- Advising that peatland emissions are a responsibility for the local area and therefore should be included in the 'net zero' scope
- Advising that offsetting actions could be anywhere in the UK, although inside the plan area would provide most co-benefits
- Confirming that it is acceptable to exclude certain sources of emissions from the scope of 'net zero' where local action cannot influence those (aviation; shipping) but that embodied carbon of building materials *should* be addressed by policy in some way because there are policy levers for this even though the emissions happen mostly outside the area.



## Bibliography


[i] E.g. the local authority-level data produced annually by the UK government's department for Business, Energy, Innovation and Skills (BEIS), as acknowledged by Cambridgeshire County Council in its annual reporting on council and county-wide GHGs: https://consultcambs.uk.engagementhq.com/3017/documents/3607

[ii] Most countries and frameworks follow the Kyoto Protocol to define which gases should be included in national GHG accounts. This was originally 6 gases, but a 7th gas was added in 2013. https://unfccc.int/process-and-meetings/the-kyoto-protocol/what-is-the-kyoto-protocol/kyoto-protocol-targets-for-the-first-commitment-period and https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-kyoto-protocol/second-commitment-period/kyoto-protocol-base-year-data-for-the-second-commitment-period-of-the-kyoto-protocol

[iii] Committee on Climate Change (2019), *Net Zero: The UK's contribution to stopping global warming*. Available: https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf

[iv] BEIS. (2019) 2017 UK Greenhouse gas emissions, final figures as cited in CUSPE and Cambridgeshire County Council (2019), *Net Zero Cambridgeshire: What actions must Cambridgeshire County Council take to reach net zero carbon emissions by 2050?* Available: https://cambridgeshire.cmis.uk.com/CCC_live/Document.ashx?czJKcaeAi5tUFL1DTL2UE4zNRBcoShgo=n50fNihP782F1JKAFVjeBMwN1gceCgmEfBXigJlSowUZI20hL9YDZA%3D%3D&rUzwRPf%2BZ3zd4E7Ikn8Lyw%3D%3D=pwRE6AGJFLDNlh225F5QMaQWCtPHwdhUfCZ%2FLUQzgA2uL5jNRG4jdQ%3D%3D&mCTIbCubSFfXsDGW9IXnlg%3D%3D=hFflUdN3100%3D&kCx1AnS9%2FpWZQ40DXFvdEw%3D%3D=hFflUdN3100%3D&uJovDxwdjMPoYv%2BAJvYtyA%3D%3D=ctNJFf55vVA%3D&FgPlIEJYlotS%2BYGoBi5olA%3D%3D=NHdURQburHA%3D&d9Qjj0ag1Pd993jsyOJqFvmyB7X0CSQK=ctNJFf55vVA%3D&WGewmoAfeNR9xqBux0r1Q8Za60lavYmz=ctNJFf55vVA%3D&WGewmoAfeNQ16B2MHuCpMRKZMwaG1PaO=ctNJFf55vVA%3D

[v] It must be noted that while some damaged peatlands can eventually become net carbon sinks again when restored (re-wetted), this is a complex issue and depends on how the land has been used and changed since the peatland was initially drained or converted – such as if nitrogen fertilisers have been applied for the purposes of forestry or agriculture. In some cases, re-wetting can result in an initial increase in some GHGs as methanogenic microbes return, before the 'sink' status is restored. For more detail, see Natural England (n.d.), *England's peatlands: carbon storage and greenhouse gases*. Available: http://publications.naturalengland.org.uk/file/6394909851910144

[vi] Committee on Climate Change (no date), *UK Regulations: The Climate Change Act*. Available: https://www.theccc.org.uk/tackling-climate-change/the-legal-landscape/the-climate-change-act/

[vii] However, research from leading UK climate academics has shown that the budgets used by the Committee on Climate Change are more than twice as large as the amount that the UK could reasonably afford to emit, if the aims and equity principles of the Paris Agreement are to be met (see Anderson, Broderick & Stoddard 2019, referenced below). This is because the CCC carbon budget includes allowances from the EU emissions trading scheme and makes the assumption that we will develop carbon-removal technologies in future. For more on carbon budgeting and how this can be fairly allocated between countries, sub-national regions and sectors, see the invaluable work of the Tyndall Centre: https://www.tyndall.manchester.ac.uk/research/themes/carbon-budgets-pathways/

[viii] WWF (2020), *Carbon Footprint: Exploring the UK's contribution to climate change*. https://www.wwf.org.uk/sites/default/files/2020-04/FINAL-WWF-UK_Carbon_Footprint_Analysis_Report_March_2020%20%28003%29.pdf

[ix] House of Commons library (2019), research briefing: Net Zero in the UK. Available: https://commonslibrary.parliament.uk/research-briefings/cbp-8590/

[x] Tyndall Centre for Climate Change (2018) response to Committee on Climate Change Call for Evidence on building a zero-carbon economy. https://www.theccc.org.uk/wp-content/uploads/2019/04/Tyndall-Centre-for-Climate-Change-Research-response-to-Call-for-Evidence-2018.pdf

[xi] Committee on Climate Change (2019), *Net Zero: The UK's contribution to stopping global warming*. Available: https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf

[xii] An average-sized UK new home of typical form, even if notionally built to 'zero carbon' using the calculations in Part L of building regulations, does not have enough roof space available to accommodate the solar panels it would need to become truly zero-carbon. This becomes more difficult the taller the building is, making it extremely difficult to combine on-site zero carbon with dense, efficient land use and reduced transport carbon. This shows the importance of optimising the building's orientation, fabric and form (using modelling that actually reflects the building's physics and its other energy use due to user behaviour) and to have a mechanism to make sure new-build projects come with additional off-site renewable energy generation, if they cannot provide their own on-site over the course of a year. https://www.passivhaustrust.org.uk/UserFiles/File/2019.03.20-Passivhaus%20and%20Zero%20Carbon-Publication%20Version1.2(1).pdf

[xiii] RIBA 2030 Climate Challenge guidance document https://www.architecture.com/-/media/files/Climate-action/RIBA-2030-Climate-Challenge.pdf

[xiv] https://ghgprotocol.org/about-us

[xv] Greenhouse Gas Protocol FAQ. Available: https://ghgprotocol.org/sites/default/files/standards_supporting/FAQ.pdf

[xvi] https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

[xvii] https://shop.bsigroup.com/Browse-By-Subject/Environmental-Management-and-Sustainability/PAS-2070-2013/

[xviii] BSI Standards Limited (2014), *Application of PAS 2070 – London, United Kingdom An assessment of greenhouse gas emissions of a city*. https://shop.bsigroup.com/upload/PAS2070_case_study_bookmarked.pdf

[xix] https://tyndall.ac.uk/about

[xx] https://carbonbudget.manchester.ac.uk/reports/E07000008/print/

[xxi] International Panel on Climate Change (2019), *Mitigation Pathways Compatible with 1.5˚C in the Context of Sustainable Development.* https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_Chapter2_Low_Res.pdf

[xxii] This is in accordance with the United Nations Framework Convention on Climate Change which recognises that richer and poorer countries have 'common but differentiated responsibility and respective capability' to address climate change. This principle also underlies the Paris Agreement of 2015 to which the UK is a signatory. https://www.nortonrosefulbright.com/en/knowledge/publications/7f6d3528/cop21---the-paris-agreement

[xxiii] Anderson, K., Broderick, J.F. and Stoddard, I. (2019), "A factor of two: how the mitigation plans of 'climate progressive' nations fall far short of Paris-compliant pathways". *Climate Policy*, 20:4. Open access article published by two representatives of the Tyndall Centre and one from Uppsala University, Sweden. https://www.tandfonline.com/doi/full/10.1080/14693062.2020.1728209

[xxiv] As this assumption was not explained in detail in the Tyndall Centre's methodology online, we reached out to ask what it was based on. The response in private correspondence was as follows:

> "The assumption on the pathway for aviation is from our own assessment of a potential ceiling for aviation emissions, reflecting that if the DfT [Department for Transport] pathway for aviation at the time were used this would leave a more limited carbon budget for other sectors.
>
> It is an optimistic outlook from a carbon perspective, relying on any increase in passenger demand going forward balanced out by improved operational efficiency, and industry expectations that the commercial deployment of alternative fuels for aircraft can be available to significantly impact emissions from 2030 onwards. As such planned increases in aviation, such as airport expansion, undermine the carbon budget for local authorities. It is the case that if aviation emissions are greater than the assumed pathway then sub-national carbon budgets would have to be smaller to compensate.
>
> Prior to 2020 this pathway would have been out of step with industry expectations for growth like https://www.sustainableaviation.co.uk/wp-content/uploads/2020/02/SustainableAviation_CarbonReport_20200203.pdf and is premised on aviation policy that doesn't allow increased aviation emissions while pushing reductions in other sectors. This might be considered un-realistic from a political standpoint. The pathway is however realistic from a technical standpoint. Continued growth (or a return to high levels) in the UK will in large part be a product of whether airport expansion is given a go ahead and aviation continues to have a privileged role in policy. Policy choices either way will determine the actual emissions pathway.
>
> Of course, projections for aviation are now going to need a rethink following the disruption [due to COVID-19] this year. Incidentally, reductions this year and estimates that demand might not get back to 2019 levels until 2024, may mean that UK aviation emissions stay within the aviation pathway for the local carbon budgets for a while even without policy choices to limit aviation emissions growth for climate change goals."

[xxv] https://scattercities.com/

[xxvi] BEIS (2020), *Sector, gas and uncertainty summary factsheets – Greenhouse gas emissions, 24th April 2020*. https://naei.beis.gov.uk/resources/Sector_Summary_Factsheet_2020-v2.html

[xxvii] BBC (2019), *Climate change: Electrical industry's 'dirty secret' boosts warming*. Article on SF6, one of the F-gases. https://www.bbc.co.uk/news/science-environment-49567197

[xxviii] For more information about the whole-life climate impact of heat pumps as compared with other heating systems, including embodied carbon and refrigerants as well as energy source, please see CIBSE webinar from 27th August 2020. https://www.cibse.org/GrowYourKnowledge and associated slides at https://go.cibse.org/heat-pumps-webinar (warning: direct download link)

[xxix] Ricardo Energy & Environment on behalf of Committee on Climate Change (2019), *Assessment of the potential to reduce UK F-gas emissions beyond the ambition of the F-gas regulation and Kigali amendment*. https://www.theccc.org.uk/publication/assessment-of-potential-to-reduce-uk-f-gas-emissions-ricardo-and-gluckman-consulting/

[xxx] CUSPE and Cambridgeshire County Council (2019), *Net Zero Cambridgeshire: What actions must Cambridgeshire County Council take to reach net zero carbon emissions by 2050?* Available: https://cambridgeshire.cmis.uk.com/CCC_live/Document.ashx?czJKcaeAi5tUFL1DTL2UE4zNRBcoShgo=n50fNihP782F1JKAFVjeBMwN1gceCgmEfBXigJlSowUZI20hL9YDZA%3D%3D&rUzwRPf%2BZ3zd4E7Ikn8Lyw%3D%3D=pwRE6AGJFLDNlh225F5QMaQWCtPHwdhUfCZ%2FLUQzgA2uL5jNRG4jdQ%3D%3D&mCTIbCubSFfXsDGW9IXnlg%3D%3D=hFflUdN3100%3D&kCx1AnS9%2FpWZQ40DXFvdEw%3D%3D=hFflUdN3100%3D&uJovDxwdjMPoYv%2BAJvYtyA%3D%3D=ctNJFf55vVA%3D&FgPlIEJYlotS%2BYGoBi5olA%3D%3D=NHdURQburHA%3D&d9Qjj0ag1Pd993jsyOJqFvmyB7X0CSQK=ctNJFf55vVA%3D&WGewmoAfeNR9xqBux0r1Q8Za60lavYmz=ctNJFf55vVA%3D&WGewmoAfeNQ16B2MHuCpMRKZMwaG1PaO=ctNJFf55vVA%3D

[xxxi] European Commission Climate Action - overview of fluorinated greenhouse gases. No date. https://ec.europa.eu/clima/policies/f-gas_en

[xxxii] https://www.fmj.co.uk/the-energy-performance-gap/

[xxxiii] Passivhaus Trust recently calculated that a typically sized new house whose building elements notionally achieve 'zero' regulated carbon emissions using Part L may still emit more carbon than could be offset by solar panels on its own roof. To deploy enough renewables nationally to offset this would add an additional burden to the existing enormous challenge of transitioning existing homes and transport to renewable energy. See Passivhaus Trust (2019), *The route to zero carbon?* https://www.passivhaustrust.org.uk/UserFiles/File/2019.03.20-Passivhaus%20and%20Zero%20Carbon-Publication%20Version1.2(1).pdf

[xxxiv] Passivhaus Trust (2017), https://www.passivhaustrust.org.uk/UserFiles/File/Technical%20Papers/The%20performance%20of%20Passivhaus%20in%20new%20construction_July%202017%20V2.pdf

[xxxv] https://www.cibse.org/News-and-Policy/August-2013/Close-the-Performance-Gap-with-CIBSE-TM54

[xxxvi] https://bepit.org/

[xxxvii] https://www.passivhaustrust.org.uk/certification.php

[xxxviii] https://www.leti.london/one-pager

[xxxix] https://www.architecture.com/-/media/files/Climate-action/RIBA-2030-Climate-Challenge.pdf

[xl] Construction Leadership Council, May 2019. Buildings Mission 2030. http://www.constructionleadershipcouncil.co.uk/news/green-construction-board-issues-new-report-on-buildings-energy-mission/

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[xlii] Passivhaus Trust (2019), *The route to zero carbon?* https://www.passivhaustrust.org.uk/UserFiles/File/2019.03.20-Passivhaus%20and%20Zero%20Carbon-Publication%20Version1.2(1).pdf

[xliii] UK Green Building Council (2019), *Net Zero Carbon Buildings: A Framework Definition*. https://www.ukgbc.org/wp-content/uploads/2019/04/Net-Zero-Carbon-Buildings-A-framework-definition.pdf

[xliv] Royal Institute of Chartered Surveyors (2017), *RICS professional standards and guidance, UK: Whole life carbon assessment for the built environment, 1st edition, November 2017*. https://www.rics.org/globalassets/rics-website/media/news/whole-life-carbon-assessment-for-the--built-environment-november-2017.pdf

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[xlvi] UK Government (July 2019) https://www.gov.uk/government/consultations/electric-vehicle-chargepoints-in-residential-and-non-residential-buildings

[xlvii] HM Government, *Planning and Compulsory Purchase Act 2004 – Section 19: Preparation of development plan documents*. https://www.legislation.gov.uk/ukpga/2004/5/section/19

[xlviii] HM Government, *Planning and Energy Act 2008 – Section 1: Provisions* https://www.legislation.gov.uk/ukpga/2008/21/section/1

[xlix] HM Government Ministry of Housing, Communities and Local Government (2019), *National Planning Policy Framework,* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/810197/NPPF_Feb_2019_revised.pdf

[l] TCPA, RTPI and ClientEarth (2019), *Rising to the Climate Crisis: A Guide for Local Authorities on Planning for Climate Change.* Available: https://www.rtpi.org.uk/practice/2019/september/rising-to-the-climate-crisis-a-guide-for-local-authorities-on-planning-for-climate-change/

[li] National Planning Policy Framework (previously referenced), paragraph 8

[lii] National Planning Policy Framework (previously referenced) paragraphs 148-149

[liii] National Planning Policy Framework (previously referenced), paragraph 150

[liv] HM Government Ministry of Housing, Communities and Local Government (2019), *Planning System – Guidance – Viability*.

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[lvi] Planning Resource (2020), *How the ruling rejecting Heathrow expansion will affect other projects and policies*. https://www.planningresource.co.uk/article/1676106/ruling-rejecting-heathrow-expansion-will-affect-projects-policies

[lvii] Friends of the Earth (5th October 2020), *Heathrow airport expansion – Supreme Court Appeal briefing*. https://friendsoftheearth.uk/climate/heathrow-airport-expansion-supreme-court-appeal-briefing

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[lxi] DCLG (2015), Written Ministerial Statement (HCWS488) (online). https://www.gov.uk/government/speeches/planning-update-march-2015.

[lxii] MHCLG (2019), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/728498/180724_NPPF_Gov_response.pdf

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[lxv] "The UK's legally-binding climate change targets will not be met without the near-complete elimination of greenhouse gas emissions from UK buildings" - Committee on Climate Change (2019), *UK Homes: Fit for the future?* Available: https://www.theccc.org.uk/publication/uk-housing-fit-for-the-future/. Please note this is the same organisation that prepares the UK's carbon reduction budgets for parliament to adopt to fulfil requirements of the Climate Change Act 2008.

[lxvi] Greater London Authority/Mayor of London (2019) *The London Plan: Intend to Publish (clean version).* *https://www.london.gov.uk/sites/default/files/intend_to_publish_-_clean.pdf*

[lxvii] https://www.london.gov.uk/sites/default/files/1.5c_compatible_plan.pdf

[lxviii] Reading Borough local plan, adopted November 2019. https://www.reading.gov.uk/media/10410/Reading-Borough-Council-Local-Plan/pdf/Local_Plan_Adopted_November_2019.pdf

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[lxx] Centre for Sustainable Energy/Currie + Brown (2018) states that in homes, unregulated energy typically adds an additional 80 to 95% to a home's regulated energy load, making it 45-49% of the total. *Cost of carbon reduction in new buildings Final report*. https://www.bathnes.gov.uk/sites/default/files/sitedocuments/Planning-and-Building-Control/Planning-Policy/LP20162036/cost_of_carbon_reduction_in_new_buildings_report_publication_version.pdf

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[lxxx] HM Treasury (2019) https://www.gov.uk/government/speeches/spring-statement-2019-philip-hammonds-speech

[lxxxi] These are known as 'energy positive' or 'active buildings'. An example is given in UKGBC's article on Swansea University's Active Building Centre which created the Active Classroom building. Buildings certified Passivhaus Premium would also be energy positive. https://www.ukgbc.org/ukgbc-work/specifics-active-classroom-swansea-university/

[lxxxii] It is worth noting that Passivhaus Plus and Passivhaus Premium certifications both use this metric (kWh of renewable energy produced per m2 of building footprint, not of interior space). Depending on the height of the building, it is likely that Passivhaus Premium buildings would produce more energy than they need, therefore being able to export clean energy to the grid or to other nearby buildings. https://passipedia.org/certification/passive_house_categories

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[cxvi] Royal Town Planning Institute (2019), *Planning for a smart energy future*. Available: https://www.rtpi.org.uk/media/1435/planning-for-a-smart-energy-future.pdf

[cxvii] HM Treasury (2019) Chancellor's Spring Statement. https://www.gov.uk/government/speeches/spring-statement-2019-philip-hammonds-speech - In this Statement, the government confirmed it intends to require increased levels of green gas in the grid.

[cxviii] Previously, some estimations have asserted that the peat carbon displaced by excavations for a wind turbine could take 3 to 5 years to be paid back by the carbon savings from the turbine's electricity generation. However, a more recent on-the-ground study at a peatland wind farm in Scotland found that this was not the case, because in fact it is not necessary to drain the peat to install the turbine, resulting in a payback time of only 47 days. Lutz, K (2019) referenced in Point and Sandwick Trust (2019), *Research debunks myth of peatland carbon payback time*. http://www.pointandsandwick.co.uk/news/wind-farm-study-debunks-myth-of-carbon-payback-time-for-peat/ .

This study assumed that the excavated peat would be spread on the surrounding bog and would gradually be re-enter into the bog rather than fully oxidising. This scenario might conceivably be further improved, if the excavated peat were used as infill in old drainage ditches to restore damaged peatlands.

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