South Downs National Park Policy Study

A technical evidence base for embodied carbon planning policy

April 2026

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Contents

Executive summary – Explainer

The purpose of this study

The purpose of this Embodied Carbon Policy Study is to provide the technical evidence to support the development of a planning policy approach for reducing embodied carbon emissions from developments in the South Downs National Park Authority (SDNPA) area.

What is embodied carbon?

The embodied carbon emissions of a building are the total greenhouse gas emissions associated with materials, construction processes, maintenance and demolition.

An explanation of embodied carbon can be found on the following page and a full glossary of terms can be found in the Appendix Section 5.1.

How the study fits in to planning policy for the SDNPA

Addressing carbon emissions through planning policy is vital to meet local and national climate targets. The SDNPA has simultaneously appointed a net zero operational energy evidence base, complimentary to this. Despite the absence of building regulation in England to reduce embodied carbon, this evidence-base recommends an embodied carbon policy to complement the SDNPA energy and carbon policies.

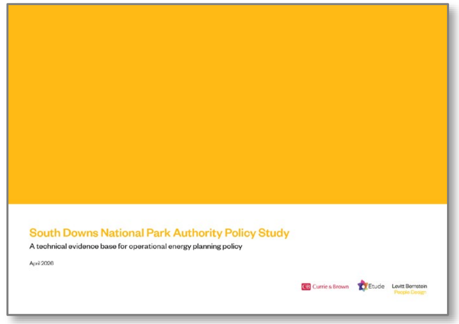
Who the study is aimed at

The prime audience is the SDNPA and Planning Inspectors examining local plans. The study will also support planning officers and the development industry and other stakeholders to reduce embodied carbon emissions from new development. The study builds upon a body of evidence that is developing nationally, and will be of interest to other Local Authorities, industry bodies and other stakeholders in the UK seeking to address embodied carbon emissions from development.

What the evidence-base covers

The evidence-base provides wider context for the recommended policy requirements. It also provides a technical evidence base for the introduction of upfront carbon limits (particularly for low-rise residential and commercial use Class E developments).

This study *– A technical evidence base for embodied carbon planning policy.*



Complimentary study *– A technical evidence base for operational energy planning policy.*

Embodied carbon *– The carbon locked up in the manufacture, transport, and use of materials in buildings.*

Operational energy *– energy consumed by the building detectible at the building's energy meters*

Executive summary – Embodied carbon explained

Carbon emissions are associated with the making of materials, their transport, repair and deconstruction. In order to account for and reduce the emissions associated with materials, embodied carbon is assessed across different boundaries as shown opposite and explained below. Carbon is measured in tonnes (tCO_2e) and is normalised to $kgCO_2e/m^2$.

Whole life carbon (WLC)

For buildings, whole life carbon is the sum of life cycle embodied carbon and operational carbon. The focus of this evidence base is on embodied carbon, but SDNPA policy is planned to cover both operational and embodied carbon.

Life cycle embodied carbon

Life cycle embodied carbon includes both upfront carbon and the embodied carbon associated with using the building and its end of life.
The primary focus for this evidence base is on upfront carbon, as it represents the parts of embodied carbon where planning policy has the greatest influence.

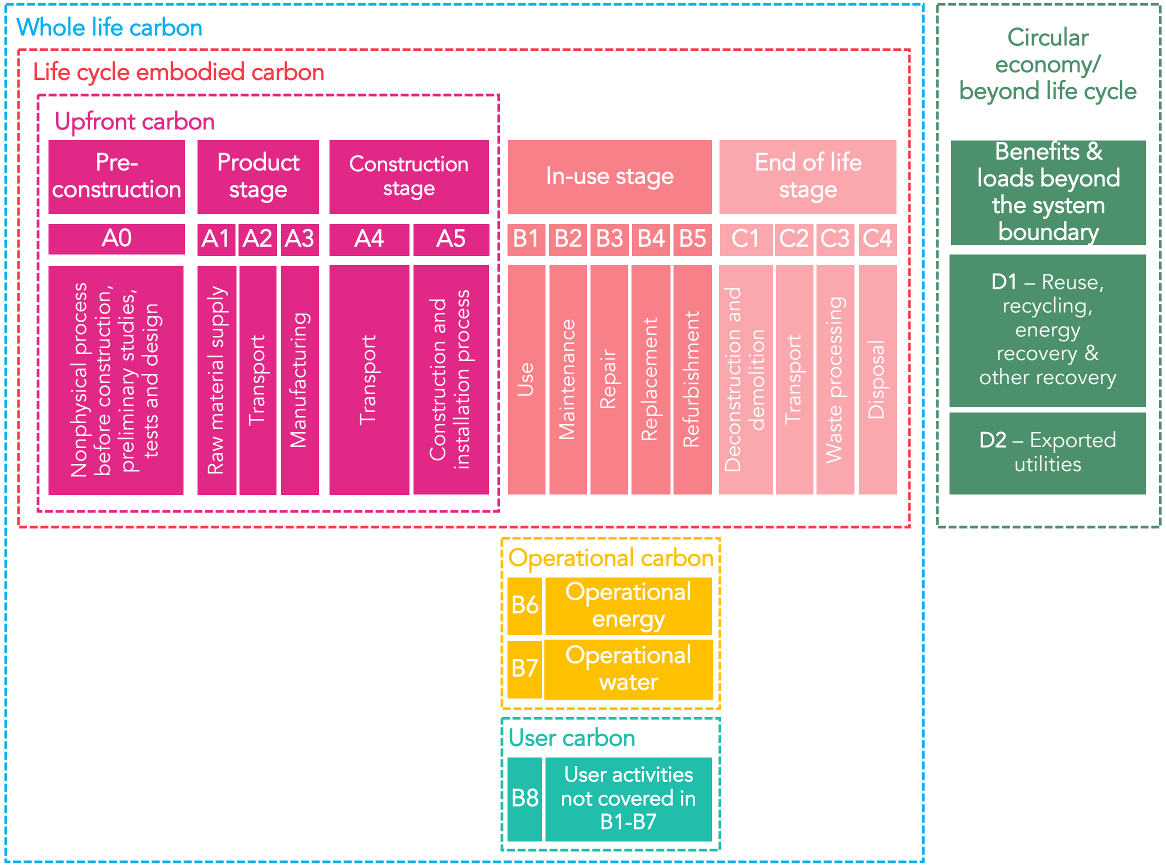
Upfront carbon

Upfront carbon is a focused part of life-cycle embodied carbon and refers to the greenhouse gas (GHG) emissions associated with design, material use and construction stages, this includes the carbon locked in a building up to its practical completion (I.e. preliminary studies, raw material supply, manufacture, transport and construction of all building elements).
Designers have the greatest ability to reduce upfront carbon pre-planning by considering how a new building can be optimally designed and through the materials specified. This lends itself to benchmarking or target setting through planning policy, as it is the area most easily influenced by policy and addressed by client and design teams during the planning process.

To have the greatest immediate influence on the design and construction of buildings in the South Downs National Park, the primary focus for this evidence base is upfront carbon.

> *"Upfront carbon emissions are GHG emissions associated with materials and construction processes up to practical completion (modules A0-A5). Upfront carbon excludes the biogenic carbon sequestered in the installed products at practical completion."*

RICS 2023 definition of upfront carbon



Modular information for the different boundaries of the building assessment. *This version of the diagram is adapted from a combination of the diagram from the BS EN 15978, RICS 2023 and LETI.*

Return to contents >

Executive summary – Why is the SDNPA proposing limits to embodied carbon in new buildings?

The South Downs National Park Authority climate change commitments

The South Downs National Park Authority (SDNPA) formally committed to accelerated, comprehensive climate action in March 2020 by adopting its first Climate Change Strategy and Action Plan. This has since been updated to cover the period of 2026-2031 and states: "*Working together as a National Park family, we have ambitious targets to reach net zero by 2040*".

The Authority has duties and powers to mitigate climate change

The National Planning Policy Framework 2023 recognises that the Climate Change Act 2008 duties are relevant to planning for climate change. Paragraph 158 requires that local plans should "take a proactive approach to mitigating and adapting to climate change". Section 19 of the Planning and Compulsory Purchase Act 2004 requires that development plan documents must include policies designed to secure that development and use of land "contribute to mitigation of, and adaptation to, climate change".

There is no minimum requirement in Building Regulations?

Unlike operational energy which has building regulations Part L to reduce emissions from building in-use. There are no regulations on the reduction of carbon emissions associated with embodied carbon. Therefore planning policy is required to fill this gap.

Together for Nature, Climate and People – South Downs National Park Partnership Management Plan 2026-2031

Planning and Compulsory Purchase Act 2004

2004 CHAPTER 5

An Act to make provision relating to spatial development and town and country planning; and the compulsory acquisition of land.
[13th May 2004]

Climate Change Act 2008

2008 CHAPTER 27

The SDNPA has primary duties and powers to mitigate change, including the impact of new development

Return to contents >

Executive summary – The need to reduce upfront carbon emissions

The South Downs National Park Embodied Carbon Policy Study provides an evidence base for the setting of embodied carbon planning policy, to contribute to the delivery of net zero carbon buildings.

The importance of reducing embodied carbon emissions

Addressing the national carbon emission targets for the building sector has traditionally focused on reducing operational carbon emissions (associated with energy consumed in a building) through regulation and planning policy. However, as buildings become more energy efficient, the operational carbon emissions are reduced. Therefore, embodied carbon emissions associated with the materials are a greater portion of the total carbon emissions of a building.

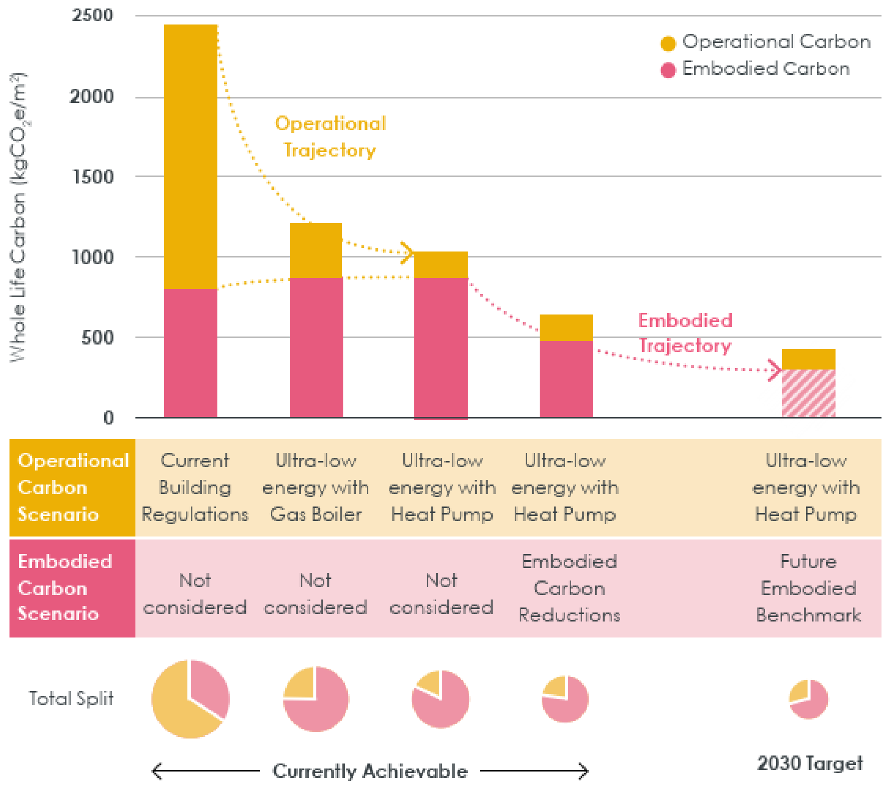
Addressing embodied carbon and the circular economy through planning policy is vital to meet local and national climate targets.

Bringing embodied carbon into policy

Despite the absence of building regulation in England to reduce embodied carbon, local authorities have a duty to mitigate climate change through planning policy. An increasing number of local authorities (Greater London Authority, Westminster City Council, City of London, Bath and North East Somerset, Bristol City Council and some others emerging now) are incorporating embodied carbon and/or whole life carbon considerations into planning policy. The SDNPA has appointed a parallel evidence-led net zero operational carbon policy, the embodied carbon policy recommendations in this study complement the net zero operational carbon policy study.

To have the greatest immediate influence on the design and construction of buildings in the South Downs National Park, the primary focus for this evidence base is on upfront carbon. This includes the carbon locked in a building up to its practical completion (material manufacturing, transport, use on-site and waste), and it represents the parts of embodied carbon where planning policy has the greatest influence.

To this end, comprehensive upfront carbon and capital cost modelling has been carried out on two house types and one commercial use class to assist in setting policy limits. Policy requirements have been recommended across domestic and non-domestic building types.



General operational and embodied carbon trajectories for buildings in the UK. As operational emissions are reduced in new buildings, the proportion of embodied carbon emissions becomes higher. (Source: LETI)

Return to contents >

Executive summary – Wider considerations for embodied carbon in planning policy

The recommended policy requirements for embodied carbon sit within a wider context with the following considerations:

Links between operational and embodied carbon policies

The focus should be on reducing embodied carbon alongside and in support of ultra-low energy buildings, as opposed to trading one off another.

Solar PV offers one of the lowest carbon forms of electricity generation available, and it is getting better all the time. For this reason, it is one of the central technologies for decarbonising our energy supply.

To prevent an unwanted trade-off of carbon between the operational energy and embodied carbon policies, PV panels to generate energy and solar shading to minimise overheating have been calculated separately/excluded from calculations. These are necessary elements of a building for net zero operational carbon and it is not intended to detract from the use of low embodied carbon materials for solar shading elements.

Net Zero Carbon Building Standard – well evidenced targets

The Net Zero Carbon Building Standard (NZCBS) represents the biggest cross industry working group that has looked at a net zero carbon standard. The research is a comprehensive review of previous guidance and targets and pulls information from a variety of data sources (including planning submissions, assessment databases) to arrive at proposed limits for different building types. However, the limits set in the Standard represent the best practice and are therefore not yet suitable for use in policy. The limits are however useful as benchmarks to understand performance.

Understanding current and future costs and non-cost factors

Reducing the upfront and life cycle embodied carbon of a building does not necessarily mean higher capital costs. Contrary to this, adopting strategies such us lean and circular economy design can reduce capital costs.

Many of the strategies that a contractor might propose to reduce upfront and life cycle embodied carbon will have little or no material impact on cost. These might include:

- Resource efficiency and circularity measures that reduce wastage, entail the selection of reused materials or those containing higher levels of recycled content.
- Effective co-ordination of designs and management of site teams to reduce wastage.
- Designing for effective maintenance and disassembly, for example through use of mechanical fixings in cladding systems.

Some specification changes may result in additional costs being incurred, however, it is critical to determine those that are likely to persist over the long term and those where any cost premium should dissipate over time as the supply chain becomes more mature and scale increases.

In much of England timber frame is considered a more expensive solution than the more typical masonry construction, yet in Scotland timber frame is predominant and is cost competitive on this basis. It is therefore important to distinguish between cost premiums that arise due to historic market practice rather than due to an underlying difference in cost base.

While material cost is an important component influencing the viability of a construction method, a range of other factors are also important and should be considered. These include: the ability of a low carbon construction or material solution to meet demand; transition/duplication of costs for organisations with refined existing supply chains; and risk for smaller companies to provide warranties for example.

Encouraging (but not mandating) use of natural building materials in the South Downs National Park will lead to increased market demand and provide opportunities for new businesses and supply chains to develop in response. Additional scale and local supply chains will help to reduce cost as well as transport related emissions while also supporting economic growth within the region.

Seeking outcomes

The preconception is that the introduction of embodied carbon policy could be challenging and costly to adhere to while bringing more burden to applicants and the submission process. This need not be the case. Policy can be streamlined to work hand in hand with a submission process that:

- rewards quality and clarity over quantity of submission
- uses guidance to apply policy proportionately across development scales.

Streamlining policy and process

The use of ready made RICS WLCA PS 2nd ed. reporting templates would help align with industry outputs, to save results being presented more than once.

Executive summary – Embodied carbon modelling and cost analysis (1/2)

To support the setting of upfront carbon limits, modelling and cost analysis has been carried out.

Typologies modelled

Three typologies have been modelled, two residential and one non-residential:

- Semi-detached house (3 bed)
- Terraced house (3 bed)
- Commercial use Class E.

Modelling

The upfront carbon models in this evidence base have been built from the ground up, using widely available industry data and following the RICS methodology to ensure alignment with standard practice.

The diagram opposite shows the modelling process for the houses, using a ‘materials database’, which feeds data to an ‘element library’, which is then used to construct an overall model and building scenarios. Scenarios 1 and 3 were formed to bring the higher and lower upfront carbon elements together. Scenario 2 was also created based on combination of cost and carbon optimised building elements.

On the commercial model, a range of tools and data sources were used and cross-referenced to ensure robustness and validity of results, including VERT, One Click LCA, Heyne Tillett Steel and the ICE Database.

Upfront carbon modelling results

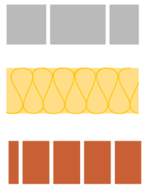
Houses - This study found that the total upfront carbon emissions of a semi-detached and terrace house can be more than 40% lower, when compared to traditional masonry construction (Scenario 1). This is through the use of an off-site timber frame construction, wood fibre and hempcrete insulation and render (Scenario 3).

Commercial use Class E – The total upfront carbon emissions of a commercial use Class E could be approx. 40% lower, when compared to a large grid concrete frame construction. This is through the use of Cross Laminated Timber (CLT) opposed to a rainscreen cladding system.

Modelling process - summary

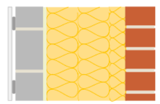
1 Material Database

- Enter carbon datapoints (KgCO_2 per kg) for each material/product. Modules A1-A5 upfront carbon which include material extraction, transport, and waste to practical completion, including upfront biogenic carbon.
- Datapoints entered for lots of materials/ products that represent UK average construction performance.
- Broken down into life stages



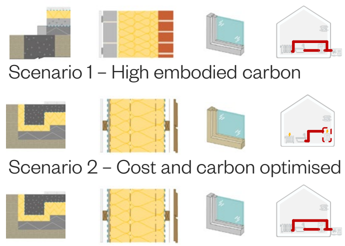
2 Element library

Combine materials to create the elements that are capable of achieving net zero operational carbon. Calculate the A1-A5 and upfront biogenic carbon of each element per sqm.



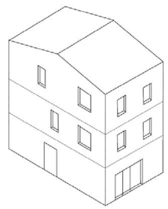
3 Scenarios per building typology

Combine the elements to create high, low and cost-carbon optimised upfront carbon scenarios for each element and typology. Carry out cost analysis for each scenario.



4 Building models

Categorise the elements according to RICS building elements guidance and analyse the upfront carbon and cost results per set menu, per building typology.



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Policy recommendations

Inform the embodied carbon policy recommendation for setting limits per typology.

Recommended policy

Return to contents >

Executive summary – Embodied carbon modelling and cost analysis (2/2)

Upfront carbon modelling results

The graph shows the upfront carbon for two house types and a commercial building. All typologies include a 'typical' net zero operational building (Baseline), which uses commonly specified construction materials at a level to meet operational net zero construction (e.g. extra insulation, low carbon heating systems etc).

The residential typologies include three scenarios: the higher carbon (Scenario 1), lower carbon (Scenario 3) and cost and carbon optimised (Scenario 2). Similarly, the commercial typology includes three scenarios: business as usual structural design (Scenario 1), structural grid dimensions optimised (Scenario 2) and low carbon materials (Scenario 3). For further detail see Appendix 5.3.

Cost analysis

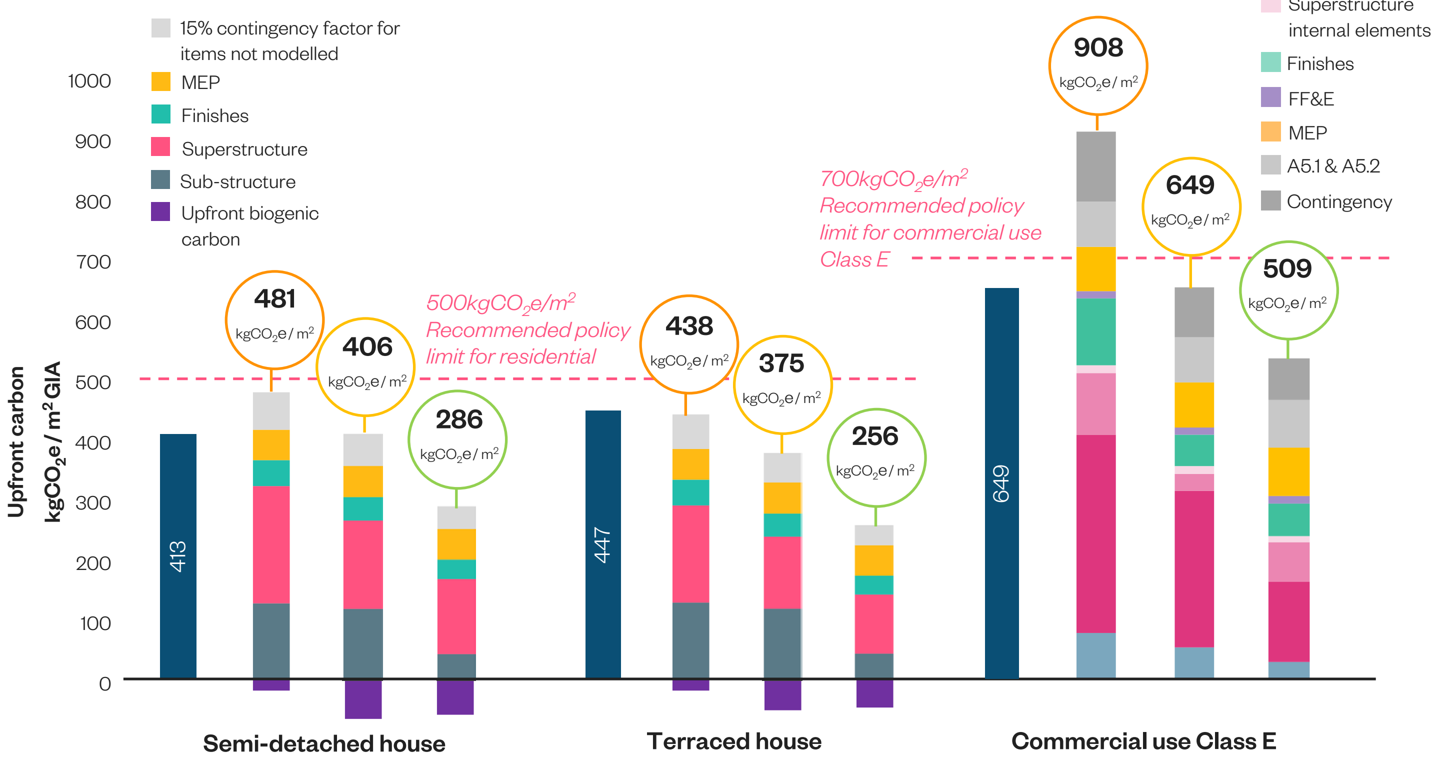
The percentage impact on overall build costs of each of modelled scenario compared to the 'typical' net zero operational carbon specifications has been shown opposite.

Meeting an upfront carbon target of 500kgCO_2e/m^2 GIA for residential or 700 kgCO_2e/m^2 for non-residential is not expected to add any cost to meeting operational net zero. This is because all scenarios tested including the baseline are below the recommended policy limits, or can be designed without additional cost (e.g. scenario 1 of non-domestic). The setting of these limits has the advantage of preventing poor performance while ensuring there is some consideration of building form, typology and material selection, without seeking to exclude specific materials or designs. It also allows a transition period for embodied carbon modelling to become normalised in the SDNPA without policy limits being perceived as onerous.

Future limits for consideration

This study recommends reviewing the limit every 3-5 years to determine if it can be tightened or altered in planning policy.

Upfront carbon emissions A1-A5 and cost uplift



	Baseline 'Typical' net zero operational	Scenario 1 Highest embodied carbon	Scenario 2 Cost and carbon optimised	Scenario 3 Lowest embodied carbon	Baseline 'Typical' net zero operational	Scenario 1 Highest embodied carbon	Scenario 2 Cost and carbon optimised	Scenario 3 Lowest embodied carbon	Baseline 'Typical' net zero operational	Scenario 1 Business as usual	Scenario 2 Optimised structural grid	Scenario 3 Low carbon structure
Cost difference from a 'typical' net zero operational building	0%	+2.4%	+1.4%	+2.5%	0%	+2.3%	+1.8%	+1.6%	0%	+6.8%	0%	-0.7%
Cost uplift to meet the recommended upfront carbon policy limits	0%				0%				0%	*Does not meet the limit*	0% to -0.7%	

Return to contents >

Executive summary – Policy conclusions and recommendations

A summary of the recommended limits and targets for policy is displayed on the right side of this page.

Recommended limit for policy

Residential (<11m) - 500 kgCO_2e/m^2 GIA

Setting the limit for low-rise housing (under 11m for purposes of building regulations Part B) at <500 kgCO_2e/m^2 GIA would be a relatively loose limit to begin with to allow applicants and planning officers in the South Downs National Park to get used to carrying out or reviewing upfront carbon calculations. It has the advantage of preventing poor performance while ensuring there is some consideration of building form, typology and material selection, without seeking to exclude specific materials or designs.

Recommended limit for policy - 700 kgCO_2e/m^2 GIA

On the basis that all three tested scenarios are technically feasible while still allowing a range of design responses, the recommendation is to adopt a limit of < 700 kgCO_2e/m^2 GIA in policy for use Class E shell and core and Cat A fit out. This allows a typical palette of materials to be used but requires some thought about material efficiency and lean design measures to meet the limit. This also provides a cost neutral outcome.

While a simple shell and core commercial building should be able to meet an upfront carbon limit of <600 kgCO_2e/m^2 (GIA), there are likely to be multiple other performance and contextual factors that suggest a higher limit should be used at the introduction of the policy with a mechanism to reduce during the policy period.

Future limits for consideration

We recommend reviewing the limit every 3-5years to determine if it can be lowered or should be altered.

Upfront carbon

≤ 500

kgCO_2e/m^2 GIA

Recommended policy limit for residential buildings <11m in height

Upfront carbon

≤ 700

kgCO_2e/m^2 GIA

Recommended policy limit for commercial use Class E buildings

Return to contents >

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The justification for embodied carbon policies

The need for embodied carbon policy in the UK

Global climate emergency

There is overwhelming scientific consensus that significant climate change is happening. This is evidenced in the latest assessment of the Intergovernmental Panel on Climate Change (IPCC AR6). The IPCC Synthesis Report, published in 2023, summarises five years of reports on global temperature rises, fossil fuel emissions and climate impacts. To keep within the 1.5°C limit, emissions need to be reduced by at least 43% by 2030 compared to 2019 levels, and at least 60% by 2035. This is the decisive decade to make that happen.

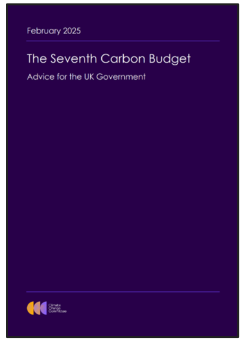
National commitment

The UK's national commitment is set through the Climate Change Act 2008, which was updated in 2019. It legislates that the UK must be net zero carbon by 2050 and sets a system of carbon budgets to ensure that the UK does not emit more than its allowance in the next 27 years. This legal requirement is underpinned by the Climate Change Committee's (CCC) report '*Net Zero: The UK's Contribution to Stopping Global Warming*'. Net Zero is not only about a destination: a very significant and fast decarbonisation pathway is needed. The Climate Change Committee's Seventh Carbon Budget (Feb 2025) highlights that the embodied carbon from materials features in the top three highest emitting UK sectors ('surface transport' to move materials, 'residential buildings' to influence the performance of the fabric, and 'industry' in the making of the materials). The scope of the budget includes the reduction of emissions associated with products manufactured in the UK but not those used in the UK and manufactured elsewhere. By including embodied carbon (emissions from construction process, maintenance and demolition of the building) in planning policy it will not only assist local authorities in meeting the CCC's carbon budget, but could also positively influence the decarbonisation efforts of other countries manufacturing building materials for the UK.

The CCC's Key actions for the Seventh Carbon Budget suggests that minimum standards should be set for the whole-life carbon impact of products that are at risk of increasing the UK's imported emissions. This could include new rules to measure and limit the embodied carbon of buildings.

As part of the Sixth Carbon Budget the CCC called on government to agree a standard for the 'whole-life' carbon footprint of buildings and infrastructure with industry; introduce mandatory disclosure of whole-life carbon in buildings and infrastructure; and introduce a mandatory minimum whole-life carbon standard for both buildings and infrastructure which strengthens over time. To date, no building regulations have been introduced to tackle embodied or whole life carbon.

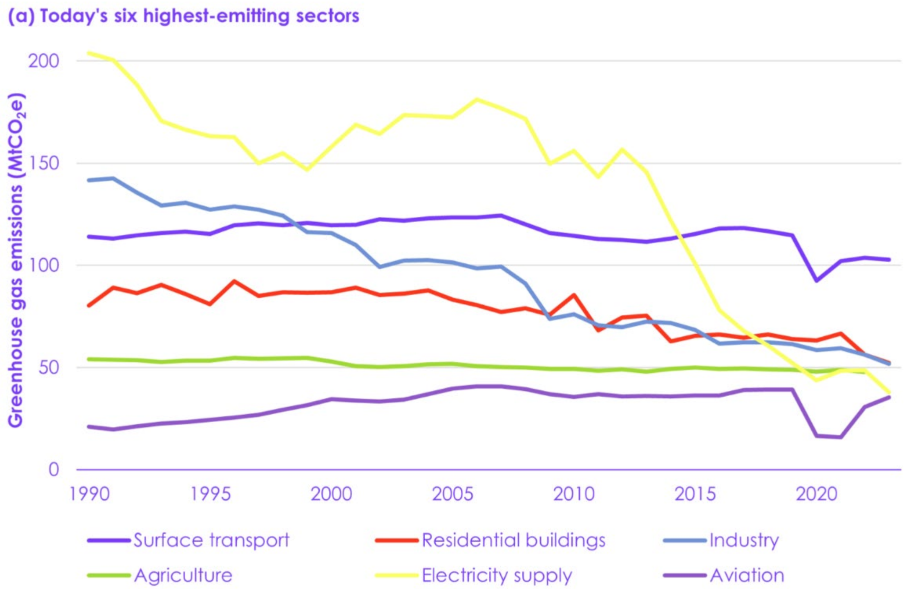
Net Zero: The UK's Contribution to Stopping Global Warming (Source: CCC, 2019)



The seventh carbon budget (Source: CCC, 2025)

The UK's path to Net Zero

"By the middle of the Seventh Carbon Budget, on our pathway, emissions in the UK will be only a quarter of the level they are today, and 87% lower than levels in 1990"



Climate Change Committee – Seventh Carbon Budget – The residential building sector has been the second highest emitter of greenhouse gas emissions by sector since 2017. The emissions from these buildings are closely linked to their operational energy use, which relies on the building fabric to be effective. Embodied carbon is inherently locked up in the building fabric and therefore affects the ability to bring building emissions down. Embodied carbon also features in the first and third highest emitters – surface transport and industry, from which materials are moved and processed.

Return to contents >

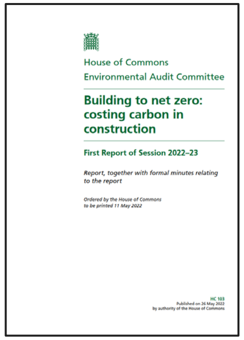
Building regulation is not addressing embodied carbon, creating a policy gap (1/2)

National policy and regulation does not address embodied carbon

On 13th December 2023, the government published a consultation on the Future Homes and Buildings Standard, which claims that new buildings built from 2025 will produce 75-80% less carbon emissions than buildings delivered under the 2021 Building Regulations. However, the consultation does not address embodied carbon even though the CCC recommended that a whole life carbon standard for homes should be included within the Future Homes Standard, as part of the Policies for the Sixth Carbon Budget.

In May 2022, the Environmental Audit Committee (EAC) published a report, urging the government to start acting now on the impact of embodied carbon by stating "*if the UK continues to drag its feet on embodied carbon, it will not meet net zero or its carbon budgets*". The report examines and proposes the best routes to achieve net zero, including:

1. Introducing a mandatory requirement to undertake whole life carbon (WLC) assessments for new buildings as part of the Future Homes Standard.
2. Establishing the RICS methodology as the UK industry standard for WLC assessments and develop a centralised national database of environmental product declarations (EPDs).
3. Learning from international best practice embodied carbon regulation.
4. Investing in research and incentivising low-carbon and re-used materials.
5. Evaluate and inform the impact of permitted development rights on retrofit.
6. Requiring circular economy statements, including pre-demolition audits in planning applications when it entails demolition of existing buildings.


House of Commons
Environmental Audit Committee

Building to net zero: costing carbon in construction

First Report of Session 2022–23

Report, together with formal minutes relating to the report

Ordered by the House of Commons to be printed 11 May 2022

HC 103
Published on 26 May 2022
by authority of the House of Commons

Costing carbon in construction (Source: Environmental Audit Committee (EAC))

EAC- Building to net zero: Costing carbon in construction

"We recommend that the Government introduce, not later than December 2023, regulations to mandate whole-life carbon assessments for buildings above a gross internal area of 1,000m^2, or which create more than 10 dwellings.

This requirement should be established in Building Regulations, and ought to be reflected in the planning system through national planning policy. Local authorities should be encouraged and supported to include this requirement within their Local Plans ahead of the introduction of national planning requirements."

Return to contents >

Building regulation is not addressing embodied carbon, creating a policy gap (2/2)

Policy position paper

In February 2024, the UK's leading embodied carbon experts issued a paper to political leaders requesting the inclusion of embodied carbon regulation as part of their manifesto for the 2025 general elections. This champions the use of the industry proposed Part Z.

Consideration of measuring and reducing embodied carbon in new buildings

AECOM were commissioned by the Ministry of Housing, Communities and Local Government (MHCLG) to understand the sector-wide technical, practical, and economic impacts of carbon assessments. *"Overall, the widespread measurement and reduction of embodied carbon in new buildings will not only help achieve net zero aims but also help to increase employment in green jobs and give people the ability to up-skill in an emerging market."*

Some of the considerations identified in the conclusion include:

- Standardising approaches and assumptions to drive consistency
- Improving carbon data quality and availability.
- Drive consistency within carbon tools
- Instil tracking of carbon assessments
- Upskilling the whole construction industry in low carbon design
- Addressing challenges within the insurance market for new and innovative materials.

Creating policy incentives for low carbon design measures is also a key recommendation in the conclusion of this research. It is expected to drive action and improvement on all the above considerations.

The report also included an indication of process costs for the various levels of embodied and whole life carbon reporting.

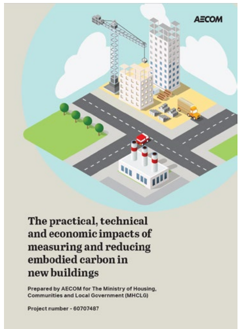
January 2024: Policy paper by Part Z group of experts

Policy position paper – a call to the party leaders

"The undersigned groups call on party leaders to make the following manifesto commitments

Key ask: *Our government will move to reduce embodied carbon emissions in building construction within two years of taking office.*

Specific steps: *Within six months of taking office: Policy signalled confirming the dates and interventions below. By 2026: Mandate the measurement and reporting of whole-life carbon emissions for all projects with a gross internal area of more than 1,000m^2 or that create more than 10 dwellings. By 2028: Introduce legal limits on the upfront carbon emissions of such projects, with a view to future revision and tightening as required."*



July 2025: Consideration of measuring and reducing embodied carbon in new buildings

MHCLG and AECOM research paper

"The aim of this research into the sector-wide practical, technical, and economic impacts of measuring and reducing embodied carbon is to inform policy driven embodied carbon reductions and better understand the cost of building with reduced embodied carbon."

Return to contents >

The powers and duties of local authorities to address climate change

The role of local authorities

Both operational and embodied carbon must be reduced to address the climate crisis. However, upfront carbon is emitted as part of the construction process, this means the client/developer has control over emissions.

As embodied carbon is not addressed at the national level it is left for local authorities to fill the gap in their planning policies and decision making. The role of local authorities in mitigating climate change in the UK and delivering sustainable development is articulated in statute and guidance.

A Local Plan would be expected to address:

- **Section 19(1A) of the Planning and Compulsory Purchase Act 2004**, which requires local planning authorities to include in their Local Plans "*policies designed to secure that the development and use of land in the local planning authority's area contribute to the mitigation of, and adaptation to, climate change*".
- The **Climate Change Act 2008**, which establishes a legally binding target to reduce the UK's greenhouse gas emissions by 100% in 2050 from 1990 levels. To drive progress and set the UK on a pathway towards this target, the Act introduced a system of carbon budgets.
- The **Planning and Energy Act 2008,** which empowers local planning authorities to include policies in their development. plans that impose "reasonable requirements" for energy efficiency and generation.
- The **National Planning Policy Framework (NPPF),** updated 2023, states that a main objective of the planning system is environmental, and that *"using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy"* form part of this objective. Paragraph 20 sets an expectation that *"strategic policies ... make sufficient provision for" "conservation and enhancement of the natural, built and historic environment including landscapes and green infrastructure...to address climate change mitigation and adaptation"* Footnote 61, para 158 also requires local plans' approach to climate change to be in line with the objectives and targets of the Climate Change Act 2008. The Dec 2025 NPPF Consultation proposed to remove the powers of local authorities to set their own energy efficiency standards through PM13, particularly if they were already covered by regulation. However, this proposal lacked justification and evidence, it was also not made sufficiently clear if this would extend to embodied carbon emissions. Determination on the updates to the NPPF are pending at the time of writing this evidence base.

By setting an embodied carbon policy in Local Plans, authorities would be responding appropriately to the relevant statutes. Local authorities have primary powers to act on their duty to mitigate climate change.

To this end, there is a growing number of local authorities requiring embodied carbon and/or whole life carbon in policy (see pages 22-23 and Appendix 5.2 for examples).

Planning and Compulsory Purchase Act 2004

2004 CHAPTER 5

An Act to make provision relating to spatial development and town and country planning; and the compulsory acquisition of land.

[13th May 2004]

Climate Change Act 2008

2008 CHAPTER 27

An Act to set a target for the year 2050 for the reduction of targeted greenhouse gas emissions; to provide for a system of carbon budgeting; to establish a Committee on Climate Change; to confer powers to establish trading schemes for the purpose of limiting greenhouse gas emissions or encouraging activities that reduce such emissions or remove greenhouse gas from the atmosphere; to make provision about adaptation to climate change; to confer powers to make schemes for providing financial incentives to produce less domestic waste and to recycle more of what is produced; to make provision about the collection of household waste; to confer powers to make provision about charging for single use carrier bags; to amend the provisions of the Energy Act 2004 about renewable transport fuel obligations; to make provision about carbon emissions reduction targets; to make other provision about climate change; and for connected purposes. 9

[26th November 2008]

Department for Levelling Up, Housing & Communities

National Planning Policy Framework

Relevant statutes and guidance for planning policy

Return to contents >

Planning policy that focuses on both embodied carbon and operational carbon

The need to reduce embodied carbon emissions

According to the Low Energy Transformation Initiative (LETI) Climate Emergency Design Guide the UK building construction industry is responsible for approximately 49% of total UK carbon emissions. These are the sum of operational energy emissions (heating, hot water, lighting, ventilation and plug loads) and the embodied carbon emissions associated with materials, components and systems. To date, reductions in operational energy has been the main focus. It is essential to consider operational energy and embodied carbon in tandem, as measures implemented to reduce operational carbon emissions can affect the embodied carbon and vice versa.

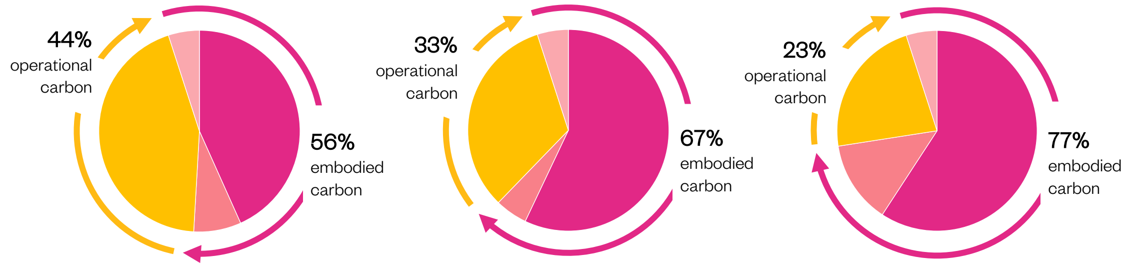
According to Net Zero Whole Life Carbon Roadmap technical report published by the UK Green Building Council in 2021 ''*Embodied carbon emissions contribute to some 40-50 million tonnes of* CO_2 *annually, more than emissions from aviation and shipping combined*''. Therefore, addressing embodied carbon is vital to meet national and local climate targets.

Embodied carbon vs operational carbon

As new buildings become more efficient, operational carbon emissions increasingly reduce. As a result, embodied carbon emissions make up a greater proportion of the total building whole life carbon. Therefore, it is important that the life cycle carbon emissions are considered, to make sure the built environment industry is designing, constructing and operating buildings that have overall low carbon emissions. The pie charts on the right demonstrate the whole life carbon emissions breakdown for three residential buildings with different energy use intensities (EUIs) for operational carbon.

The importance of embodied carbon emissions

Addressing embodied carbon through legislation and policy is vital to meet local and national climate targets. As embodied carbon relates to materials, it is also important to develop policies that help to transition to a circular economy, in which the resource intensive linear process of use and disposal is stopped.



EUI 60 kWh/m² – with gas

Building regs compliant with gas heating, business as usual embodied carbon

Operational carbon (B6) makes up the largest proportion of whole life carbon, due to the inefficiency of the gas heating system

EUI 60 kWh/m² - all electric

Building regs compliant with electric heating and improved embodied carbon

Upfront carbon (A1-A5) makes up the largest proportion of whole life carbon.

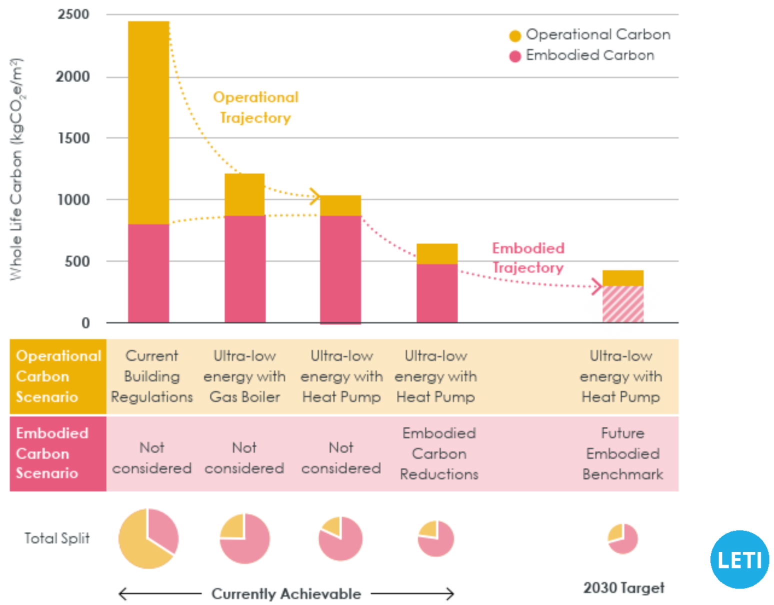
EUI 35 kWh/m² - all electric

Ultra-low energy fabric with heat pump, best practice embodied carbon

Upfront carbon (A1-A5) makes up the largest proportion of whole life carbon.

Key – WLC boundaries

- (A1 – A5) Upfront carbon
- (B1-B5) Maintenance and replacements
- (B6) Operational carbon
- (C1-C4) End of life disposal



The LETI operational and embodied carbon trajectories demonstrate that as operational emissions are reduced in new buildings, the proportion of embodied carbon emissions becomes higher. (Source: LETI)

Return to contents >

South Downs National Park Authority’s ambition

South Downs Climate Change Action Plan

The South Downs National Park Authority (SDNPA) formally committed to accelerated, comprehensive climate action in March 2020 by adopting its first Climate Change Strategy and Action Plan.

The climate and nature emergency was to be addressed by:

- Setting a target for the South Downs National Park Authority to become a ‘Net-Zero’ Organisation by 2030
- Agreeing to work with constituent Local Authorities in the South Downs National Park (SDNP) and other partners, in particular local communities and landowners, to deliver actions that respond effectively to the climate and nature emergency
- Working towards the SDNP becoming ‘Net-Zero with Nature’ by 2040, a strategy focusing on carbon sequestration, nature restoration, and sustainable land management

The Action Plan is updated every year, with the latest SDNP Climate Action Plan - 2024-25 transitioning from planning to active delivery, with a particular emphasis on "Net Zero with Nature" initiatives, enhanced community action, and mandatory biodiversity net gain.

Together for Nature, Climate and People (2026 -2031)

The South Downs National Park Partnership Management Plan is set out to shape the future of the South Downs National Park. It is a Partnership Management Plan (PMP) but it does not contain planning policies.

The document states that *‘The South Downs National Park is on track to become net zero by 2040 by mitigating and adapting to the impacts of climate change’,* defining net zero as *‘no longer adding to the total amount of greenhouse gases in the atmosphere’.*

The South Downs National Park has joined the United Nations backed “Race to Zero”, committing to drive action to halve carbon emissions within their landscapes by 2030 and to become significant net carbon sinks by 2050.

Together for Nature, Climate and People – South Downs National Park Partnership Management Plan

Return to contents >

2

Embodied carbon explained

Areas of influence for embodied carbon planning policy

Embodied carbon metrics should be combined with operation energy to ensure a holistic approach in planning policy.

This page outlines the policy areas that can have the greatest effect on the design, construction and performance of a building:

1 Energy efficient fabric and ventilation

Space heating demand (kWh/m^2_{GIA}/yr)

The building should achieve an ultra-low level of space heating demand, in line with the recommendations of the Climate Change Committee.

2 Low total energy use

Energy Use Intensity (EUI) (kWh/m^2_{GIA}/yr)

The predicted level of total energy use of the building (regulated and unregulated) should be less than a limit.

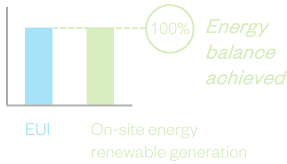
3 Fossil fuel free

Yes/ No

The budling must not connect to the gas network or, more generally, use fossil fuels on-site. It must use a low carbon heating system (e.g. heat pump).

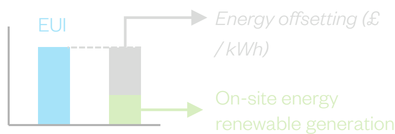
4 On-site renewable energy generation

% of total energy use



The building should seek to generate as much renewable energy as possible. Ideally there should be a balance between predicted annual energy use (EUI) and annual renewable energy generation.

5 Energy offsetting as last resort

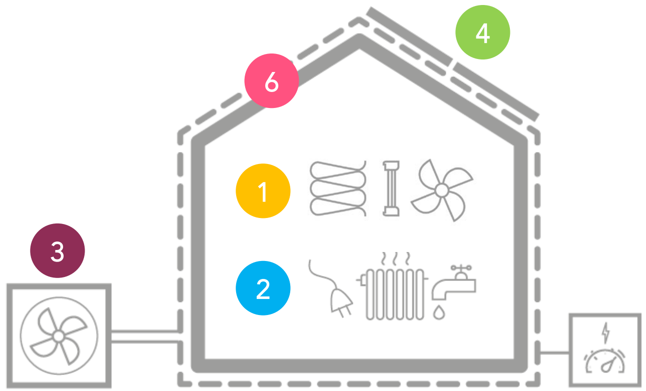


If the building cannot generate enough renewable energy to match energy use on an annual basis, an energy offset contribution will be required.

6 Embodied carbon

Upfront carbon limit (kgCO_2e/m^2_{GIA})

Building design should also minimise embodied carbon in materials throughout their lifecycle.



Return to contents >

Embodied carbon in the wider carbon context

The making of materials, their transport, repair and deconstruction affects how much carbon is associated with them. Embodied carbon is assessed through the use of different boundaries. This page provides a summary of the key boundaries and the terms associated with them. Upfront and lifecycle embodied carbon is measured in tonnes (tCO_2e) and is normalised to $kgCO_2e/m^2$. For example, if the volume of concrete in one building is the same as that of another, they will emit the same total tCo_2e. However, if one building is twice the area of the other, when normalised, it will become obvious that the smaller building has higher emissions per m^2 GIA ($kgCO_2e/m^2$).

Upfront carbon

Upfront carbon refers to the greenhouse gas emissions associated with material and construction stages: raw material supply, manufacture, transport and construction of all building elements.

Life cycle embodied carbon

Life cycle embodied carbon includes both upfront carbon and the embodied carbon associated with:

- In-use - maintenance, replacement and refrigerant leakage.
- End of life - waste processing of demolition/deconstruction and disposal of any products.

Operational carbon

Operation carbon refers to the emissions associated with energy and water use during operation.

User carbon

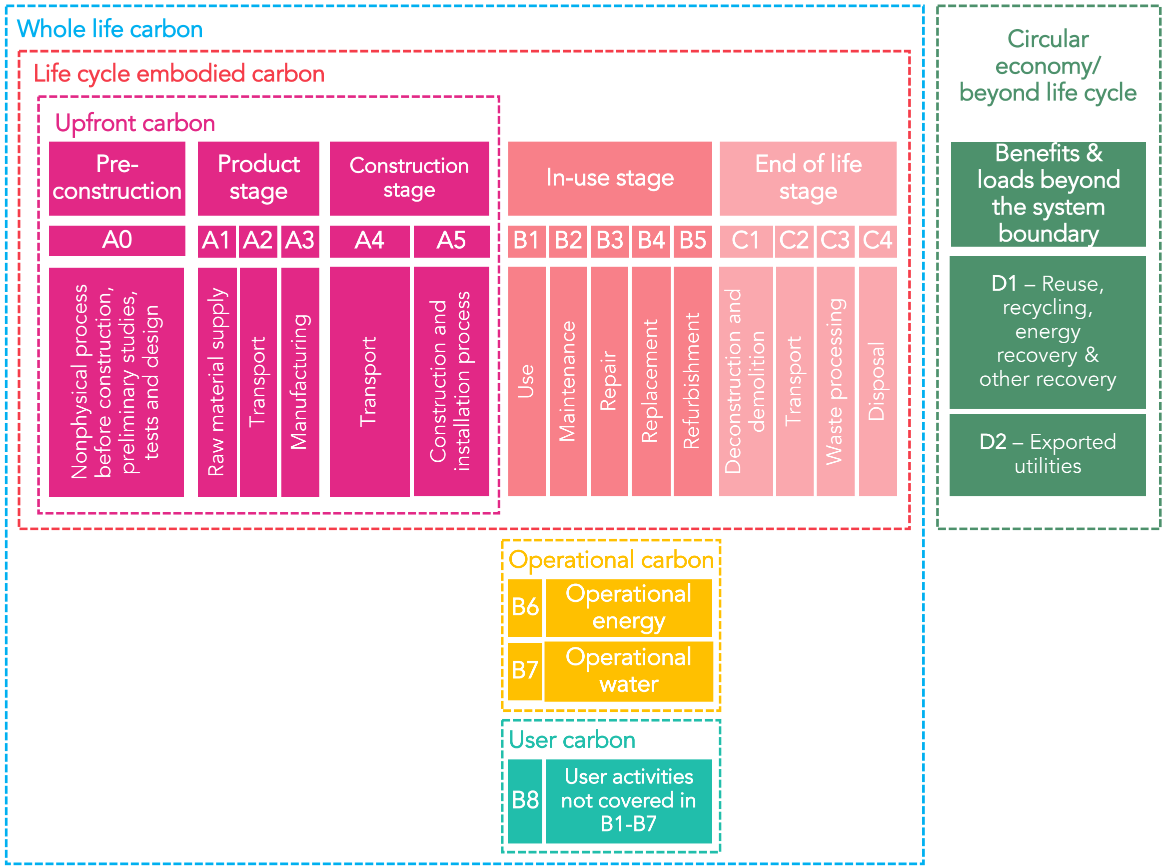
User carbon covers the emissions from user activities, outside of the use of energy and water emissions from the operation of the building. An example includes transport or vehicle charging. This module is typically outside the remit of building design.

Whole life carbon (WLC)

For buildings, whole life carbon is the sum of life cycle embodied carbon and operational carbon.

Circular economy/beyond life cycle

A circular economy seeks to ensure materials can be re-used again and again and are ultimately diverted from landfill or incineration. This builds on embodied carbon principles, such as material re-use, recovery and recycling.



Modular information for the different boundaries of the building assessment. *This version of the diagram is adapted from a combination of the diagram from the BS EN 15978, RICS 2023 and LETI.*

RICS 2023 definitions:

Greenhouse gases (GHGs) (often referred to as 'carbon emissions')

"Constituents of the atmosphere, both natural and anthropogenic (human-created), that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds."

Carbon dioxide equivalent (CO_2e)

"A metric for expressing the impact of all greenhouse gases on a carbon dioxide basis."

Upfront and life cycle embodied carbon explained further

Upfront carbon

Upfront carbon refers to the greenhouse gas emissions associated with material and construction stages: raw material supply, manufacture, transport and construction of all building elements.

Designers have the greatest ability to reduce upfront carbon pre/post-planning by considering how a new building can be optimally designed and through the materials specified. This lends itself to benchmarking or target setting through planning policy, as it is the area most easily influenced by policy and addressed by client and design teams during the planning process.

Industry targets such as LETI and the UK Net Zero Carbon Building Standard are framed around upfront carbon (modules A1-A5) and some recently adopted planning conditions across the UK also focus on these modules. See Section 3 for further information.

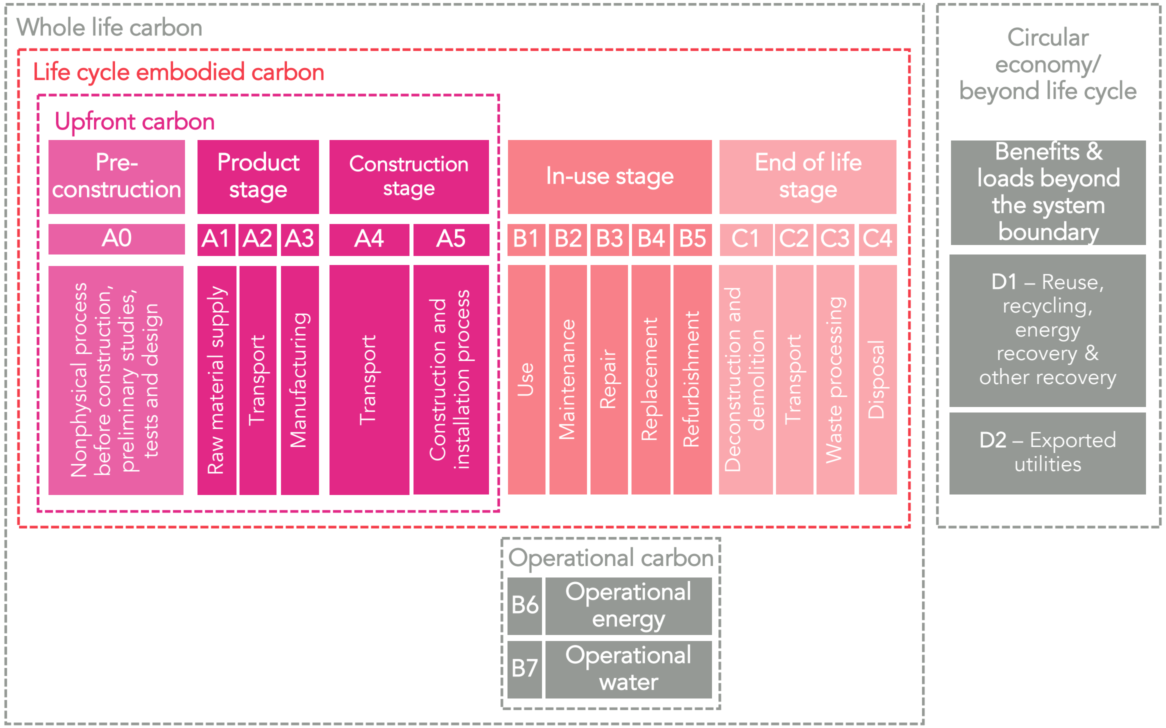
Module A0 (pre-construction stage) covers non-physical pre-construction activities, such as surveys and activities associated with the design of the asset. For buildings, these emissions do not normally have a significant environmental impact and therefore, are assumed to be negligible. Module A0 has a greater significance for larger infrastructure projects.

To have the greatest immediate influence on the design and construction of buildings in the South Downs National Park, the primary focus for this evidence base will be on upfront carbon.

Life cycle embodied carbon

Life cycle embodied carbon includes both upfront carbon (above) and the embodied carbon associated with the building in-use and at the end of life.

While design teams have some influence of the B and C modules in new build (through robust design, specification, and design for deconstruction), building owners and occupiers who will maintain and refurbish the building will have the most influence. This makes life cycle embodied carbon more complex to integrate into planning policy through target setting or benchmarking. Planning policies set around life cycle carbon may benefit from being more qualitative than quantitate. However, examples exist of planning policies and industry targets that consider life cycle carbon.



Building assessment modules with a focus on life cycle and upfront carbon. *This version of the diagram is adapted from a combination of the diagram from the BS EN 15978, RICS 2023 and LETI.*

RICS 2023 definition:

Life cycle embodied carbon

> *“The embodied carbon emission of an asset are the total green house gas (GHG) emissions and removals associated with materials and construction processes, throughout the whole life cycle of an asset (modules A0-A5, B1-B5, C1-C4, with A0 assumed to be zero for buildings).“*

Upfront carbon

> *“Upfront carbon emissions are GHG emissions associated with materials and construction processes up to practical completion (modules A0-A5). Upfront carbon excludes the biogenic carbon sequestered in the installed products at practical completion.“*

3

Industry guidance and policies on embodied carbon

Industry standards and supporting guidance for upfront carbon

RICS - Whole Life Carbon Assessment for the Built Environment

The Royal Institute of Chartered Surveyors (RICS) 'Professional Statement: Whole Life Carbon (WLC) assessment for the built environment' is the industry standard methodology for WLC assessments and provides supporting guidance in line with BS EN 15978 principles. The second edition (RICS Professional Statement (PS) v2 2023) is the most widely understood and comprehensive method for calculating embodied carbon emissions.

The document outlines the minimum scope required for a WLC assessment, including demolition, facilitating works, substructure, superstructure (structural element, building envelope, internal elements), finishes, fittings, furnishing and equipment (FF&E), services (MEP) and external works within the building's boundary. The RICS methodology accounts for sequestered carbon in materials separately but does not account for biogenic carbon losses from the existing site (existing plants, habitats, etc.).

The evidence generated in this study has followed the RICS Professional Statement (PS) v2 2023 methodology, to correlate with industry standards. It is also recommended that policy should align with this methodology too.

Industry guidance and standards

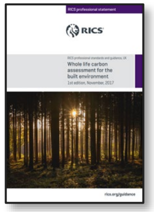
Built environment industry bodies have provided guidance and standards to raise awareness, improve performance and build upon more technical documents (such as RICS) for a wider group of professionals. This includes:

- LETI (Low Energy Transformation Initiative) Embodied Carbon Primer (2020)
- UKGBC Net Zero Carbon Net zero whole life carbon roadmap (2021)
- LETI Embodied Carbon Alignment work (2021)
- RIBA 2030 Challenge (2022)
- CIBSE TM 65 – Embodied carbon in building services (2022)
- The UK NZCBS v1 - a science-based methodology for achieving net zero carbon buildings in the UK (2026).

Other useful guidance and industry proposals

Other useful guidance also exists to assist consultants with calculating the embodied carbon of materials. In addition the industry has also set out a national campaign to mandate for WLCA in building regulations, called Part Z.

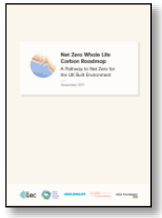
Professional standard assessment methodology:



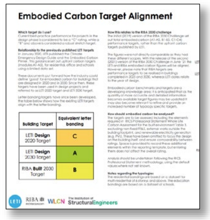
RICS 2017 (left) and 2023 (right) professional statements: Whole Life Carbon assessment for the built environment. The industry standard methodology for calculating embodied carbon emissions.

Industry guidance and standards:

LETI embodied carbon primer

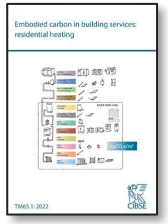


UKGBC – Net zero whole life carbon roadmap



LETI embodied carbon alignment

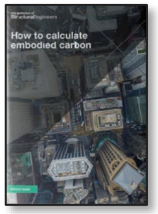
RIBA 2030 climate challenge



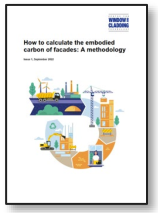
CIBSE TM 65 – Embodied carbon in building services

UK Net Zero Carbon Building Standard (v1)

Other useful guidance:



IStructE – How to calculate embodied carbon

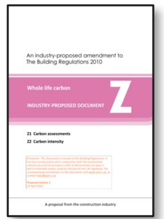


CWCT– How to calculate embodied carbon of facades

The concrete centre– Sustainable concrete

BAMB – Material passports

Industry proposal:



The Part Z proposal sought to provide a framework for bringing whole life carbon assessments and embodied carbon into building regulations.

Return to contents >

Industry standards continued - Net Zero Carbon Building Standard

Of the standards explored on the previous page, the most current and relevant is the UK Net Zero Carbon Building Standard :

UK Net Zero Carbon Building Standard (UK NZCBS) – well evidenced targets

Following a pilot testing period the UK NZCBS Version 1 was released in March 2026. It is a science-based standard, aligned with the 1.5deg Paris Agreement and achieving Net Zero in the UK by 2050. It was developed collaboratively by prominent industry bodies to form a single agreed definition of Net Zero Carbon and conclude a Standard for demonstrating whether it has been met.

As part of this, limits (energy use and embodied carbon) have been set using case study data submitted by the industry and correlated with technical feasibility and the national carbon budget. Following the release of Version 1, projects are now able to verify that they conform to the as-built/in-use metrics in the Standard.

The UK NZCBS sets limits for upfront carbon (A1-A5, $kgCO_2e/m^2$) by year, from 2025 to 2050, for new build and retrofit projects across a range of sectors. For new build residential schemes the limits between now and 2030 are as follows:

	Upfront carbon ($kgCO_2e/m^2$ GIA)					
Date of commencement	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Single family homes	403	400	375	345	320	290
Flats	565	525	490	450	420	380

The Standard's limits have been created to be achievable but ambitious, particularly for new buildings, informed by the required pathway for the UK built environment to stay within its energy and carbon budgets by 2050. The limits also assume/account for steep decarbonisation of material industrial processes.

In comparison to the to modelling carried out for this study the above figures are deemed to be particularly ambitious for use in planning policy and therefore, have not been relied upon, instead alternative limits are recommended to be set with review every 3-5 years.

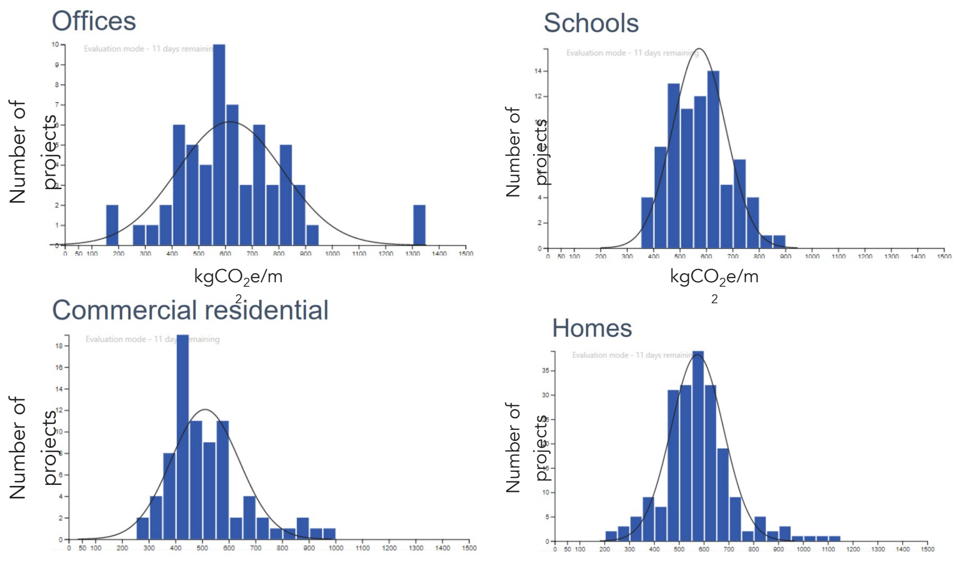
Use of the Standard in policy

In January 2026, the UK NZCBS published a note regarding use of the Standard in Planning Policy, it noted that "*the Standard may provide a useful reference point that policy officers can compare against*" but that "*it is not yet appropriate for policy to state that buildings need to be verified to meet the Standard*" because it "*is based on in-use performance [after 12 months], which sits outside the time period currently considered at Planning stage".*

UK Net Zero Carbon Building Standard (UK NZCBS) (Source: NZCbuildings) developed collaboratively by Better Buildings Partnership, Building Research Establishment (BRE), Carbon Trust, Chartered Institute of Building Services Engineers (CIBSE), Low Energy Transformation Initiative (LETI), Royal Institute of British Architects (RIBA), Royal Institute of Chartered Surveyors (RICS), Institute of Structural Engineers (IstructE), and UK Green Building Council (UKGBC).

Using the UK NZCBS in Planning Policy

(Source: NZCbuildings)



Upfront carbon case study data submitted by industry - The Standard's limits were developed based on analysis of in-use data collected from across the UK built environment industry, alongside an energy and carbon balancing exercise to define what building performance was needed to stay within the UK's carbon budget. The EUI limits and upfront carbon limits for new buildings depend on when the building work commences on site, and get more onerous over time. (Source: Net Zero Carbon NZCBS)

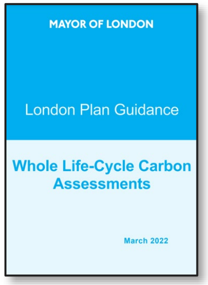
Summary of adopted embodied carbon policies and approaches in UK

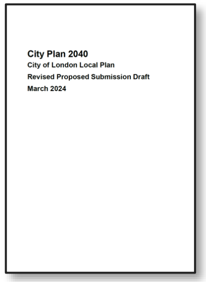
Adopted planning policy

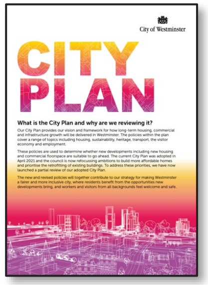
In the absence of national regulation, planning authorities across the UK have developed their own evidence bases and policy proposals that are in varying stages of adoption, public consultation and examination.

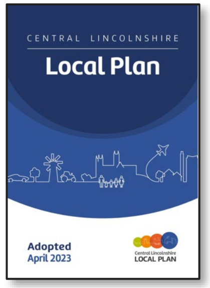
These new policies commonly utilise an upfront carbon metric ($kgCO_2e/m^2$) with the expectation that other policies are in place to require reporting and limiting of operational energy in $kWh/m^2/yr$.

This page summarises the adopted embodied carbon approaches to policy in the UK. With many more emerging polices currently in consultation. See Appendix 5.2 for further information.







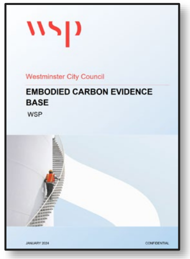


	Greater London Authority	City of London Council	City of Westminster Council	Central Lincolnshire Council	Bath and North East Somerset Council (B&NS)	Bristol City Council
Presumption against demolition	✗	✓	✓	✓	✗	✗
Embodied carbon assessment + reporting	✓ (whole life carbon assessment)	✓ (whole life carbon assessment)	✓ (whole life carbon assessment)	✗ (Seek to reduce embodied carbon only)	✓ (upfront carbon)	✓ (upfront carbon)
Meet embodied carbon target/limit/benchmark	✓ (benchmarks)	✓ (benchmarks)	✓ (either upfront of life cycle embodied carbon)	✗ (no targets/limits/ benchmarks)	✓ (limits for substructure, superstructure and finishes only)	✓ (upfront carbon targets)
Applies to	Referrable schemes	Major developments must submit a whole life-cycle carbon assessment	Major developments	All developments	Large scale new- build developments	Major developments
Other requirements	Demonstrate actions taken to reduce life-cycle carbon emissions	Development proposals should minimise whole life-cycle carbon emissions.	Demonstrate the maximum embodied carbon reductions deliverable without affecting the delivery of affordable housing	Take opportunities to reduce the development's embodied carbon	If the development is not compliant with the policy, a valid justification must be provided with the appropriate reasons and evidences.	Demonstrate actions taken to reduce life-cycle carbon emissions

Summary of embodied carbon evidence base studies in the UK

Evidence bases developed for planning policy

This page summarises the results from published evidence bases used to develop planning policy. The table below includes the upfront carbon emissions modelling results and limit/ target recommendations. See Appendix 5.2 for further information on these evidence bases.



	Evidence-base for West of England net zero building policy: embodied carbon	Westminster embodied carbon evidence-base	Essex embodied carbon policy study
Domestic buildings – results	Semi-detached house (<11 m in height): **310-520** kgCO_2e/m^2 Low to mid-rise apartment block (<18 m in height): **240-350** kgCO_2e/m^2	Mid to high-rise apartment block (>18 m in height): **685-893** kgCO_2e/m^2	Semi-detached house (<11 m in height): **405-480** kgCO_2e/m^2 Terrace house (<11 m in height): **375-440** kgCO_2e/m^2 Low-rise apartment block (<11 m in height): **360-430** kgCO_2e/m^2
Mixed-use buildings – results	✘ n/a	Mixed use - 45% Office, 45% Residential, 10% Retail (>18 m in height): **583-781** kgCO_2e/m^2	✘ n/a
Non-domestic buildings - results	Office (<18 m in height): **320-610** kgCO_2e/m^2 School (<18 m in height): **305-550** kgCO_2e/m^2	Office (>18 m in height): **579-802** kgCO_2e/m^2	✘ n/a
Limit/ target recommended	**All building typologies**: achieve LETI band C (residential 6+ storeys and education: <500 kgCO_2e/m2 , office: <600 kgCO_2e/m2) as a minimum target and set LETI band A (residential 6+ storeys and education: <300 kgCO_2e/m2 , office: <350 kgCO_2e/m2) as an aspirational target.	**All building typologies**: adopt NZCBS limits.	- **Low rise residential** (up to 11m): 500 kgCO_2e/m^2 - **Mid and high rise residential** (over 11m): 500 kgCO_2e/m^2 - **Non-domestic buildings**: adopt NZCBS limits.

4

Upfront carbon modelling for policy

Building typologies modelled

Typologies modelled

Three typologies have been identified as being relevant locally and have been modelled to determine the upfront carbon emissions and any associated cost uplifts:

- 3 bed semi-detached house
- 3 bed terraced house
- Commercial use Class E building

How building form affects embodied carbon

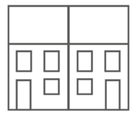
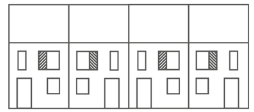
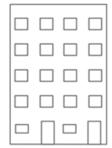
An efficient building form (lower form factor) is more likely to have reduced construction costs and emit less upfront carbon than a complex building form (higher form factor). This also supports a reduction in operational energy as part of wider policy. A form factor of 2.5 or below should be aimed for where possible to ensure the building is efficient to build and run.

Where other home typologies are built, such as detached houses or bungalows, they will likely require more careful consideration of the materials used to ensure they are low carbon to build within policy limits.

Commercial buildings scale

Commercial buildings within the South Downs Local Plan are subject to a landscape-led approach, requiring developments to conserve and enhance the National Park's special qualities. This approach generally encourages low-rise buildings. While the scale of the commercial building modelled in this study is unlikely to be built in the area, the results will still be relevant for construction types and level of fit-out. Should developments diverge from the modelled construction types, it will be likely because they have become more domestic in scale, leading to upfront carbon emissions more akin to residential development.

Nevertheless, this typology has been included within this study to provide a point of reference and to contextualise the scale of embodied carbon targets that commercial buildings could be expected to achieve.

	Residential		Non-residential
	Semi-detached	Terraced	Commercial use Class E
Number of storeys	3	3	10
Dwelling size	3 bedroom, 5 person	3 bedroom, 5 person	N/A
GIA (m^2)	114	114	5,400
Ground to height of top floor (m)*	9.2m *(<11m)*	9.2m *(<11m)*	3.8m
Form factor	2.2	2.1 (3-terraced houses) 1.9 (6-terraced houses)	0.9

Building typologies modelled, general information.
**This information is for the purpose of understanding fire regulation Part B – Volume 1: Dwellings, 2019 edition inc. 2020 & 2022 amendments.*

Relationship between upfront carbon and capital cost

Many of the strategies that a contractor might propose to reduce upfront carbon will have little or no material impact on cost. These might include:

- Resource efficiency and circularity measures that reduce wastage or entail the selection of reused materials or those containing higher levels of recycled content.
- Effective co-ordination of designs and management of site teams to reduce wastage.
- Designing for effective maintenance and disassembly, for example through use of mechanical fixings in cladding systems

Some specification changes may result in additional costs being incurred (for example niche environmental products), however, it is critical to determine those that are likely to persist over the long term and those where any cost premium should dissipate over time as the supply chain becomes more mature and scale increases.

Understanding both current and future costs

A good example of this issue is the use of timber frame solutions for domestic superstructures. In much of England timber frame is considered a more expensive solution than the more typical brick and block construction, yet in Scotland timber frame is the predominant form of structural solution and is cost competitive on this basis. It is therefore important to distinguish between cost premiums that arise due to historic market practice rather than due to an underlying difference in cost base.

Importantly, where a low carbon product or supply chain is currently more expensive because it is relatively small scale or immature, then there is an opportunity to achieve both economic development and carbon savings by incentivising the use of these solutions within the market. As these products scale they become more cost competitive in other locations (outside the South Downs National Park) and will be increasingly deployed even where there is no formal embodied carbon requirement.

In this study we aim to identify the cost implications of the different upfront carbon specification options and also the longer term costs and potential for economic benefits linked to scale. Although the future costs of any product or technology are inherently uncertain there can be potential for cost reductions using the principles of learning rates / experience curves and, where appropriate, by reference to other locations where these solutions are more mature (for example open or close timber frame systems).

Non-cost factors

While material cost is an important component influencing the viability of a construction method, a range of other factors are also important and should be considered. These include:

- Ability to meet demand – some low carbon solutions could not immediately be deployed for a large proportion of new construction and so their use would need to be incentivised / encouraged in a way that provides the opportunity for capacity to develop.
- Transition / duplication costs for organisations with refined existing supply chains – this is particularly the case with large developers who have well developed delivery processes and regional / national supply chains. Even if lower carbon products are not more expensive there is additional cost associated with adding to or changing these existing practices particularly where their installer base may be less familiar with the new approach.
- Risk – these might take many forms but would include the ability of smaller companies to provide the necessary warranties or assurance for their products.

These additional factors should be considered when appraising how an applicant might seek to meet an upfront carbon limit in planning.

Residential

Semi-detached and terraced houses

Residential modelling – process overview

Model structure and rationale

The upfront carbon residential models in this evidence base have been built from the ground up, using widely available industry data at its heart to ensure it aligns with standard practice. The diagram opposite shows the modelling process, using a 'materials database', which feeds data to an 'element library', which is then used to construct an overall model for a given building scenario. The flexibility of the modelling tool is important to accommodate updates and variations efficiently, enhancing the adaptability of the models to changing data or scenario.

The 'materials database'

The materials used in the study were mostly sourced from the OneClick database (a commonly used software) or Inventory of Carbon and Energy (ICE) free to access database. Both databases are well understood by assessors and used in most concept stage assessments of whole life carbon.

The 'materials database' includes materials and products useful for testing the various building upfront carbon scenarios. The upfront carbon datapoints for materials, are considered to represent the typical UK performance for each material or product. For some of the more bespoke products, a typical value was not available and a suitable environmental product declaration (EPD) was used.

The 'element library' and 'scenarios'

The materials and products in the database are combined in the 'element library' to create a range of building elements (e.g. walls, floor, roof, and building services). Several build-ups have been created in each building element category to present values from standard practice to best practice, this includes consideration of thermal performance and likely embodied carbon content (see Appendix 5.3 for further information). All element build-ups used are capable of a Space Heating Demand of 20 kWh/m^2/yr (GIA) and Energy Use Intensity of 40 kWh/m^2/yr (GIA).

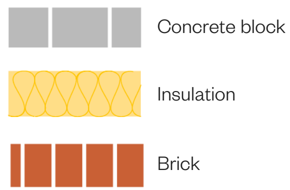
A comparison and sensitivity analysis between the building element build-ups was carried out to identify the typical highest to lowest upfront carbon range in each element category.

The element library has been multiplied up and combined per building typology to inform policy recommendations.

Modelling process - summary

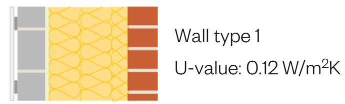
1 Material Database

- Enter A1-A5 and upfront biogenic carbon datapoints (KgCO_2 per kg) for each material/product.
- Datapoints entered for lots of materials/ products that represent UK average construction performance.
- Broken down into life stages



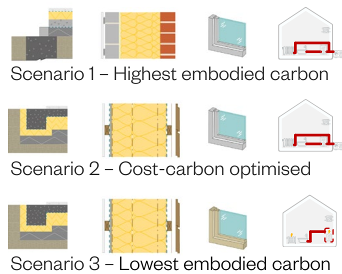
2 Element library

Combine materials to create the elements that are capable of achieving operational carbon policy limits. Calculate the A1-A5 and upfront biogenic carbon of each element per sqm.



3 Scenarios per building typology

Combine the elements to create higher, lower and cost-carbon optimised upfront carbon scenarios for each element and typology. Carry out cost analysis for each scenario.



4 Building models

Categorise the elements according to RICS building elements guidance and analyse the upfront carbon and cost results per scenario, per building typology.

↓

Policy recommendations

Inform the embodied carbon policy recommendation for setting limits per typology.

Return to contents >

Residential modelling - elements modelled

To determine which building elements should form part of this upfront carbon modelling, the building element categories from RICS Professional Statement (PS) v2 2023 were used.

Building element categories - Modelled

The modelling has covered as much of the upfront carbon emissions from the sub-structure, super-structure, finishes and building services (MEP) as possible for each building typology.

Building element categories – Assumed

The upfront carbon emissions from furniture, fixtures and equipment (FF&E), and sanitaryware have not been calculated, and therefore an assumption has been made. There is a lack of industry data for FF&E and sanitaryware.

Building element categories - Not modelled

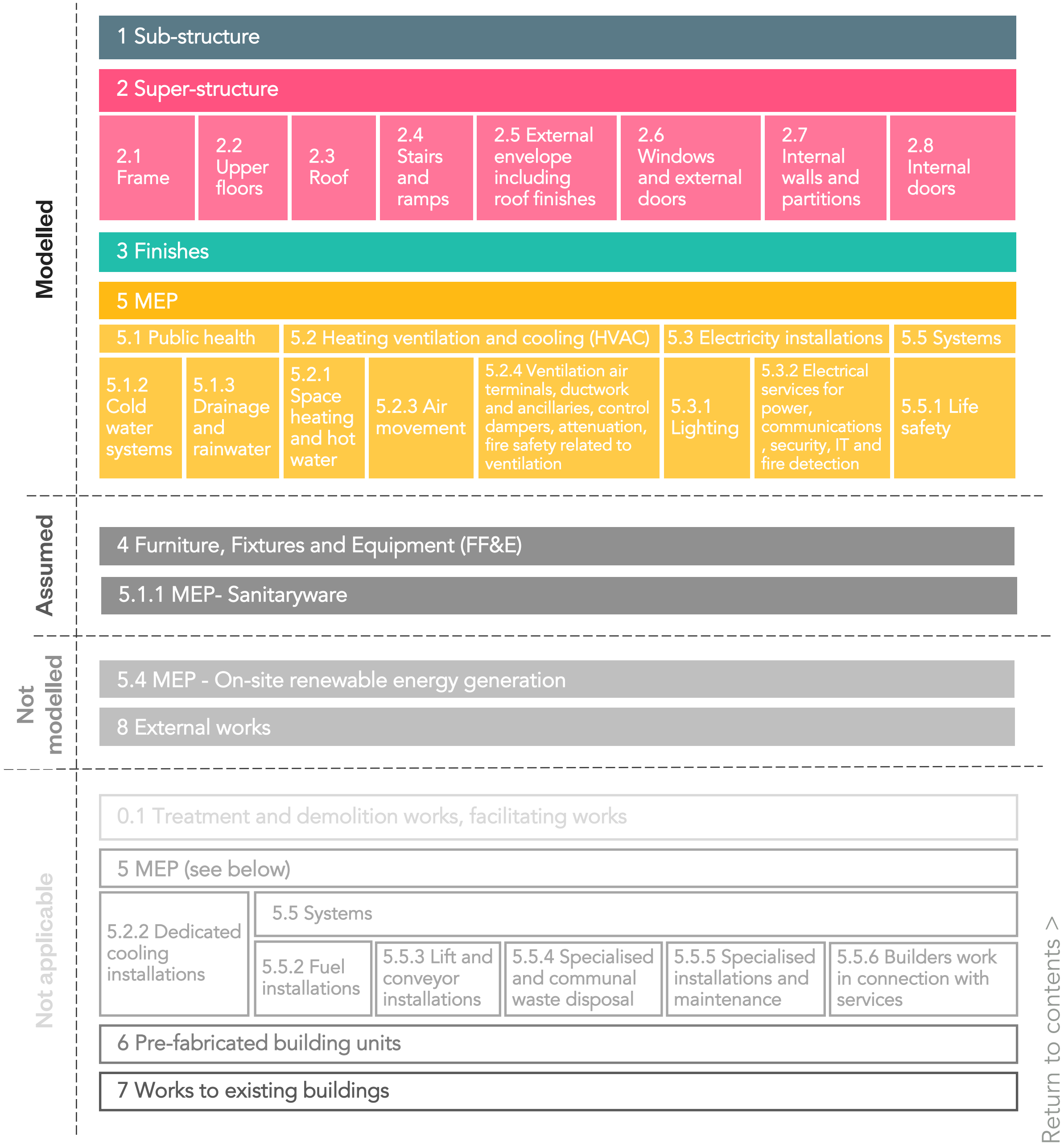
On-site renewable energy was excluded due to the conflict between the operational energy policy and embodied carbon policy. External works were excluded because individual homes have been modelled and this would require understanding of external works associated with a whole site.

Building element categories - Not applicable

In addition, on the right there is a list of all building elements that are not applicable for the building typologies modelled.

Contingency factor

Following RICS WLCA PS 2nd ed., to account for uncertainty and lack of detailed or complete information, a contingency factor based on the project phase is applied to all modules (A, B, C and D) or to each building element. Uncertainty generally reduces as the project phases proceed, more is known and finalised. For the purpose of this evidence-base, an early design contingency factor of 15% has been applied to all modules before reporting the final figure. The contingency factor for projects at the technical and design construction stage is 6% and for project post completion is 0%.



Building elements in and out of the scope of the upfront carbon modelling following the RICS building element categories.

Return to contents >

Residential modelling – upfront carbon emissions

Using the modelling results to set limits in planning policy

Three Scenarios have been modelled for each dwelling type - Scenarios 1 and 3 represent the highest and lowest upfront carbon options formed by mixing a selection of compatible building elements together. Scenario 2 was created based on combination of cost and carbon optimised building elements. Through the modelling of these scenarios it is possible to see how the buildings perform and their resultant upfront carbon emissions.

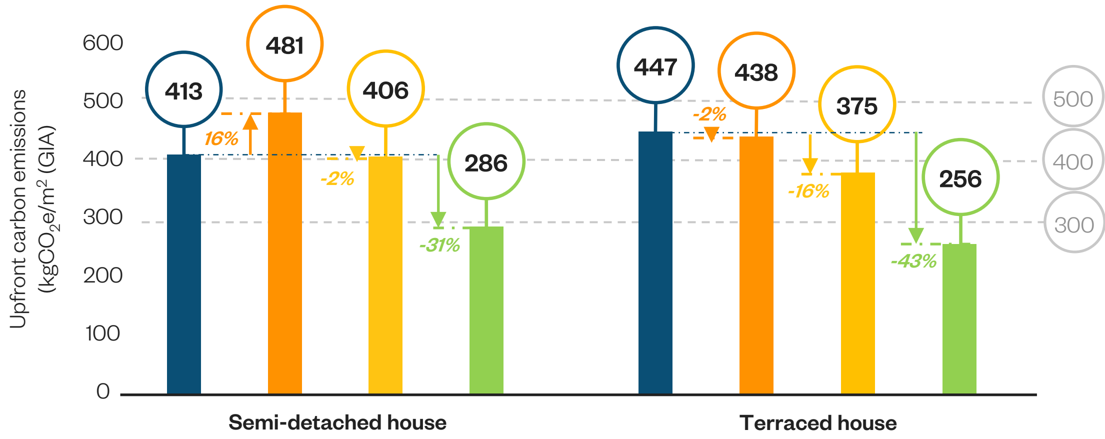
Upfront carbon results

The results (opposite) demonstrate that for the semi-detached house and terrace house all three recommended scenario options are shown to be technically feasible as follows:

- A typical construction Baseline scenario has been established as a reference point for comparison against the other scenarios examined in this study. The Baseline and Scenario 1 demonstrate comparable upfront carbon values (< 500 $kgCO_2e/m^2$ GIA), which can be attributed to both utilising traditional brick and block construction methods. However, a key distinction exists between the two scenarios: while the Baseline is representative of the most prevalent construction approach, Scenario 1 adopts traditional construction methods whilst incorporating materials with lower overall environmental impact (avoidance of UPVC windows, or phenolic insulation).
- Under Scenario 1 (highest embodied carbon), where typical brick and block construction and aluminium-framed windows are assumed, both house typologies achieve between 438-481 $kgCO_2e/m^2$ (GIA), demonstrating that <500$kgCO_2e/m^2$ can be met using a 'business as usual' construction approach.
- In the cost and carbon-optimised Scenario 2, upfront carbon can be reduced to <400$kgCO_2e/m^2$ by switching to lower-carbon timber structure, UPVC-framed windows while maintaining a brick outer leaf.
- <300$kgCO_2e/m^2$ is proven technically feasible for both house typologies under Scenario 3, which assumes timber structure, wooden-framed windows and render or timber cladding.

Note: Scenarios 2 and 3 contain combustible materials in the external walls. While this is acceptable under Part B fire regulations for residential buildings <11m, this can be problematic for some funders and insurers. For further detail on how upfront carbon can interact with fire regulation see Appendix 5.4.

Upfront carbon emissions (A1-A5) – tested scenarios



Upfront carbon emissions in $kgCO_2e/m^2$ (GIA) per scenario for semi-detached and terraced houses.

	Foundations, ground floor	External wall	Party and internal wall	Internal floor	Roof	Windows
Baseline net zero operational	Strip foundations + in-situ concrete slab + screed	Traditional brick and block + glass wool	Traditional block and block + glass wool, timber stud structure	Timber i-joists	Timber rafters + phenolic insulation	UPVC
Scenario 1 highest embodied carbon	Same as Baseline	Same as Baseline	Traditional block and block + glass wool, metal stud structure	Timber joists + metal ceiling system	Timber rafters + mineral wool	Aluminium frame
Scenario 2 cost-carbon optimised	Strip foundations + beam & block floor + screed	Stick timber frame + cellulose +brick	Timber frame + glass wool, timber stud structure	Timber I-joists	Timber rafters + phenolic insulation	UPVC frame
Scenario 3 lowest embodied carbon	Raft foundations + screed	Off-site timber + wood fibre & hempcrete + render	Same as Scenario 2	Same as Scenario 2	Same as Scenario 2	Wooden frame

Building elements used to form scenarios 1, 2 and 3 for the residential typologies.

Mechanical ventilation with heat recovery and individual air sourced heat pumps have been assumed as the heating and hot water strategy for all the scenarios and typologies.

Return to contents >

Residential modelling – cost analysis

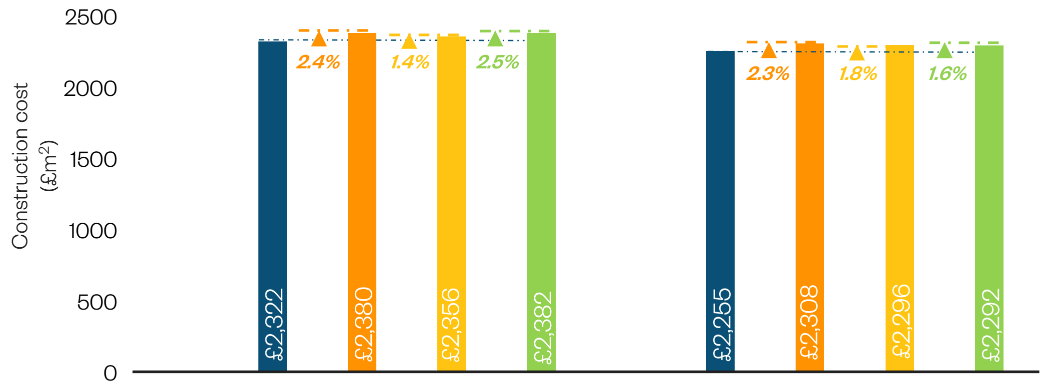
Cost analysis of each of the scenarios modelled has been conducted for the semi-detached and terrace houses. As detailed on the previous page and in Appendix 5.3.

Cost analysis for residential buildings <11m

The cost analysis draws on locally applicable cost data from Q4 2025:

- For the semi-detached and terraced houses, the variation in cost across the different specifications is equivalent to <2.5% of the total build cost of the Baseline scenario.
- From the three scenarios tested, the cost-carbon optimised specifications (Scenario 2) is the least expensive for the semi-detached, while the low carbon scenario (Scenario 3) represents the lowest cost for the terraced house. This is because the cost uplift associated with external walls and window upgrades is less prominent in the terrace house under Scenario 3.
- Where a limit of <500kgCO_2e/m^2 is set this would provide a cost neutral outcome (all scenarios including the Baseline are lower than this) while discouraging poor performance. This also encourages the consideration of a compact building form and low carbon material selection, without seeking to exclude specific materials or home designs (e.g. detached homes).

Cost uplift for residential typologies < 11m in height



Options for policy requirement	Capital cost uplift (upfront carbon)	
	Residential (<11m) Semi-detached house	**Residential (<11m) Terraced house**
Baseline < 500 kgCO_2e/m^2 (GIA)	£2,322/m^2	£2,255/m^2
Scenario 1 < 500 kgCO_2e/m^2 (GIA)	+2.4% (+£58/m^2)	+2.3% (+£52/m^2)
Scenario 2 < 400 kgCO_2e/m^2 (GIA)	+1.4% (+£34/m^2)	+1.8% (+£40/m^2)
Scenario 3 < 300 kgCO_2e/m^2 (GIA)	+2.5% (+£60/m^2)	+1.6% (+£36/m^2)

Variation in capital costs from baseline for Scenarios 1, 2 and 3 for Upfront Carbon Limits. Relative costs (% or £/m²) of each case compared to the 'O' Baseline scenario

Return to contents >

Residential modelling – cost breakdowns

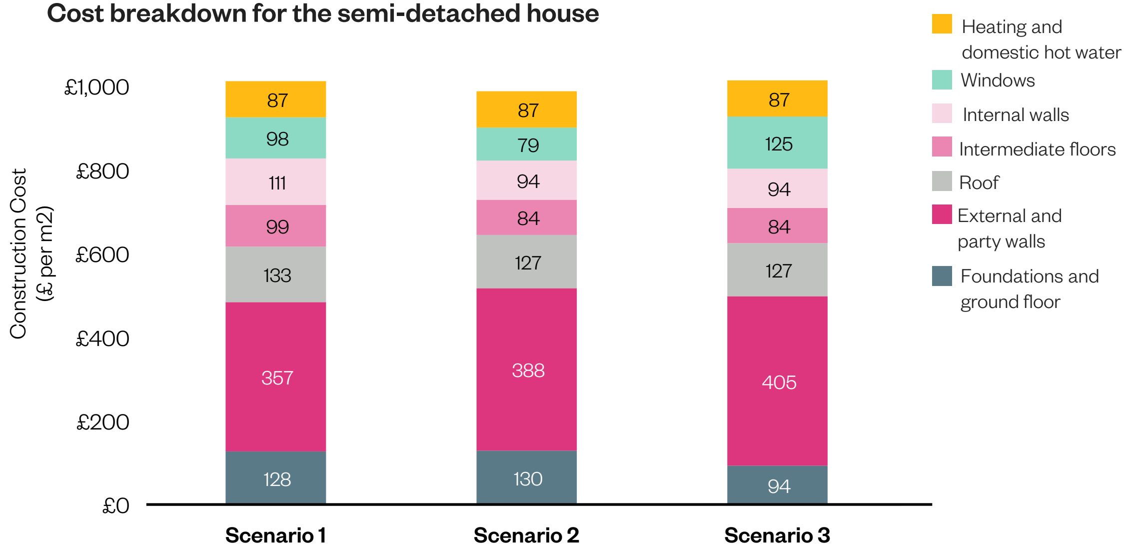
This page breaks down the overall construction cost per construction element for each of the three scenarios on the residential typologies, excluding costs not linked to embodied carbon.

Cost-carbon comparison analysis for residential buildings <11m

The typologies tested for South Down National Park show a similar total construction cost across the range, however, there are variations at an elemental level:

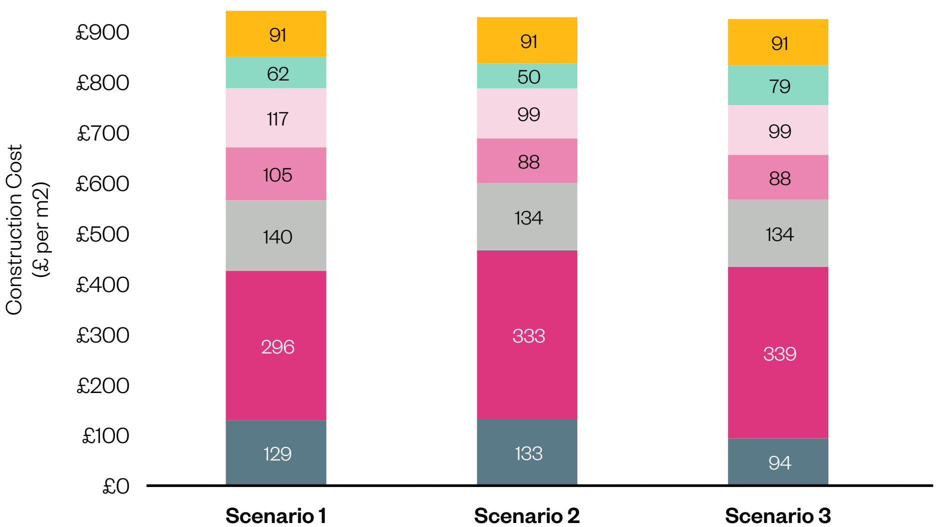
- Internal walls made from timber structures (Scenarios 2 and 3) exhibit lower costs and significant lower upfront carbon. Timber stud structure internal walls show a reduction on upfront carbon of 44% against metal stud structure internal walls.
- A timber I-joist solution for intermediate floors (Scenarios 2 and 3) represents a cheaper and lower embodied carbon solution than timber joists with a metal suspended ceiling (Scenario 1).
- Wooden frame windows (Scenario 3) have a higher cost. However, UPVC windows (Scenario 2) have a lower cost and lower upfront carbon than aluminium windows (Scenario 1). It is worth noting than UPVC is a petroleum-based material, therefore its use is supporting the continued extraction of crude oil.
- Timber frame external wall (Scenarios 2 and 3) have a lower upfront carbon and higher cost. While traditional brick and block construction has the highest upfront carbon, it is important to note that bricks offer some benefit when used as external leaf: they act as a non-combustible, durable, low maintenance material during their lifecycle.
- Raft foundations (Scenario 3) are significantly lower in upfront carbon and cost. However, it is important to note that foundation size and type can vary based on project-specific constraints (i.e. ground conditions, structural loads, etc.).

Cost breakdown for the semi-detached house



Costs (£/m²) of the three scenarios tested for the semi-detached house, excluding costs not linked to embodied carbon

Cost breakdown for the terraced house



Costs (£/m²) of the three scenarios tested for the terraced house, excluding costs not linked to embodied carbon

Return to contents >

Residential modelling – conclusions

Further parameters to be considered

When setting limits for upfront carbon through policy, there are a few considerations to take into account:

- An upfront carbon limit has the ability to encourage lower embodied carbon buildings, but as a consequence can inadvertently restrict material choice. For example, the lowest embodied carbon scenario (3) prevents the use of brick facades.
- The substructure can form a significant portion of the upfront carbon of a home/building. Therefore, the depth of foundations, which is reliant on ground conditions, can make the building appear higher or lower embodied carbon. However, applicants may not have much choice over which foundations are most suited to the site.
- While the modelling demonstrates what is reasonably achievable for given typologies, the materials chosen in calculations could inflate or deflate the outcomes for applicants. Design and size of dwelling can also alter the perception of results.
- For a net zero operational carbon home, as per the current the SDNPA policy position, the cost difference between high, low and cost and carbon optimised is negligible. Therefore, when developers/builders are selecting their construction type, the choice is likely due to other factors, like speed of build, supply chain or construction skills of workforce.

Recommended limit for policy - 500 $kgCO_2e/m^2$ GIA

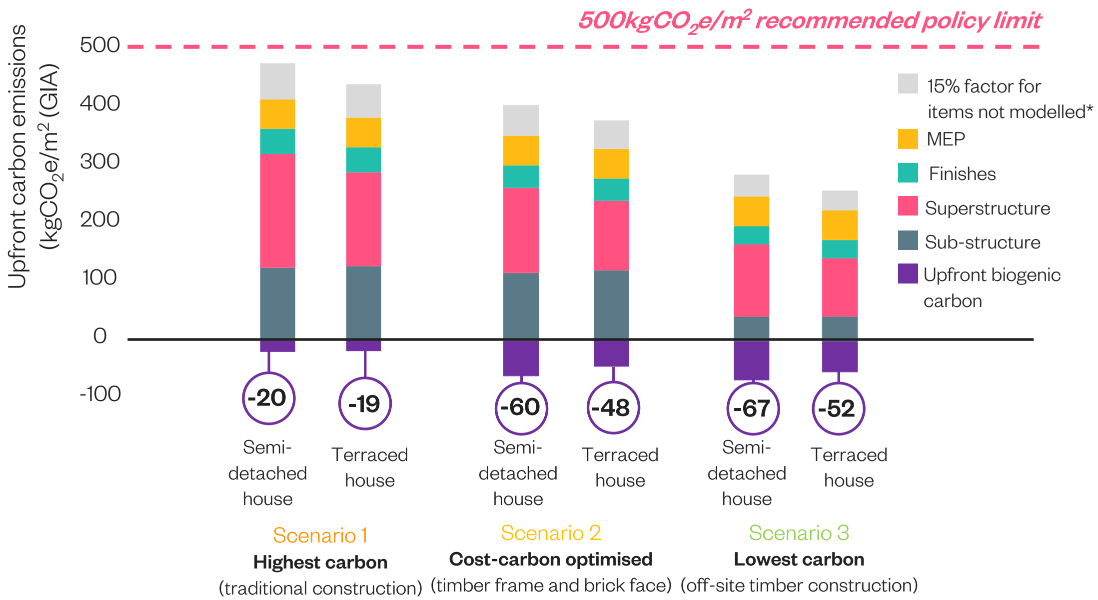
Setting the limit for low-rise housing (under 11m for purposes of building regulations Part B) at <500 $kgCO_2e/m^2$ GIA would be a relatively loose limit to begin with to allow applicants and planning officers in the SDNPA to get used to carrying out or reviewing upfront carbon calculations. It has the advantage of preventing poor performance while ensuring there is some consideration of building form, typology and material selection, without seeking to exclude specific materials or designs.

Future limits for consideration

We recommend reviewing the limit every 3-5years to determine if it can be lowered or should be altered.

A limit of around 400 $kgCO_2e/m^2$ GIA would allow for a timber structure with brick face, while a limit of 300 $kgCO_2e/m^2$ GIA would likely exclude the use of brick.

Upfront carbon emissions (A1-A5) – recommended policy limit



Breakdown of upfront carbon emissions in $kgCO_2e/m^2$ (GIA) per scenario for semi-detached and terraced houses.

** RICS PS v2 2023 provides guidance on adding a percentage uplift for contingency and uncertainty. The default contingency of 15% for design stage calculations has been applied to the results opposite.*

Upfront carbon

≤ 500

$kgCO_2e/m^2$ GIA

Recommended policy limit
for residential buildings <11m in height

Return to contents >

Non-residential

Commercial use Class E

Non-residential modelling – process overview

Modelling methodology

The upfront carbon non-residential model in this evidence base has been built using detailed, design-led optioneering. It aims to quantify how key design variables such as grid spacing, floorplate efficiency, structure, and façade - affect upfront carbon (A1–A5) to:

- Map variation across modelled design options
- Benchmark by key parameters (e.g. grid size, structure, façade build-up)
- Identify consistently low-carbon design pathways
- Provide an evidence base for performance-based benchmarks to inform the SDNPA policy

Through scenario testing across varied design options, three unique combinations were modelled against a baseline Use Class E building, exploring variations in the range of variables.

Design Parameter	Options Tested
Structural grid size (m)	6 × 6, 7.5 × 7.5, 9 × 9
Framing material	Reinforced concrete, CLT on steel frame, Steel frame with Composite deck
Façade system	GRC panel, Aluminium rainscreen, Brick with internal plasterboard

The following parameters were held constant throughout the study to provide a consistent baseline for comparing the impact of design changes:

Non-residential baseline	
Typology	Office
Scope	Cat A Shell & Core
Reference Study period (RSP)	60 years
No. floors above ground	10

A range of tools and data sources were used and cross-referenced to ensure robustness and validity of results. These include:

1. Whole Life Carbon emissions from each scenario modelled
   VERT: Visionary Emissions Reduction Tool | WLCA
2. Façade build-up embodied carbon analysis & EPD Data
   One Click LCA https://oneclicklca.com/
3. Structural quantities (excluding substructure)
   Heyne Tillett Steel
4. Inventory for Carbon and Energy (ICE) Database
   The ICE Database v03 – Circular Ecology

In order to build the evidence base and investigate setting upfront carbon limits for commercial buildings various sources of information have been collated:

- NZCBS data
- Westminster council evidence base September 2024 (WSP)
- LPNZ evidence base September 2025

Further modelling was undertaken to fill gaps in the data received and fully investigate the upfront carbon (modules A1-A5) of multiple commercial building options (Shell and Core and Category A scopes). Capital cost modelling has been carried out to understand how cost and viability may affect policy.

Carbon measurement standard

The modelling for this evidence-base has adopted RICS WLCA PS, 2nd edition (2023), which is the industry's supported standard.

Operational performance

Decisions taken during the design of a building to improve operational energy can have an impact on the resulting upfront carbon. Rather than considering operational energy and upfront carbon separately a balance needs to be struck across all environmental considerations.

The outline specifications for Scenarios 1, 2 and 3 upfront carbon have all been aligned with the performance parameters used to meet a Space Heating Demand of 20 kWh/m^2/yr (GIA) and Energy Use Intensity of 90 kWh/m^2/yr (GIA).

Return to contents >

Non-residential modelling – upfront carbon emissions

Using the modelling results to set limits in planning policy

The modelling of Commercial use Class E has investigated a number of factors that will impact the outcomes, including:

- Allowances for demolitions or enabling works
- Grid spans, slab depths and impact of non-stacking ground floors
- Basement works
- Complex facades with high form factors and shading devices

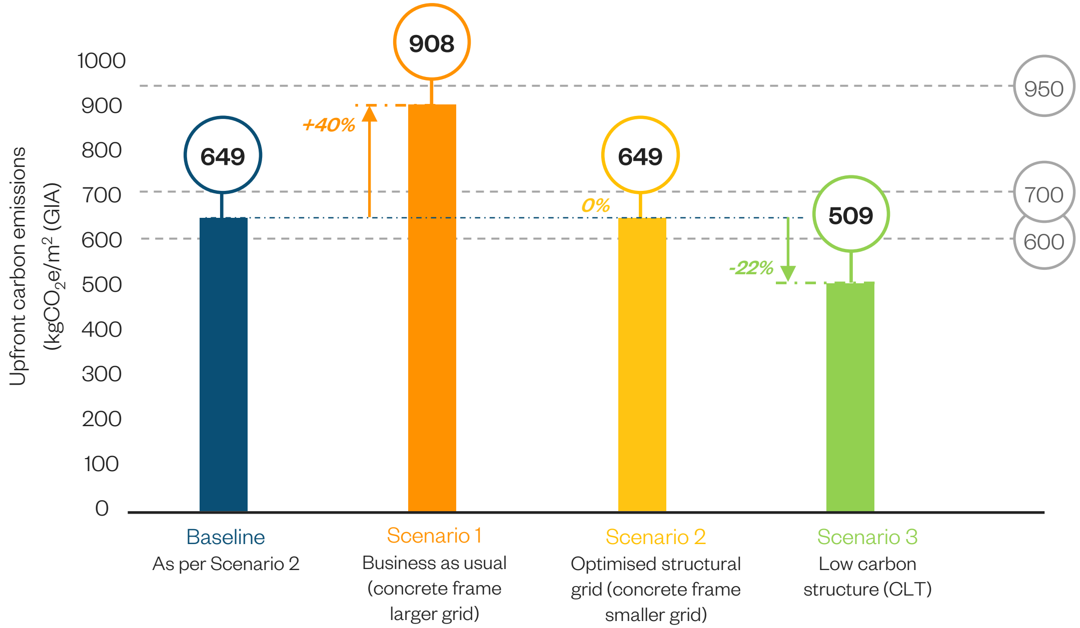
It was found that some elements like fully planted roof terraces, façade weight and form factor had negligible impact on upfront carbon intensity.

Upfront carbon results

The upfront carbon results (opposite) demonstrate the performance that can be expected for commercial use Class E:

- Scenarios 2 and 3 drive some design decisions, particularly when designing with shallower floorplates and introducing basements.
- Performance is contingent on massing decisions, structural grids and materiality and façade complexity. Sub-structure is also impacted by the structural material choice with more lightweight dead load reducing sub-structure quantities.
- Designs will need to balance demands on the site. For example, smaller grids and lightweight structural solutions can help mitigate the impacts of sub-structure and challenging ground conditions.
- Following material efficiency measures being undertaken within the design, the specification of cement replacements and recycled content can further contribute to reducing upfront carbon.
- Upfront carbon intensity increases as the depth of the floorplate reduces compared to the envelope, so it is actually easier to achieve intensity for deeper plan developments.
- A double basement reduces the carbon intensity as the emissions are distributed across a larger GIA. Therefore, where the policy limit is set is not likely to affect the decision to omit a basement or not. The inclusion of a basement will drive up total emissions.

Upfront carbon emissions (A1-A5) – tested scenarios



Upfront carbon in $kgCO_2e/m^2$ (GIA) per scenario for the commercial use Class E typology.

	Substructure	Superstructure	Superstructure – building envelope	Services (MEP)
Baseline Optimised structural grid	Concrete piles 70% cement replacement	RC concrete frame and slabs 7.5 x 7.5m grid, 25% cement replacement	Brick, form factor 0.7-0.9	ASHP, FCUs, mixed mode
Scenario 1 business as usual	Concrete piles 50% cement replacement	RC concrete frame and slabs 9 x 9 grid, 0% cement replacement	Pre-cast concrete, form factor 0.9-1.2	ASHP, FCUs, mech led
Scenario 2 optimised structural grid	As per Baseline	As per Baseline	As per Baseline	As per Baseline
Scenario 3 low carbon structure	Concrete piles 70% cement replacement	CLT slab and steel frame, 50% recycled 6 x 6m grid	GRC rainscreen, , form factor 0.7-0.9	ASHP, FCUs, mixed mode

Detailed building elements forming Scenario 1, 2 and 3 for the commercial use Class E typology.

Return to contents >

Non-residential modelling – cost analysis

Cost analysis for each scenario has been carried based on the specification options shown in the previous page and Appendix 5.3.

A typical construction Baseline has been established as a reference point for comparison against all three scenarios examined in this study. The Baseline and Scenario 2 share the same specifications - these specifications rely on utilising lean structural and architectural design, for which this would be both a cost and carbon saving.

Cost analysis for commercial use Class E buildings

Across the scenarios some of the design changes to reduce upfront carbon deliver cost savings resulting from reduced material quantities (e.g. less concrete and rebar) resulting from structural optimisations and form factor efficiencies, while others such as use of composite windows rather than aluminium windows result in cost increases.

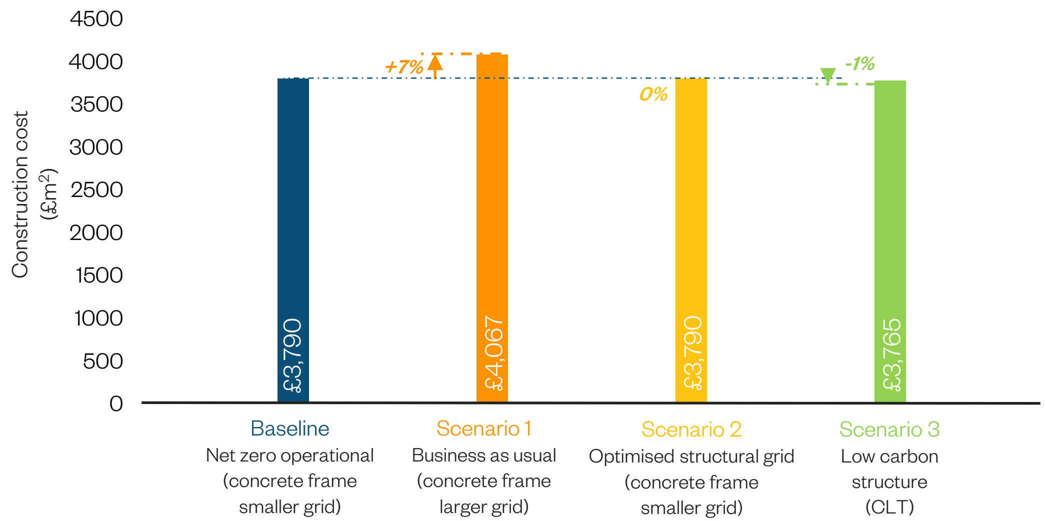
Some of the low carbon finishes selected for Scenarios 2 and 3 are less expensive than premium finishes that might be specified for a large prime office, for example vinyl, linoleum or ceramic tile finishes instead of marble or encaustic tiles. In other instances, the lower carbon finish may be slightly more expensive than an equivalent 'standard' product for example low carbon vs standard metal ceiling tiles.

The analysis shows that Scenarios 2 and 3 achieve < 700 kgCO_2e/m^2 GIA without increasing overall development costs and that the cost in £m^2 is lower for the lower carbon solutions (Scenario 3). This reduction in cost is delivered, in part, through the selection of lower carbon but also less expensive façade and finish materials, reduction of glazing area and adoption of reduced spans between columns in the structural grid. These changes would result in a less glassy look and feel of the building externally and smaller open spans internally.

Embodied carbon results show a trend on costs lowering, as carbon lowers too. This may feel initially counter intuitive, however, lower carbon solutions tend to use less material, and therefore, cost less. Lower carbon solutions are not necessarily costlier in practice, but they involve different construction methods that the contractor or developer may be less experienced in.

Costs have been based on Q4 2025.

Cost uplift for commercial use Class E



Capital costs for Scenarios 1, 2 and 3 for Upfront Carbon Limits. Relative costs (%) of each case compared to the '0' Baseline scenario

Options for policy requirement	**Capital cost uplift** (upfront carbon)
	Commercial use Class E
Baseline = Scenario 2 **< 700** kgCO_2e/m^2 (GIA)	£3,790/m^2
Scenario 1 **< 950** kgCO_2e/m^2 (GIA)	+6.8% (+£277/m^2)
Scenario 2 **< 700** kgCO_2e/m^2 (GIA)	+0% (£0/m^2)
Scenario 3 **< 600** kgCO_2e/m^2 (GIA)	-0.7% (-£25/m^2)

Variation in capital costs from baseline for Scenarios 1, 2 and 3 for Upfront Carbon Limits. Relative costs (% or £/m²) of each case compared to the '0' Baseline scenario

Return to contents >

Non-residential modelling – conclusions

Further parameters to be considered

When setting limits for upfront carbon through policy, there are a few considerations to take into account:

- It is not recommended to have different performance limits for different commercial development scales, so there needs to be a recognition that the limits will drive certain design decisions. For example, a larger building with a deeper plan will have more flexibility to design with larger structural girds and a wider material palette.
- Use Class E covers offices, retail, financial and professional services, restaurants/cafes, some primary health, creches, nurseries, and light indoor sports/recreation uses like yoga studios/ gyms (excluding swimming pools etc). In this evidence base it is considered that the Shell & Core and Cat A scopes for these commercial buildings are similar enough that a single target could be applied to them all. The Cat B fit out will likely differ the most and therefore, the recommendation is to exclude this type of fit-out from the limit. This aligns with the ethos of the recent introduction of planning use Class E, where occupants can adapt the space to suit their use through fit out rather than formal change of use.

Recommended limit for policy - 700 $kgCO_2e/m^2$ GIA

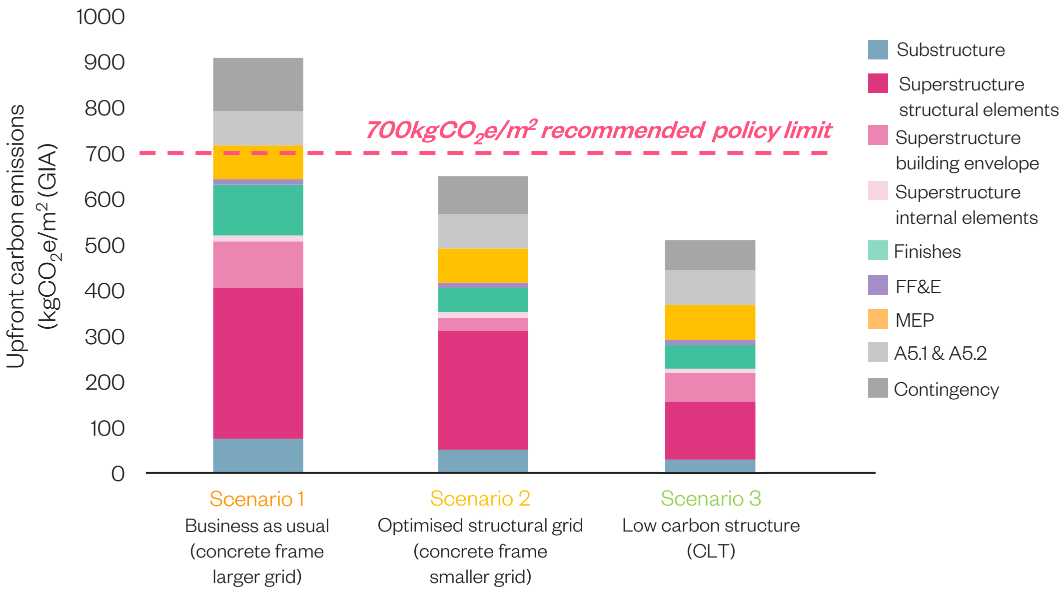
On the basis that all three tested scenarios are technically feasible while still allowing a range of design responses, the recommendation is to adopt a limit of <700$kgCO_2e/m^2$ GIA in policy for use Class E shell and core and Cat A fit out. This allows a typical palette of materials to be used but requires some thought about material efficiency and lean design measures to meet the limit. This also provides a cost neutral outcome.

While a simple shell and core commercial building should be able to meet an upfront carbon limit of <600 $kgCO_2e/m^2$ (GIA), there are likely to be multiple other performance and contextual factors that suggest a higher limit should be used at the introduction of the policy with a mechanism to reduce during the policy period.

Future limits for consideration

We recommend reviewing the limit every 3-5years to determine if it can be lowered or should be altered.

Upfront carbon emissions (A1-A5) – recommended policy limit



Breakdown of upfront carbon emissions in $kgCO_2e/m^2$ (GIA) per scenario for the commercial use Class E building.

Upfront carbon

≤ 700

$kgCO_2e/m^2$ GIA

Recommended policy limit

for commercial use Class E buildings

Return to contents >

5

Appendix

5.1
Glossary of terms, abbreviations and links

Glossary of terms

Biogenic/ sequestered carbon – '*Carbon removals associated with carbon sequestration into biomass, as well as any emissions associated with this sequestered carbon. Biogenic carbon must be reported separately if reporting only upfront carbon, but should be included in the total if reporting embodied carbon or whole life carbon.*' Source: *RICS Whole life carbon assessment for the built environment, 2nd edition*

Carbon sequestration – '*The process by which CO2 is removed from the atmosphere and stored within a material, for example by being stored in biomass as biogenic carbon by plants.*' Source: *RICS Whole life carbon assessment for the built environment, 2nd edition*

Chartered institute of Building Services Engineers (CIBSE) TM65 methodology - '*A calculation methodology (TM65) outlines the need for assessment of embodied carbon of products linked to building services engineering systems, to increase knowledge and facilitate research related to whole life carbon.*' Source: CIBSE

Circularity – '*A process that considers the potential for recovery, reuse and recycling of items following circular economy principles.*' Source: *RICS Whole life carbon assessment for the built environment, 2nd edition*

Circular economy – '*An economy that is restorative and regenerative by design, and that aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles.*' Source: *RICS Whole life carbon assessment for the built environment, 2nd edition*

Disassemble and reuse - '*Disassemble sections of a building and enable their direct reuse ideally on the site or, where this is not possible, off site (with nearby sites preferred). This approach also includes careful selective deconstruction of the building and material types i.e. taking apart each layer and material type as much as possible, minimising damage to parts and maintaining their value, and then reusing those elements and materials. If reuse is not possible, materials may be carefully and selectively separated for processing and recycling into new elements, materials and objects.*' Source: *CE Statement 2022.*

Embodied carbon – '*The embodied carbon emissions of an asset are the total GHG emissions and removals associated with materials and construction processes, throughout the whole life cycle of an asset (modules A0–A5, B1–B5, C1–C4, with A0[2] assumed to be zero for buildings.*' Source: *RICS Whole life carbon assessment for the built environment, 2nd edition*

Environmental Product Declaration (EPD) – '*A document that clearly shows the environmental performance or impact of any product or material over its lifetime*'.. Source: *RICS Whole life carbon assessment for the built environment, 2nd edition*

Inventory of carbon & energy (ICE) database – '*The Inventory of Carbon and Energy (also know as the ICE database) is an embodied carbon database for building materials which is available for free on this page. It contains data for over 200 materials, broken down into over 30 main material categories.*' Source: ICE

Life Cycle embodied carbon – *See 'embodied carbon'*

One Click LCA - '*One Click LCA is an all-in-one software to automate Life Cycle Assessment (LCA) and Environmental Product Declaration (EPD) generation. Schedule a time to get help for your LCA, EPD, and sustainability needs.*' Source: One Click LCA

Operational carbon – '*Operational carbon – energy (module B6) refers to GHG emissions arising from all energy consumed by an asset in use, over its life cycle.*' Source: *RICS Whole life carbon assessment for the built environment, 2nd edition*

Oriented Strand Board (OSB) – '*Oriented strand board is a composite engineered wood panel made of long strands (also called wafers or flakes) of wood, bonded together with synthetic resin adhesive.* ' Source: Timber Development UK

Photovoltaics (PV) – solar panels converting sunlight into electricity.

RICS - the Royal Institution of Chartered Surveyors

RICS Professional Standard (RICS PS v2 2023)– '*Sets requirements or expectations for RICS members and regulated firms about how they provide services or the outcomes of their actions. RICS professional standards are principles-based and focused on outcomes and good practice. Any requirements included set a baseline expectation for competent delivery or ethical behaviour. They include practices and behaviours intended to protect clients and other stakeholders, as well as ensuring their reasonable expectations of ethics, integrity, technical competence and diligence are met. Members must comply with an RICS professional standard.*' Source: *RICS Whole life carbon assessment for the built environment, 2nd edition*

Upfront carbon – '*Upfront carbon emissions are GHG emissions associated with materials and construction processes up to practical completion (modules A0–A5). Upfront carbon excludes the biogenic carbon sequestered in the installed products at practical completion.*' Source: *RICS Whole life carbon assessment for the built environment, 2nd edition*

Whole life carbon (WLC) - '*Whole life carbon emissions are the sum total of all asset-related GHG emissions and removals, both operational and embodied, over the life cycle of an asset, including its disposal (modules A0–A5, B1–B7, B8 optional, C1–C4, all including biogenic carbon, with A0[2] assumed to be zero for buildings). Overall whole life carbon asset performance includes separately reporting the potential benefits or loads from future energy or material recovery, reuse, and recycling and from exported utilities (modules D1, D2).*' Source: *RICS Whole life carbon assessment for the built environment, 2nd edition*

Return to contents >

Abbreviations

B&NS: Bath and North East Somerset

BAMB: Buildings as Materials Banks

CCC: Climate Change Act

CE: Circular Economy

CES: Circular Economy Statement

CIBSE: Chartered Institution of Building Services Engineers

CLT: Cross Laminated Timber

CO_2e: Carbon dioxide equivalent

CWCT: Centre of Window and Cladding Technology

EAC: Environmental Audit Committee

EPD: Environmental Product Declaration

EUI: Energy Use Intensity

FF&E: Fittings, furnishing and equipment

GGBS: Ground Granulated Blast-furnace Slag

GHG: Greenhouse gas

IPCC: Intergovernmental Panel on Climate Change

IStructE: Institution of Structural Engineers

KPI: Key Performance Indicator

LETI: Low Energy Transformation Initiative

MEP: Mechanical, electrical and plumbing

NPPF: National Planning Policy Framework

NZCBS: UK Net Zero Carbon Buildings Standard

PAN: Planning Advice Note

RIBA: Royal Institute of British Architects

RICS: Royal Institute of Chartered Surveyors

RICS PS: RICS Professional Statement

SDS: Spatial Development Strategy

SPD: Supplementary planning document

UKGBC: The UK Green Building Council

WBLCA: Whole Building Life-Cycle Assessment

WLC: Whole life carbon

Return to contents >

Useful links

- B&NES - Sustainable Construction checklist SPD
- BAMB –Building as material passports
- BECD – Built Environment Carbon Database
- Bristol City Council draft Local Plan
- Building to net zero: costing carbon in construction: Government Response to the Committee's First Report – Environmental Audit Committee
- Central Lincolnshire updated local plan
- CIRCuIT
- City of London - Carbon Options Guidance
- City of London City Plan 2024
- City of Westminster - City Plan 2019-2040
- Climate action tracker 2023
- Climate Change Committee - the seventh carbon budget
- CWCT– How to calculate embodied carbon of facades
- European Union's Roadmap for Whole Life Carbon
- GLA - Whole Life-cycle carbon assessment guidance
- Greencore Homes – low carbon offsite construction
- IStructE – How to calculate embodied carbon 2nd edition
- IStructE Lean design: 10 things to do now
- LETI - Circular economy 1 pager
- LETI Climate emergency design guide
- LETI opinion piece - Circular economy and carbon in construction
- LETI opinion piece – operational carbon in whole life carbon assessments
- LETI The Whole Life Carbon Alignment paper
- Net Zero: The UK's Contribution to Stopping Global warming
- Part B building Regulations Volume 1: Domestic
- Part Z proposed amendment to building regulations
- Policy paper by Part Z group of experts , January 2024
- RIBA 2030 climate challenge
- RICS Whole Life Cycle assessment 2017, 1st edition
- RICS Whole Life Cycle Assessment 2023, 2nd edition
- Southwest Net Zero Hub – Net Zero New Buildings Evidence and guidance
- The concrete centre– Sustainable concrete
- The construction material pyramid
- TM 65 – Embodied carbon in building services
- UK Net Zero Carbon Building Standard
- UKGBC - Circular economy guidance for construction clients
- UKGBC - Circular economy metrics for buildings
- UKGBC – Net zero whole life carbon technical study
- West of England Embodied Carbon Evidence Base 2021

Return to contents >

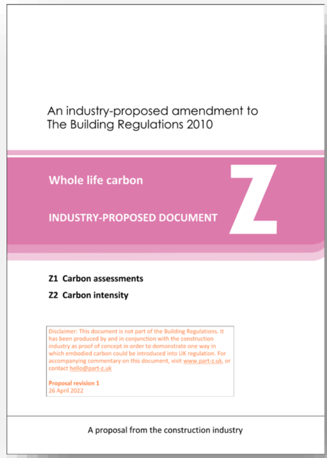
5.2
Additional information on industry standards, other carbon policies and evidence bases

Industry standards continued - Part Z and the Net Zero Carbon Building Standard

Part Z – how to regulate the construction industry at scale

The Part Z proposal sought to provide a framework for implementing whole life carbon assessments and embodied carbon targets, for all major development, by suggesting it is embedded into building regulations. The proposed Part Z uses whole life carbon assessment methods to provide a clear and tested way for developers to measure performance at the various stages of a project after planning, including the as-built stage.

The Part Z project was aimed at giving regulators a high-level template for implementing reasonable standards sooner rather than later, instead of a push towards best practice. Planning policy would still have a role in reducing whole life carbon emissions if the recommendations of Part Z were taken forward. As is the case with operational carbon regulation and policy, local authorities may choose to push policy further than the initial Part Z proposals.



Proposed Part Z (Source: [Part Z])

Industry targets and benchmarks for embodied carbon

LETI

In 2021, LETI reviewed how targets from different organisations could be reconciled with each other. To do so they consulted other industry groups including CIBSE, RIBA, IStructE, the GLA, and the Whole Life Carbon Network. The Whole Life Carbon Alignment paper set targets for upfront and life cycle embodied carbon and provided a set of reporting templates to help with consistency.

Upfront carbon, $kgCO_2e/m^2$ (modules A1-A5, excluding upfront biogenic carbon)				
Band	**Office**	**Residential (6+ storeys)**	**Education**	**Retail**
A++	<100	<100	<100	<100
A+	<225	<200	<200	<200
A (LETI 2030)	<350	<300	<300	<300
B	<475	<400	<400	<425
C (LETI 2020)	<600	<500	<500	<550
D	<775	<675	<625	<700
E	<950	<850	<750	<850
F	<1100	<1000	<875	<1000
G	<1300	<1200	<1100	<1200

Upfront carbon targets for various building typologies. *The residential targets have been set based on data from 6+ storey developments, therefore the applicability to low-rise housing is unknown (Source: LETI)*

RIBA

RIBA developed voluntary performance targets for life cycle carbon which form the basis of the RIBA 2030 Climate Challenge published in 2021. The targets are based on a growing database of projects submitted by signatories who have committed to participate the data collection for the initiative.

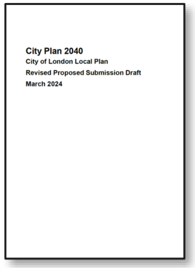
RIBA 2030 Climate Challenge target metrics for domestic / residential

RIBA Sustainable Outcome Metrics	Business as usual (new build, compliance approach)	2025 Targets	2030 Targets
Embodied Carbon $kgCO_2e/m^2$	1200 $kgCO_2e/m^2$	< 800 $kgCO_2e/m^2$	< 625 $kgCO_2e/m^2$

Full details of the RIBA 2030 Climate Challenge targets can be found here. And LETI embodied carbon alignment can be found here.

Return to contents >

City of London Corporation - Retrofit and Whole life carbon policies summary


City Plan 2040
City of London Local Plan
Revised Proposed Submission Draft
March 2024

City of London 2024 - [Local Plan draft policy]

City of London 2023- [Carbon Options Guidance]

Key requirements

The City of London's City Plan 2040 is anticipated to be adopted in summer 2025. It includes a policy on retaining and retrofitting existing buildings and on whole life carbon assessment for major developments.

Optioneering

To supplement the policy, a comprehensive Carbon Options Guidance document sets out a robust approach to evaluate options. This provides applicants with guidance on how to compare scenarios for retrofit and rebuild. This ensures a like for like comparison and enables consistency of reporting of carbon emissions.

The methodology establishes the minimum data set required at the pre-planning and planning stages, and the level of transparency to be disclosed to planning officers. The methodology aligns with the principles in the GLA's adopted guidance on Whole Life-Cycle Carbon Assessments (March 2022). The detailed WLC reporting for the applicant's chosen option is required to be provided as part of the planning application. Two dashboards have been created to equip planning officers with visual and quantified information that is clear and benchmarkable, enabling informed discussions between the applicants, planning officers and other stakeholders.

City of London Corporation – Draft policy DE1: Sustainable Design

'Development proposals should follow a retrofit first approach, thoroughly exploring the potential for retaining and retrofitting existing buildings as the starting point for appraising site options.

All major development must undertake an assessment of the options for the site, in line with the City Corporation's Carbon Options Guidance Planning Advice Note, and should use this process to establish the most sustainable and suitable approach for the site.

Development proposals should minimise whole life-cycle carbon emissions. Major developments must submit a whole life-cycle carbon assessment.'

City of London - Carbon Options Guidance

'The planning advice note (PAN) is designed to provide guidance for development site WLC optioneering evaluations. The PAN is a first step of carbon evaluation and is designed to enable a consistent, early-stage approach to assessing options.

The optioneering exercise is a means of comparing a representative number of development options, in order to find the optimum balance in carbon emissions terms, prior to evaluating other considerations in the planning process.'

Bath and North East Somerset (B&NS) and Bristol | Upfront carbon policies summary

Sustainable Construction checklist SPD – B&NES

Bath and North East Somerset Council (B&NS)

The UK's first Net Zero Carbon policy was introduced in January 2023 and covers both operational and embodied carbon. Policy SCR8 on embodied carbon states that all major developments must submit an upfront carbon assessment, demonstrating that less than 900 $kgCO_2e/m^2$ can be achieved. No offsetting is permitted and if the development is not compliant with the policy, a valid justification must be provided with appropriate reasons and evidence.

B&NES - SCR8 - Embodied Carbon

"Large scale new-build developments (a minimum of 50 dwellings or a minimum of 5,000m^2 of commercial floor space) are required to submit an Embodied Carbon Assessment that demonstrates a score of less than 900$kgCO_2e/m^2$ can be achieved within the development for the substructure, superstructure and finishes."

Bristol City Council draft Local Plan

Bristol City Council

The Bristol Local Plan sets an embodied carbon, materials and waste policy. Major developments will be required to undertake an upfront carbon assessment and are expected to achieve a set of minimum targets. Where policy is not met, carbon offsetting is used. It also provides general principles and guidance for reducing embodied carbon.

This policy has been based on the findings of the West of England Embodied Carbon Evidence Base.

Bristol City Council

"Embodied carbon – major applications

Major development will be required to undertake an embodied carbon assessment, submitted as part of the Sustainability Statement using a nationally recognised embodied carbon assessment methodology, and demonstrate actions taken to reduce life-cycle carbon emissions. New development will be expected to achieve the following targets as a minimum:

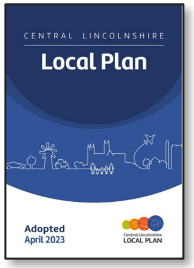
- *Residential (4 storeys or fewer) - <625 $kgCO_2e/m^2$*
- *Residential (5 storeys or greater) - <800 $kgCO_2e/m^2$*
- *Major non-residential schemes - <970 $kgCO_2e/m^2$*

Where these targets for embodied carbon cannot feasibly be met, a full justification will be required as part of the embodied carbon assessment.

Any shortfall against the embodied carbon targets will be offset through a financial contribution towards council approved renewable energy, low-carbon energy and energy efficiency schemes elsewhere in the Bristol area. The value of a tonne of CO_2e is tied to the high scenario in the Valuation of Energy Use and Greenhouse Gas supplementary guidance to the Treasury's Green Book (currently £373)."

Return to contents >

Central Lincolnshire | Embodied carbon policy summary



Central Lincolnshire updated Local Plan 2023

Central Lincolnshire adopted local plan 2023

Central Lincolnshire updated their Local Plan in 2023 to include a policy on Embodied carbon. The policy encourages the reduction of embodied carbon, with no targets set, but instead requires a qualitive assessment. The policy does not only set immediate requirements but also future requirements from 2025.

Central Lincolnshire – S11 – Embodied Carbon

"All development should, where practical and viable, take opportunities to reduce the development's embodied carbon content, through the careful choice, use and sourcing of materials."

"Major development proposals:

All major development proposals should explicitly set out what opportunities to lower a building's embodied carbon content have been considered, and which opportunities, if any, are to be taken forward. From 1 January 2025, there will be a requirement for a development proposal to demonstrate how the design and building materials to be used have been informed by a consideration of embodied carbon, and that reasonable opportunities to minimise embodied carbon have been taken."

Return to contents >

This document was commissioned by four local authorities in the West of England (i.e. Bath and North East Somerset Council, Bristol City Council, North Somerset Council and South Gloucestershire Council), and the Combined Authority. The purpose of this embodied carbon evidence-base study was to support policy makers in exploring options for setting embodied carbon planning policies and targets.

Upfront carbon modelling

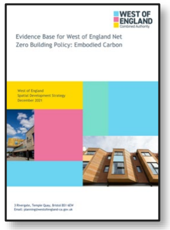
The document sets out the upfront carbon achieved by various low-rise building typologies tested under different design scenarios. The building typologies include: office (4 storeys), school (3 storeys), apartment block (5 storeys <18 m in height) and semi detached house (2 storeys). The cost uplift is also considered for the different design scenarios. All the building typologies have a height of less than 18 meters, to ensure compliance with fire regulations in terms of material combustibility.

The RICS building elements modelled include (RICS category numbers in brackets):

- Sub-structure (1), Super-structure (2) and Finishes (3).
- A percentage increase per building typology was applied to account for Building services (5) and External works (8) emissions (based on LETI's work 'Climate Emergency Design Guide' and 'Embodied Carbon Primer').
- Facilitating works (0), Furnishings fixtures and equipment (FF&E) (4), Prefabricated building and building units (6) and Work to existing buildings (7) emissions were excluded from the calculation.

An analysis of different structural, façade and finishes

As it can be seen on the adjacent table, different designs were compared for each building typology, ranging from a baseline assumed to represent standard practice all the way to a combination of the lowest embodied carbon choices.



West of England evidence-base for embodied carbon policy

Evidence-base for West of England Net Zero building policy: embodied carbon

Prepared by WSP (embodied carbon analysis) and Gardiner & Theobald (cost analysis)

December 2021

	S1 - BASELINE	S2 – HYBRID TIMBER	S3 – LOW CARBON CONCRETE	S4 – TIMBER FRAME	S5 – LOW CARBON FACADES	S6 – LOW CARBON INT. FINISHES
SEMI DETACHED HOUSE	Load bearing masonry walls, timber floors and roof	-	40% cement replacement (foundation, GF slab)	Timber studs, floor and roof (Sawn timber)	Timber cladding on timber wall assembly; Wood frame windows; Glass wool insulation (replacing rockwool)	Linoleum floors (replacing vinyl)
APARTMENT BLOCK	Concrete frame and hollowcore slabs	-	40% cement replacement (foundation, GF slab, frame, staircase)	Glulam frame, CLT walls CLT floors)	Timber cladding on timber wall assembly; Wood frame windows	Internal timber wall assembly; Linoleum floors (replacing vinyl)
OFFICE / SCHOOL	Steel frame and composite concrete-steel deck floor slabs	Steel frame and CLT floors/roof	40% cement replacement (foundation, GF slab, staircase)	Glulam frame – CLT floor	Timber cladding on timber wall assembly; Wood frame windows	Internal timber wall assembly; Linoleum floors (replacing vinyl); Exposed soffits

Summary of the different scenarios modelled in terms of embodied carbon (upfront and whole life) and costed by WSP and G&T

Return to contents >

The West of England embodied carbon evidence base | Summary (2/2)

Modelling results

The results opposite show the carbon reductions per scenario of each building typology and the comparison with the LETI upfront carbon targets.

The baseline office scenario (Office_S1) almost complies with LETI 600 kgCO_2e/m^2 2020 target, and the most challenging scenario (Office_S6) complies with the LETI 350 kgCO_2e/m^2 2030 target. For the school typology, the results are similar to the office typology, given that these two typologies share the same baseline. The baseline apartment block scenario (ApartBlock_S1) complies with LETI 500 kgCO_2e/m^2 2020 target and the most challenging scenario (ApartBlock_S6) complies with the LETI 300 kgCO_2e/m^2 2030 target. On the other hand, the baseline semi-detached scenario (SemiDetached_S1) almost complies with LETI 500 kgCO_2e/m^2 2020 target and the most challenging scenario (SemiDetached_S6) almost complies with the LETI 300 kgCO_2e/m^2 2030 target.

Recommendations of the study

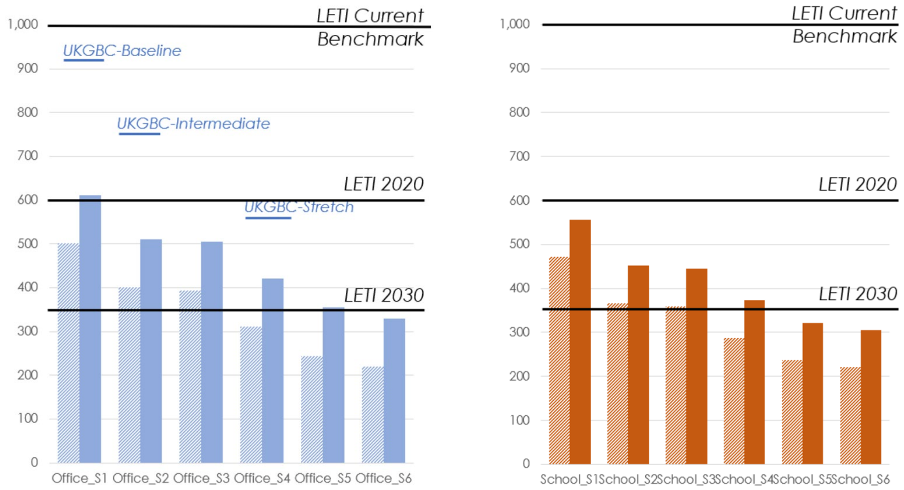
- Conduct and report whole life carbon assessment (including sequestration) and report upfront carbon (modules A1-A5) and circular economy (module D) separately.
- Set upfront (A1-A5) and lifecycle (A1-A5, B1-B5, C, including sequestration) embodied carbon targets.
- Careful investigation of an appropriate carbon offsetting price specific for providing advantage to low carbon alternatives is recommended.

Important limitations raised

Some important limitations were noted:

- The embodied carbon benefits of alternative design choices (e.g. lean design) are not tested.
- As noted in the follow-on Westminster evidence base, the building services additional allowance assumed in this study (15%) consists of much less embodied carbon of building services, than by calculating them using the CIBSE TM65 methodology.

Upfront carbon emissions A1-A5



Non-domestic typologies (office-left and school-right): carbon reduction (kgCO_2e/m^2) per scenario and comparison with LETI upfront carbon targets

Domestic typologies (apartment block-left and semi-detached-right): carbon reduction (kgCO_2e/m^2) per scenario and comparison with LETI upfront carbon targets

Detailed analysis Scope – RICS 1-3 (substructure/ superstructure/ finishes)

Extended scope – RICS 1-3, 5, 8 (+ building services, external works)

Return to contents >

The Westminster embodied carbon evidence base | Summary (1/2)

An embodied carbon evidence base was produced by WSP in September 2024 (version 2), aiming to inform Westminster City Council's embodied carbon targets for new builds. It is framed around the WSP evidence-base report for West of England (WOE), completed in December 2021.

Upfront carbon modelling

This analysis explored the impact of common measures of reducing embodied carbon across four common building typologies in the City of Westminster; an office (7 and 3 storeys), a mixed-use (7-storeys) and a block of flats (8-storeys). They were all modelled with a single-storey basement as it was dimmed more representative of typical buildings currently in construction. RICS WLCA PS 2nd ed. methodology was used. The cost impact of these measures was analysed as well.

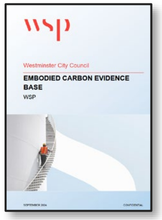
The modelling is based on a mixture of empirical data from previous WSP projects in London, along with material quantities developed from generated structural, MEP, façade and finishes design information per archetype. Internal elements were assumed based on WSP LCA data and fittings, furnishing and equipment (FF&E) were calculated using the GLA benchmark values referenced in the WLC guidance document. Impact of demolition works, renewables and external works were also included in the assessment. CIBSE TM65 methodology was used to calculate the carbon impact of MEP*.

*Methodology upgraded from previous WSP WOE evidence-base, which made allowances for MEP as opposed to calculating it. FF&E wasn't included in WOE, whereas an allowance has been made here.

Scenarios modelled

The adjacent table shows the different design scenarios tested for each building typology, ranging from a baseline assumed to represent standard practice all the way to a combination of the lowest embodied carbon choices. The cost uplift of these scenarios were considered as well.

This evidence-base has considered the impact of lean design on upfront carbon through 2 tested scenarios: *1.not including a basement 2.reduction in grid spacing.*



Westminster City Council: embodied carbon evidence-base

Prepared by WSP

September 2024

	Large and small office	Mixed use	Residential
	Alternative baseline without basement		
S1- baseline with basement	Steel frame and composite concrete-steel deck floor slabs	Steel frame and composite concrete-steel deck floor slabs	Concrete frame and reinforced concrete in-situ flat slabs
S2 – low carbon facade	Increase recycled aluminium content of window framing & replace terracotta rainscreen with timber cladding	Increase recycled aluminium content of window framing and review external wall build-up including bricks as finishing	Replace window aluminium framing with composite and review external wall build-up including bricks as finishing
S3 – low carbon finishes	Removal of ceiling tiles and use of reclaimed floor tiles for 50% of net internal area	Removal of ceiling tiles and use of reclaimed floor tiles for 50% of net internal area	Removal of ceiling tiles and use of reclaimed floor tiles for 50% of net internal area
S4- low carbon MEP	Replace 4 pipe fan coil with floor AHU	Replace ambient loop system with more typical heating only system	Replace ambient loop system with more typical heating only system
S5- reduced grid spacing	Reduction in grid spacing from 12m to 9m	Reduction in grid spacing from 12m to 9m	Reduction in grid spacing from 8m to 6m
S6 low carbon concrete	+25% cement replacement	+25% cement replacement	+25% cement replacement
S7- low carbon/ 50% GGBS	+10% steel reuse & +15% EAF steel	+10% steel reuse & +15% EAF steel	+50% cement replacement
S8- hybrid timer	Steel frame and CLT floors/ roof	Steel frame and CLT floors/ roof	-

Summary of the different scenarios modelled to investigate their upfront carbon and cost.

Return to contents >

The Westminster embodied carbon evidence base | Summary (2/2)

Modelling results

The results align with the previous report by WSP, finding that all building typologies can improve upon the GLA benchmark embodied carbon target for upfront emissions using typical design practices. The analysis found that a mixture of adopting cost saving carbon reduction measures (such as reducing grid spans and optimising MEP systems) with more expensive carbon measures (such as optimising the façade and introducing a higher percentage of recycled materials, timber and cement replacement) can be adopted to deliver carbon reductions within 2% of traditional construction costs. To provide a more conservative estimate as well, cost is also shown without cost savings considered (see table opposite).

The study found that for residential typologies above 18 m in height, it is difficult to achieve any more reductions and meet the GLA aspirational benchmark due to current fire restrictions banning the use of low carbon combustible materials.

Planning considerations

- Reducing upfront carbon may compromise thermal performance, potentially increasing operational energy emissions. Adopting a WLC approach is key in achieving a balance between the two.
- Policy should discourage basements (high carbon contributors) where appropriate but offer financial incentives, such as reducing height restrictions.
- Encourage specification of cement replacement to stimulate demand and help accelerate the introduction of more available lower carbon technologies.
- Adopt design to disassembly principles to enhance reuse of materials in demolition processes.
- Develop WLC offsetting mechanisms to drive comprehensive carbon reductions.
- Consider BREEAM requirements for a holistic sustainability approach.

	Large office	Mixed use	Residential	Small office
Baseline without basement (excl. demolition, facilitating and external works) ($kgCO_2e/m^2$ (GIA))	746	716	875	789
Baseline with basement (excl. demolition, facilitating and external works) ($kgCO_2e/m^2$ (GIA))	802	781	893	1115
A1-A5 with all measurements applied ($kgCO_2e/m^2$ (GIA))	633	618	720	884
A1-A5 (excl. demolition, facilitating and external works) ($kgCO_2e/m^2$ (GIA))	579	583	685	849
Cost uplift (all measurements)	-1.5%	-2.4%	-0.7%	1.7%
Cost uplift (excluding savings)	1.9%	1.3%	4.1%	3.5%

Table shows carbon savings and cost uplift per typology. Carbon impact of renewables included in the results. Contingency factor not included in the results.

Return to contents >

The Essex embodied carbon evidence base | Summary (1/2)

Essex County Council commissioned an embodied carbon policy study which provides evidence and guidance on planning policies that aim to reduce the embodied carbon of buildings in Essex.

Proposed policy requirements

Policy requirements have been proposed across four main embodied carbon areas, associated with: demolition; promoting a circular economy; efficient building design; material efficiency; reducing upfront carbon; and reporting whole life carbon. Upfront carbon and capital cost modelling was carried out to understand how cost and viability may affect the policy. Costs are based on a Q2 2025 base prices for Southeast England and reflect developer housebuilder costs, therefore, exclude separate overheads and profit associated with a main contractor delivery model.

Upfront carbon modelling

As part of this report, a modelling analysis was carried out to investigate the upfront carbon of three low-rise residential building typologies; a terrace house (3 storeys), a semi-detached house (3 storeys) and a low-rise block of apartments (3 storeys, 1 bed and 2 bed). All typologies modelled were also ultra-low operational energy homes.

Element library and set menus

The modelling process used a 'materials database', which fed data to an 'element library' to create a range of building element build-ups, which was then used to construct three set menus for each building typology. The build-ups modelled represent construction from standard practice to best practice, this includes consideration of thermal performance and likely embodied carbon content.

Essex embodied carbon evidence base

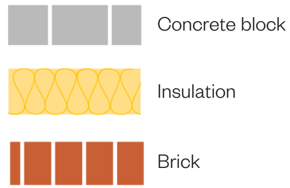
Essex Embodied Carbon Policy Study

Prepared by Levitt Bernstein, Etude, Introba, Hawkins/Brown and Currie and Brown.

May 2024

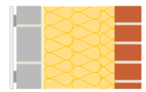
1 Material Database

A1-A5 and upfront biogenic carbon datapoints (KgCO_2 per kg) for each material/product.



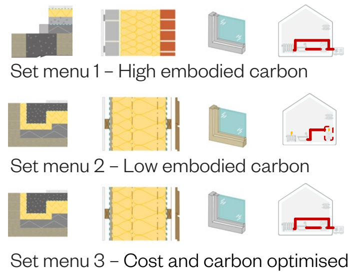
2 Element library

Materials combined to created and calculate the upfront carbon of building elements.



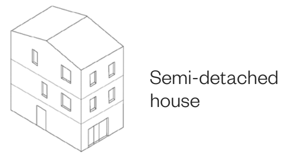
3 Set menus per building typology

Elements combined to create high, low and cost-carbon optimised upfront carbon set menus for each element and typology.



4 Building models

Analyse the upfront carbon and cost results per set menu, per building typology.



Policy recommendations

Limits per typology.

3 Reducing upfront carbon

Summary of modelling process applied in Essex Embodied Carbon Policy Study

Return to contents >

The Essex embodied carbon evidence base | Summary (2/2)

Modelling results

The results opposite show the high, low and cost and carbon optimised upfront carbon and the cost uplifts from Part L 2021 for the three residential building typologies modelled. Cost uplifts from Part L 2021 were also listed below the set menus of each building typology.

Observations

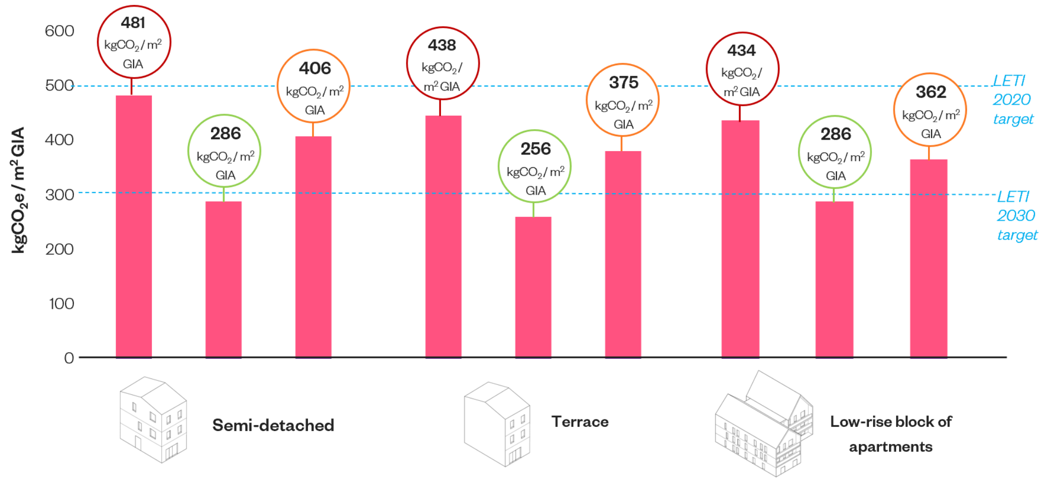
The high carbon (set menu 1) and cost and carbon optimised scenarios (set menu 3) both sit within the LETI 2020 target of 500kgCO_2e/m^2. Whilst the lowest carbon (set menu 2) sits within the LETI 2030 target of 300kgCO_2e/m^2. Lowest carbon (set menu 2) shows negligible variation in overall cost from the highest scenario (set menu 1) for the housing typologies. This is largely due to the cost savings delivered by the relatively shallow raft foundation in comparison to a deep strip foundation and floor slab. For the houses a construction cost saving could be achieved by specifying cost and carbon optimised building elements (set menu 3). For the low-rise block of apartments, both set menu 2 and set menu 3 are more expensive than the highest carbon scenario (set menu 1). This is due to the savings from the masonry structure in comparison to timber framing.

Recommended limit for policy - 500 kgCO_2e/m^2 GIA

The report recommends setting the limit for low-rise housing (under 11m) at 500 kgCO_2e/m^2 GIA. This would be a relatively loose limit to begin with to allow applicants and planning officers in Essex to get used to carrying out or reviewing upfront carbon calculations. It has the advantage of ensuring there is some consideration of building form, typology and material selection, without seeking to exclude specific materials or designs. The report recommends reviewing the limit every 3-5 years to determine if it can be lowered or should be altered. A limit of around 400 kgCO_2e/m^2 GIA would allow for a timber structure with brick face, while a limit of 300 kgCO_2e/m^2 GIA would likely exclude the use of brick.

	Foundations and ground floor	External wall	Party and internal wall	Internal floor	Roof	Windows
Set menu 1: highest embodied carbon	Strip foundations + in-situ concrete slab + screed	Traditional brick and block + glass wool	Traditional block and block + glass wool, metal stud structure	Timber joists + metal ceiling system	Timber rafters + mineral wool	Aluminium frame
Set menu 2: lowest embodied carbon	raft foundations + screed	Off-site timber + wood fibre & hempcrete + render	Timber frame + glass wool, timber stud structure	Timber I-joists	Timber rafters + phenolic insulation	Wooden frame
Set menu 3: cost and carbon optimised	Strip foundations + beam & block floor + screed	Stick timber frame + cellulose +brick	Same as set menu 2	Same as set menu 2	Same as set menu 2	UPVC frame

Table shows building elements forming set menu 1,2 and 3 for the houses.



	Set menu 1	Set menu 2	Set menu 3	Set menu 1	Set menu 2	Set menu 3	Set menu 1	Set menu 2	Set menu 3
Cost uplift from Part L 2021	+9.4%	+9.5%	+8.3%	+8.4%	+7.7%	+7.8%	+7.9%	+11.6%	+10%

Upfront carbon emissions A1-A5 and cost uplift per typology, for high, low and cost and carbon optimised scenario. *The cost analysis shows that changing from a high carbon construction to a low carbon has negligible impact on capital cost.*

Embodied carbon in building regulations in France

Figure X - Réglementation environnementale (RE2020)

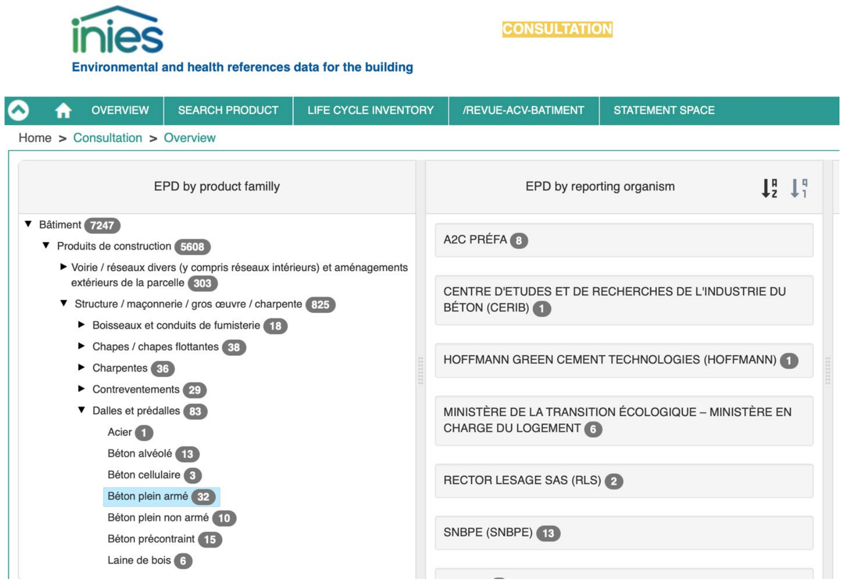
France's Réglementation environnementale (RE2020)

France's Building Regulations RE2020 was adopted in 2022 and applies to new residential, office and education buildings. This policy requires the calculation of the embodied carbon impact associated with materials, products and equipment in every new building. This is carried out in two stages of the process, at the 'construction permit' stage (equivalent to planning application) and at the end of the construction process.

Threshold carbon emissions levels are set per typology and construction permit year. Specific levels of performance must be achieved that will be incrementally reduced (improved) with a new step every three years until 2031. These levels are being revised and reduced in line with France's low carbon economy transition plan.

A specific indicator ($IC_{construction}$ - Construction impact on climate change indicator) is calculated and applied to 13 component areas, as well as an optional one on refrigerants if they are used.

The calculation is based on project specific data for the volumes/quantities of materials, products and equipment which is multiplied by figures from the publicly and freely accessible embodied carbon INIES database. Default assumptions can be used when data on a material is not known or available. These assumptions are provided and are managed at the national level by the Government. The database is based on generic data, although product specific EPDs can also be used. No standardised calculation tool is in place, but a list of compliant tools exist.



The INIES database provides the information required for the calculation.

Requirements vary between building types. They are scheduled to be stepped down every three years.

Return to contents >

Other countries with policies or regulation on embodied carbon

A number of other countries have introduced embodied carbon requirements into their regulatory environment. This page summarises some examples, highlighting that embodied carbon calculation of buildings is becoming more prominent and widespread in Europe. This is relevant to the UK as it may one day influence how and if embodied carbon comes into regulation.

Figure X - Denmark's National strategy for sustainable construction

Denmark's National strategy for sustainable construction

Introduced in 2021, Denmark's policy applies to all new buildings covered by existing energy regulation. It requires all buildings >1,000m^2 to comply with combined operational and embodied limit values (kgCO_2/m^2/year), while buildings below this threshold must only report results of their calculations. The limit is being reduced each year.

The life cycle analysis methodology is standardised with specific calculation requirements. There is no mandatory tool, although there is a public tool developed and accepted for compliance. Authorities provide a database of materials to be used for the calculations. The database is based on generic data, although product specific environmental product declarations (EPDs) can also be used.

Figure X - Finland's "Ilmastoselvitys"

Finland's "Ilmastoselvitys"

Ilmastoselvitys (2016) will be substantially updated by 2025. This regulation covers all new buildings for which a building permit is needed, except single family homes, refurbishments and almost zero energy buildings. It mandates the reporting of Whole Life Carbon. The methodology is being standardised and has no mandatory tool, although OneClick LCA is widely used.

Figure X - MilieuPrestatie Gebouwen (MPG)

Netherlands' "Milieuprestatie Gebouwen" (MPG)

MPG (2022) applies to all new residential buildings and office buildings larger than 100m^2. 11 environmental impact indicators are calculated and combined into a single value.

Checks of the MPG are undertaken on the highest contributing building elements (walls, floors, installations). The final building is compared to the environmental declaration and spot checks can be carried out for more detailed features.

Figure X - Vancouver Building By-Law Amendment

Vancouver Building By-Law Amendment

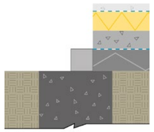
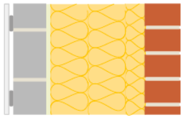
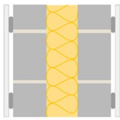
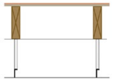
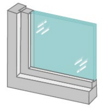
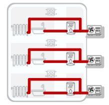
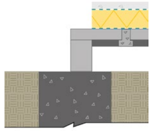
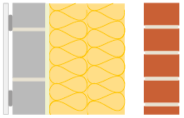
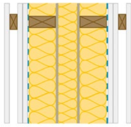
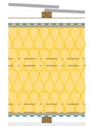
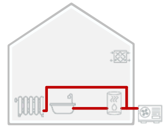
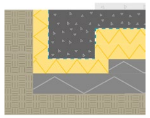
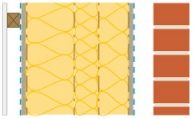
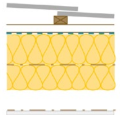
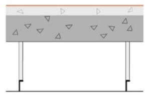
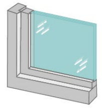
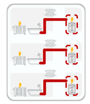
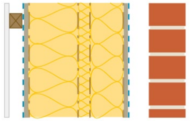
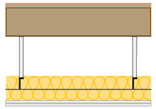
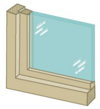
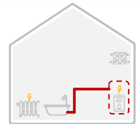
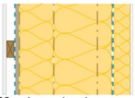
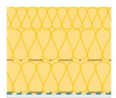
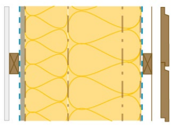
The Vancouver Building By-Law was updated in 2022 to increase the sustainability requirements of buildings. The changes regarding embodied carbon, effective since 2023, include the following:

- Completing a Whole Building Life-Cycle Assessment (WBLCA) at the time of building permit to compare the embodied carbon against a standardised baseline.
- Demonstrate via the WBLCA that the proposed building is not more than double that baseline. Starting in 2025, embodied carbon must be reduced by 10-20% compared to the baseline.
- Starting in 2025, buildings must also comply with one of three options for responsible materials, including sustainable sourcing standards, disclosure of material ingredients, or construction waste diversion and design for disassembly.

5.3
Additional information on modelling specifications

Element library

A summary of all building elements considered as part of the residential modelling

Foundations and ground floor	Superstructure						MEP
	External wall	Party wall	Intermediate wall	Roof	Internal/party floor	Window	Heating and hot water
 **F-01 & G-01:** strip foundations + in-situ concrete slab + screed	 **EW-01a:** Traditional brick and block + glass wool (best U-value)	 **PW-01:** Traditional block and block + mineral wool	 **IW-01:** Metal stud structure	 **House R-01:** Timber rafters + mineral wool	 **House IF-01:** Timber joists + metal ceiling system	 **W-01:** Aluminium	 **Flats MEP-01:** ASHP + other systems
 **F-01 & G-02:** strip foundations + beam and block floor + screed	 **EW-01b:** Traditional brick and block + glass wool (worst U-value)	 **PW-02:** Timber frame + mineral wool	 **IW-02:** Timber stud structure	 **House R-02:** Timber I-joists + cellulose	 **House IF-02:** Timber i-joists	 **W-02:** Composite	 **House MEP-02:** ASHP + other systems
 **F-02 & G-03:** raft foundations + screed	 **EW-02a:** Stick timber frame + cellulose + brick (best U-value)			 **House R-03:** Timber rafters + phenolic	 **Flats PF-01:** Pre-cast concrete planks	 **W-03:** UPVC	 **Flats MEP-01:** Direct electric + other systems
	 **EW-02b:** Stick timber frame + cellulose + brick (worst U-value)			 **Flats R-04:** Timber joist + mineral wool at loft	 **Flats PF-02:** CLT slab	 **W-04:** Wooden frame	 **House MEP-02:** Direct electric + other systems
	 **EW-03a:** Off-site timber + wood fibre and hempcrete insulation + render (best U-value)			 **Flats R-05:** Timber joist + cellulose at loft			
	 **EW-03b:** Off-site timber + wood fibre and hempcrete insulation + timber weatherboard (worst U-value)						

Upfront carbon – *residential specification*

Scenario	Upfront carbon limit achieved	Construction type	Construction types combined as part of the scenario modelling
Net zero operational ***Baseline***	<500 kgCO$_2$e/m^2 (GIA)	Typical construction	Strip foundations + in-situ concrete slab + screed Brick and block + glass wool insulation Block and block + glass wool insulation Timber and stud structure Timber rafters + phenolic insulation Timber i-joists UPVC ASHP + other systems Timber structure staircase
Highest carbon ***Scenario 1***	<500 kgCO$_2$e/m^2 (GIA)	Traditional construction	Strip foundations + in-situ concrete slab + screed Brick and block + glass wool insulation Block and block + glass wool insulation Metal stud structure Timber rafters + mineral wool Timber joists + metal ceiling system Aluminium ASHP + other systems Timber structure staircase
Cost-carbon optimised ***Scenario 2***	<400 kgCO$_2$e/m^2 (GIA)	Timber frame	Strip foundations + beam & block floor + screed Stick timber frame + cellulose + brick Timber frame + glass wool insulation Timber stud structure Timber rafters + phenolic insulation Timber i- joist UPVC ASHP + other systems Timber structure staircase
Lowest carbon ***Scenario 3***	<300 kgCO$_2$e/m^2 (GIA)	Off-site timber frame	Raft foundations + screed Off-site timber + wood fibre & hempcrete + render Timber frame + glass wool insulation Timber stud structure Timber rafters + phenolic insulation Timber i- joist Wooden frame ASHP + other systems Timber structure staircase

Return to contents >

Upfront carbon – *non-residential specification*

Scenario	Upfront carbon limit achieved	Construction type	Substructure	Superstructure	Building envelope	Services
Net zero operational ***Baseline***	700 $kgCO_2e/m^2$ (GIA)	Concrete frame smaller grid	Concrete piles 70% cement replacement	RC concrete frame and slabs 7.5 x 7.5m grid, 25% cement replacement	Brick, form factor 0.7-0.9	ASHP, FCUs, mixed mode
Business as usual ***Scenario 1***	950 $kgCO_2e/m^2$ (GIA)	Concrete frame larger grid	Concrete piles 50% cement replacement	RC concrete frame and slabs 9 x 9m grid, 0% cement replacement	Pre-cast concrete, form factor 0.9-1.2	ASHP, FCUs, mech led
Optimised structural design ***Scenario 2***	700 $kgCO_2e/m^2$ (GIA)	Concrete frame smaller grid	Concrete piles 70% cement replacement	RC concrete frame and slabs 7.5 x 7.5m grid, 25% cement replacement	Brick, form factor 0.7-0.9	ASHP, FCUs, mixed mode
Low carbon structure ***Scenario 3***	605 $kgCO_2e/m^2$ (GIA)	CLT	Concrete piles 70% cement replacement	CLT slab and steel frame, 50% recycled 6 x 6m grid	GRC rainscreen, Form factor 0.7-0.9	ASHP, FCUs, mixed mode

Return to contents >

5.4
Additional information on Approved Document Part B fire regulations

Part B Fire Safety – conflicts and opportunities in embodied carbon

New residential buildings above 11m height

The embodied carbon of new residential buildings is significantly influenced by the UK Part B fire regulations V1. In 2020, Part B received significant updates which, in certain situations, limit material choice and specification.

For example, new residential buildings between 11-18m in height (measured to top occupied storey), the external surface of walls and any insulation product used in the external wall should be Class A2-s1, d0 or better (non-combustible). New residential buildings with a top occupied storey of 18m or more above ground should have non-combustible materials in the construction of all its external walls (with minor exceptions for cavity materials for specific types of masonry cavity walls). Balconies and spandrel panels should also be non-combustible over 11 m.

In such cases, certain low embodied carbon materials, like timber structure or wood fibre, hempcrete and cellulose insulation, are no longer allowable options above 11m. Bricks and concrete are the most used materials in high-rise residential, due to their high level of fire resistance and durability, but both typically carry a substantial carbon footprint.

New residential buildings below 11m height

For new residential buildings below 11m in height, Class B-s3, d2 materials can be used (combustible and non-combustible). Therefore, there is an opportunity to encourage the use of low embodied carbon natural materials in areas where low-rise residential types are most common.

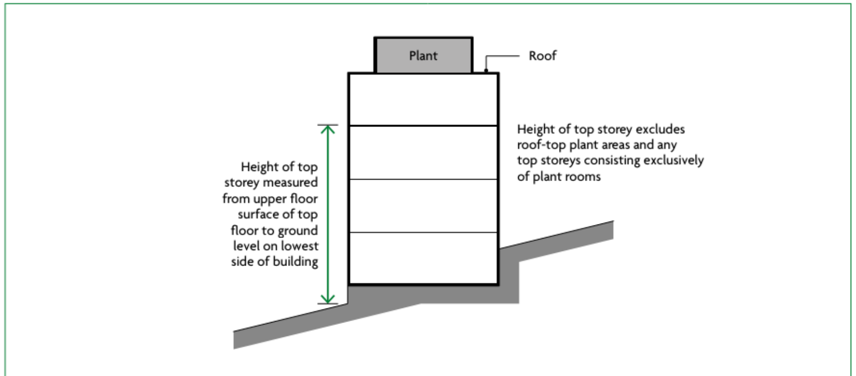


Diagram D6 Height of top storey in building

Building height measurement from Building regulations Part B volume 1, 2019 edition incorporating 2020 & 2022 amendments

Part B Building regulations, Volume 1: Dwellings, 2019 edition incorporating 2020 & 2022 amendments

Number of storeys and height of top storey in building

"To count the number of storeys in a building, or in a separated part of a building, count only at the position which gives the greatest number and exclude any basement storeys... Height of top storey measured from upper floor surface of top floor to ground level on lowest side of the building. Height of top storey excludes roof-top plant areas and any top storeys consisting exclusively of plant rooms."

External wall build-ups	Structure	Insulation	Finish
Below 11 m in height	• Timber structure • Brick and block • Concrete structure + steel infill • Steel structure	• Petroleum based (e.g. phenolic insulation) • Wood fibre • Mineral and glass wool • Hemp/ hempcrete • Cellulose • Other natural insulations	• Brick • Render • Timber rainscreen • Metal rainscreen • Concrete panels • Other cladding systems
Between 11-18 m in height	• Timber structure • Brick and block • Concrete structure + steel infill • Steel structure	• Mineral and glass wool	• Brick • Render • Metal rainscreen • Concrete panels • Other non-combustible cladding systems
Above 18 m in height	• Concrete structure + steel infill • Steel structure	• Mineral and glass wool	• Brick • Render • Metal rainscreen • Concrete panels • Other non-combustible cladding systems

Example of materials within an external wall build-up, per building height (and according to Part B fire safety regulations)

Return to contents >

Version 1.1 – April 2026

Authors:

Levitt Bernstein People.Design

Etude

Currie & Brown