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Executive summary

- Total embodied carbon emissions attributable to the UK built environment have not reduced over the past two decades as improvements in the carbon intensity of material production have been outweighed by increased construction activity. This trend is unlikely to change in the absence of additional policy.
- Based upon current and planned policies, if embodied or whole life carbon assessment is not integrated into Building Regulations or another policy instrument by the middle of this decade the UK will be an outlier compared to usual comparator countries.
- The Government (through BEIS/MHCLG) should set out an indicative long term trajectory for policy in this area and immediately provide funding to support development of critical underpinning policy infrastructure (e.g. common database and methodology). The longer this investment is delayed, the longer it will take to develop the metrics, benchmarks, and targets upon which effective policies and changes in practice depend.
- The Government should set in place formal structures to learn from the wide range of alternate approaches in emerging international policy when formulating the details of a domestic response.

Evidence

The following evidence addresses 3 of the inquiry's stated questions in turn, offers general recommendations for action by the Government, then concludes with a summary of my relevant expertise and reasons for submitting evidence to this inquiry.

To what extent have the Climate Change Committee's recommendations on decarbonising the structural fabric of new homes been met?

1. In short, not at all. Other respondents to this enquiry will doubtless provide detailed commentary on issues such as the barriers facing increased timber construction or modest increases in uptake of alternative materials. In aggregate, best estimates suggest that there is no trend towards reducing the total annual embodied carbon emissions associated with development of the UK built environment. Figure 1 overleaf illustrates these estimates within the context of the UK's territorial and consumption-based emissions accounts, based upon the most recent update against the Green Construction Board's Low Carbon Routemap for the UK Built Environment. The original Routemap was published in 2013, updated in 2015 and 2017, and the underpinning model is currently being adapted and updated for inclusion within the upcoming UKGBC Net Zero Whole Life Carbon Roadmap. Although still subject to a degree of uncertainty, the top-down model used within the Routemap shows good agreement with prior independently prepared bottom-up estimates. The overall trend in embodied carbon is driven by modest declines in the carbon intensity of material production being offset by increased construction activity. The only instances where this total declined substantially were in the years following the global financial crisis which coincided with the largest and fourth largest annual drops in construction output on record. If the goal over the next 30 years is to deliver 300,000 new homes a year, retrofit a home a minute, adapt much of our non-domestic building stock and transform our infrastructure systems then total construction activity and embodied carbon is likely to increase in the absence of additional interventions.
2. Recognising the estimated distribution of embodied carbon in the built environment across asset types, it is important that the focus of the Committee's inquiry extends beyond housing. Though based on limited datasets (which could be usefully developed), the estimated distribution of embodied carbon emissions in recent years suggests that domestic buildings account for less than a quarter of the

annual total (see Figure 2). It is therefore crucial that the Committee recognises the importance of decarbonising non-domestic buildings and infrastructure, takes corresponding evidence and makes recommendations that cover a range of asset types.

3. The recent Infrastructure Carbon Review 7 years on progress report and corresponding numerical update prepared by the ICE Carbon Project also recognised a trend of increasing capital carbon emissions from infrastructure. The largely overlapping term capital carbon is often preferred to embodied carbon when referring to infrastructure projects and is defined in specifications such as PAS2080: Carbon Management in Infrastructure. This trend is set to continue with planned increases in infrastructure investment. The extent to which this is compatible with our national carbon budgets is unknown – as highlighted in a recent Net Zero Infrastructure Industry Coalition report which unsuccessfully attempted to quantify the embodied carbon associated with the National Infrastructure Pipeline. In the absence of routine portfolio scale capital carbon assessment and the omission of capital carbon from most national infrastructure system models, at present there is insufficient data to support any reasonable estimate of the capital carbon emissions to which we are committed through planned infrastructure investment. Closing this knowledge gap is critical to ensuring we plan and develop infrastructure within our carbon budgets.

Figure 1: Capital/embodied carbon emissions from the UK built environment relative to national accounts[1]

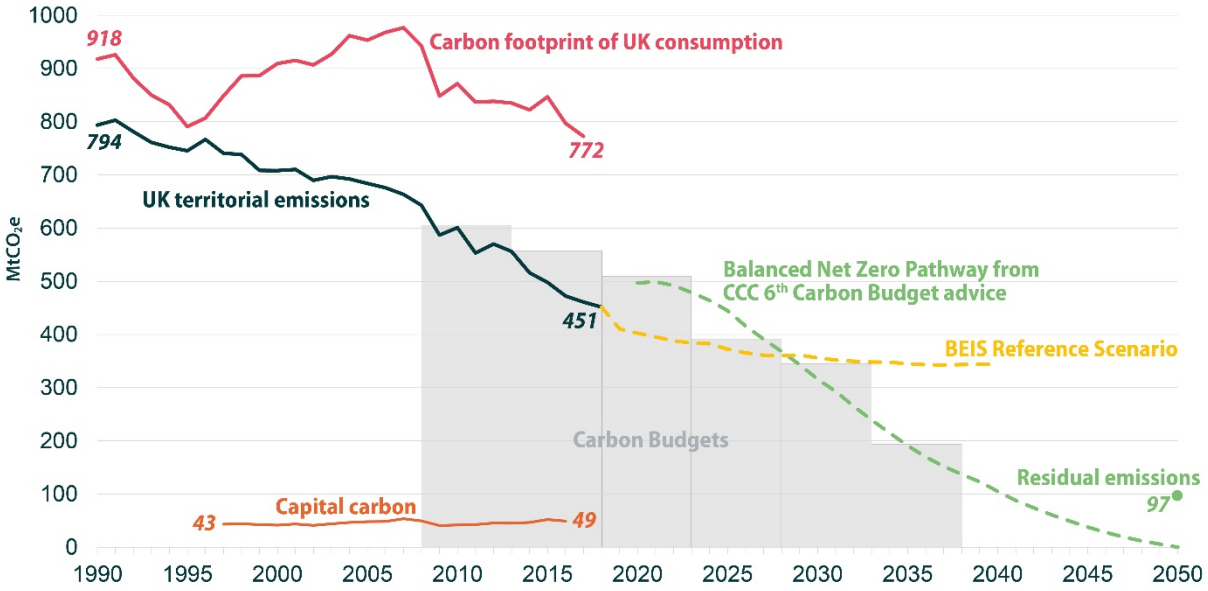
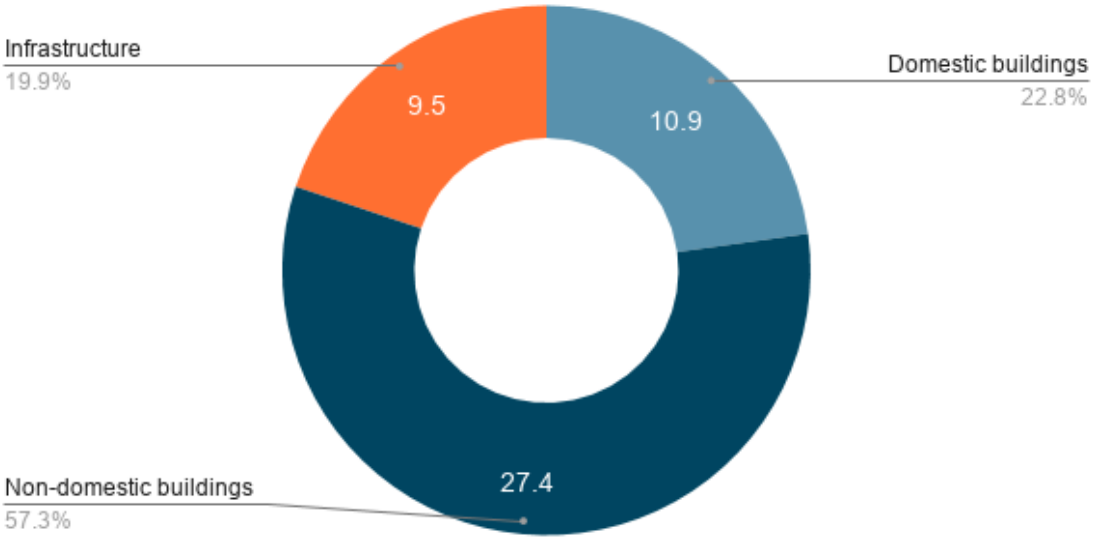


Figure 2: Estimated embodied carbon by asset type based on 2017 update to Green Construction Board Low Carbon Routemap for the Built Environment. All figures $MtCO_2e$.

[1] Territorial emissions from final statistics to 2018 and consumption-based emissions from UK's Carbon Footprint 2020 release. BEIS Reference Scenario from updated energy & emissions projections published October 2020. The apparent disconnect with the CCC balanced pathway in 2020 arises from the recent changes in inventory accounting incorporated into the CCC's Sixth Carbon Budget advice. Residual emissions within the balanced pathway are included for context.



What role can the planning system, permitted development and building regulations play in delivering a sustainable built environment? How can these policies incentivise developers to use low carbon materials and sustainable design?

4. These policies are the principal levers by which a sustainable built environment can be delivered. However, as noted by the Committee, embodied carbon in not currently considered in the majority of cases (with some exceptions such as the Greater London Authority's recently introduced SI2 policy). This omission has been the subject of repeated dispute throughout the development and abandonment of numerous policies targeting reductions in operational carbon emissions over the past two decades.
5. Recent reports, such as those by AECOM, CNCA, Bionova and ACAN have highlighted a broad suite of policy options and international precedents.
6. Table 1 overleaf provides a high level overview of related policy developments in a number of comparator countries and states. Many of these jurisdictions are engaged in multi-year programmes to develop policy targeting embodied or whole life carbon assessment or reduction. This typically takes the form of introducing a life cycle or carbon assessment requirement drawing upon common underpinning policy infrastructure such as a national methodology, product database and approved tools. Often an initial period of embedding reporting (typically 3-5 years) is followed by the introduction of targets and a long term ratcheting down of target levels. By the mid-2020s it is expected that many of the UK's comparator countries will have introduced embodied carbon targets through policy instruments of this sort.
7. These policy instruments and respective underpinning policy infrastructure (such as national methodologies) vary substantially in particular details such as the assessment boundary and application to different asset types and project scales. There is significant scope for the UK to learn from emerging international best practice and the diverse range of policies that will be implemented over the next few years. This should be supported by a formal structure, for instance an Embodied Carbon Policy Observatory, which could also provide a platform for knowledge exchange, technical support and training, and independent assessment of policy efficacy. Alternately, in the absence of such a formal structure, responsibility to monitor international developments should be allocated to individuals within the relevant Government departments (i.e. BEIS & MHCLG).
8. Many of the countries highlighted in Table 1, and others, have also introduced complementary policy requiring increased disclosure of product information, and incentives targeting related policy areas such as reduced waste, increased circularity or promotion of specific design options like timber construction. The Committee should explore recommendations around a holistic package of policy measures with embodied or whole life carbon assessment at the core.

Table 1: Example[2] international policy precedents

Location	*Instrument*	*Policy owner*	*Brief description*	*Current status*	*Future development*
Netherlands	Bouwbesluit (Building Act) 2012 Building Decree + subsequent amendments	Ministerie van Binnenlandse Zaken en Koninkrijksrelaties (Ministry of the Interior and Kingdom Relations)	Mandatory Life Cycle Assessment (LCA) calculation for residential and office buildings over 100m^2 using national assessment method, database and approved tools. The combined monetised impacts of 11 LCA impact categories are capped.	Reporting in force since 2013. Cap in place since Jan 2018.	Cap will be tightened
Sweden	New Act on Climate declarations for new buildings is under development	Boverket (National Board of Housing, Building & Planning) (with assistance from Swedish Transport Administration and Environmental Protection Agency)	Will require buildings to make a 'climate declaration', using common database and methodology, depositing results in register with limits introduced after initial period of data gathering.	Since 2018 Boverket have been working on 5 subprojects on database; register; guidance; regulation drafting and next steps. Database launched in March 2021, in testing phase til May, with final version set for publication in June. Major information campaign scheduled for autumn 2021. Policy impact assessment under way. See here for overview.	Ordinance to be enacted from 01/01/22. From 2027 limit values will be introduced and then ratcheted (with proposed relative reduction steps to 2043 published in 2020).
Finland	Reform of the Land Use and Building Act due for completion by end 2021	Ministry of the Environment	Assessment of building footprint and handprint in accordance with national methodology will be required for building permit.	Methodology published in 2019, consultation completed in August 2020, database launched in March 2021, testing phase ongoing	First limits to be introduced for public projects with limits for most buildings to be introduced by 2025
Denmark	National Strategy for Sustainable Construction & building regulations	Ministry of Transport and Housing	Mandatory LCA calculation for new buildings, with impact limits for buildings over 1000m^2.	Political agreement in March 2021 plans introduction from 2023. Overview in English here.	Ratcheting down of limits in 2025, 2027 and 2029.
France	RE2020 (Environmental Regulations 2020)	Ministry of Ecological Transition	Introduces whole life dynamic LCA requirements followed by limits. Supported by national database (with its own associated requirements driven by regulations).	Testing phase of predecessor E+C- completed in 2019. Subsequent regulation developed for Jan 2021 but introduction delayed to summer 2021.	Due to apply from summer 2021 Requirements to be progressively strengthened in 2024, 2027 and 2030 (up to 30-40% reduction).
California[3]	Buy Clean California Act	Administered by Department of General Services	Public works undertaken by state agencies must submit Environmental Product Declarations (EPD) demonstrating compliance against Global Warming Potential (GWP) limits on 4 materials.	Limits published, awarding authorities will gauge compliance from 01/07/21.	3 year review cycle from 01/01/24 will revise limits, "likely" that other materials will be added
United States	Recently proposed CLEAN Future Act (Title V Subtitle C Sec 521-524)	Administered by relevant federal agencies	Public works undertaken by federal agencies must submit EPD demonstrating compliance against GWP limits on set of up to 9 materials	Draft introduced 03/02/21, now going through committees.	Would come into force 1 year after enactment with a 3 year review cycle
EU	Level(s)	European Commission	Framework including set of indicators intended to harmonise metrics and language on sustainability performance of buildings across	Framework launched October 2020 after 5 years of development & testing on 130 projects. Initially voluntary and	EC has proposed green public procurement criteria using Level(s) for offices & schools from June

[2] Others such as Norway, Belgium, Italy and Switzerland also currently have, or are developing, related policies.
[3] Four other states have Buy Clean legislation in some stage of development whilst Minnesota and Oregon also have related orders in place.

	the EU.	requires integration through policies or regulatory framework.	2022.

What methods account for embodied carbon in buildings and how can this be consistently applied across the sector?

9. The CEN/TC 350 suite of European standards provide common methodologies for products (BS EN15804:2012+A2:2020) and building level assessment (BS EN 15978:2011). Beneath this the RICS Professional Statement on Whole Life Carbon Assessment for the Built Environment, published in 2017, provides an additional layer of detail to enable consistent assessment across UK projects in accordance with European standards. In addition, there are a wide range of guidance documents tailored to specific professions advising on best practice – e.g. The Institution of Structural Engineers' 'How to calculate embodied carbon'. There are also a range of additional methods employed by particular clients or through environmental assessment methods such as BREEAM. There are ongoing efforts to bring greater consistency between terminology across approaches e.g. through the work of the Whole Life Carbon Network.
10. A range of free and subscription-based tools of varying sophistication support implementation of calculations. These tools differ in certain key aspects, such as their default data sources and assumptions, and consequently do not yet yield comparable results for the same project. However, recent advances in these tools have significantly reduced the time and associated cost of undertaking an assessment. It is unlikely that these tools will converge on common defaults in the absence of a concerted effort to ensure alignment (e.g. through the introduction and integration of a common national database and methodology as has been done elsewhere).
11. The primary gap preventing consistent assessment across the sector is not a lack of underlying standards or guidance but the lack of prescriptive assessment boundaries and defaults that are typically prescribed within a national methodology. For instance, the RICS Professional Statement is built upon a modular reporting structure by building element and life cycle stage. This allows assessors to choose an appropriate boundary for their project. If regulations were to be introduced requiring embodied or whole life carbon assessment, these regulations (or an accompanying endorsed methodology document) would need to explicitly stipulate the assessment boundaries to ensure comparability (i.e. which building elements and life cycle stages should be included).
12. Irrespective of the preferred approach to regulating embodied carbon, development of the underpinning policy infrastructure (such as a single national methodology, common product database and building database) would greatly improve the consistency of current assessments and provide a robust basis for subsequent regulation. Much of this could be adapted from existing standards and databases.

Recommendations for action by the Government

13. Immediately commence work on developing the common resources that underpin future policy interventions:
    a. a national methodology (adapted from, or building upon, the RICS Professional Statement)
    b. a central default source of product carbon factors (an evolving repository of EPD and other LCA information, potentially starting from a resource like the ICE database)
    c. a central repository for submission of building results (potentially adapted from the existing RICS database)
14. Announce intent to include embodied or whole life carbon assessment within policy. Irrespective of the preferred policy instrument, such an announcement would provide an additional incentive to the industry to upskill, engage in greater voluntary/preparatory assessment, and encourage product manufacturers to develop further product information (e.g. EPD).
15. Develop details of a preferred policy instrument. For example, if Building Regulations is the preferred instrument, it will be necessary to determine whether to place embodied carbon assessment within a new Part or incorporate whole life carbon assessment through substantial revisions to Part L. Appropriate cut offs for assessment requirements would also have to be developed (e.g. having a simplified assessment or exemption for the smallest schemes or certain asset types).
16. Once a preferred policy instrument has been identified and developed, announce within the corresponding consultation a long term trajectory for progressively ratcheting requirements, such as targets and assessment boundaries.

17. Designate responsibility to individuals within BEIS/MHCLG to learn from international best practice and seek to establish a formal multi-year platform e.g. an Embodied Carbon Policy Observatory to support knowledge sharing and learning from the implementation of policies in comparator countries.
18. Building upon recent requirements in The Construction Playbook, implement routine programme/portfolio level assessment of embodied/capital carbon for social and economic infrastructure. This will require a plan for central amalgamation of project level assessments and the development of appropriate portfolio significance criteria. The development of portfolio significance criteria should seek to overcome known shortcomings in the current approach whereby each project's significance is assessed in isolation (e.g. every individual road project is deemed insignificant based on DMRB LA114 3.20 but their collective impact is substantial).
19. Integrate embodied/capital carbon into the suite of infrastructure system models that inform current policy and recommendations from agencies such as the National Infrastructure Commission.
20. Ensure metrics on embodied carbon are incorporated into the Construction Leadership Council's CO2nstruct Zero upcoming monitoring and reporting framework.

Expertise and reason for submitting evidence

I am a Research Fellow in Industrial Climate Policy at the University of Leeds, currently working for the Centre for Research into Energy Demand Solutions (CREDS). I have over 10 years' experience delivering research and consultancy on embodied carbon assessment and mitigation in the built environment and hold a PhD on the topic. I have published a range of related academic research (see full list here), and was awarded the 2019 Richard Trevithick Fund Prize from the Institution of Civil Engineers for my work on embodied carbon. I have been involved in numerous industry projects depicting the role of embodied carbon mitigation in achieving the UK's long term carbon targets – most recently the ongoing UKGBC Net Zero Whole Life Carbon Roadmap project which builds on previous road mapping efforts I was also involved in (e.g. co-authoring the last update of the Green Construction Board's Low Carbon Routemap for the Built Environment and the ICE's 7 years on assessment of progress against the Infrastructure Carbon Review). I am a member of several related industry working groups, such as The Embodied Carbon Group, the ICE's Carbon Project, the Net Zero Infrastructure Industry Coalition Embodied Carbon Working Group and the Whole Life Carbon Network. I have contributed to a range of related guidance and standards, such as the UKGBC's guidance for clients, and was part of the Expert Panel in the development of the RICS Professional Statement. I have provided expert review on this topic for the Climate Change Committee, Chatham House, the Overseas Development Institute, the Institution of Structural Engineers, the World Green Building Council and many others.

Though interest and voluntary industry action on embodied carbon has grown substantially over the past decade, this has been insufficient to drive the transformative change in industry practice needed. Given the multi-year period typically required by other nations to develop policy and the underpinning infrastructure, I believe it is now imperative that UK policy makers must intervene in short order, if we are to deliver the step change carbon reductions implied by the 6th Carbon Budget (2033-2037). I welcome this timely inquiry and would be happy to provide further evidence and support.

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