CIE-MAP

Centre for Industrial Energy, Materials and Products

Research Councils UK Energy For a Low Carbon Future

The role of timber in meeting carbon targets

Dr Jannik Giesekam

@jannikgiesekam J.Giesekam@leeds.ac.uk

Research Fellow in Energy, Materials and Climate Policy

University of Leeds

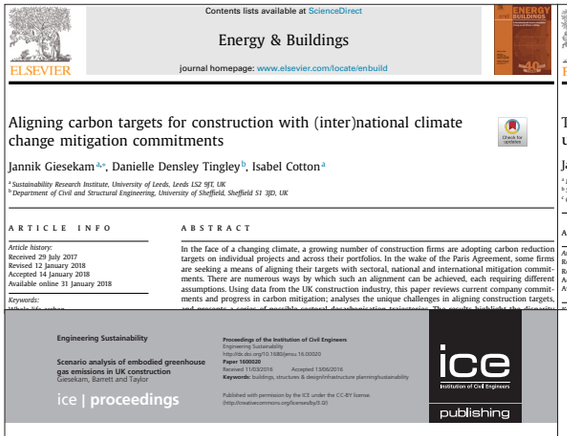
CIE-MAP publications

CIE-MAP
Centre for Industrial Energy, Materials and Products

On embodied/whole life carbon reduction in the built environment

- Mitigation options and barriers
- Scenario analyses and the use of project/company carbon targets
- Reporting progress against the Green Construction Board's Low Carbon Routemap
- Practitioner and public perceptions of low carbon building materials

All available at ciemap.ac.uk


Contents lists available at ScienceDirect
Energy & Buildings
journal homepage: www.elsevier.com/locate/enbuild

Aligning carbon targets for construction with (inter)national climate change mitigation commitments

Jannik Giesekam[a,*], Danielle Densley Tingley[b], Isabel Cotton[a]

[a] Sustainability Research Institute, University of Leeds, Leeds LS2 9JT, UK
[b] Department of Civil and Structural Engineering, University of Sheffield, Sheffield S1 3JD, UK

ARTICLE INFO
Article history:
Received 29 July 2017
Revised 12 January 2018
Accepted 14 January 2018
Available online 31 January 2018
Keywords:

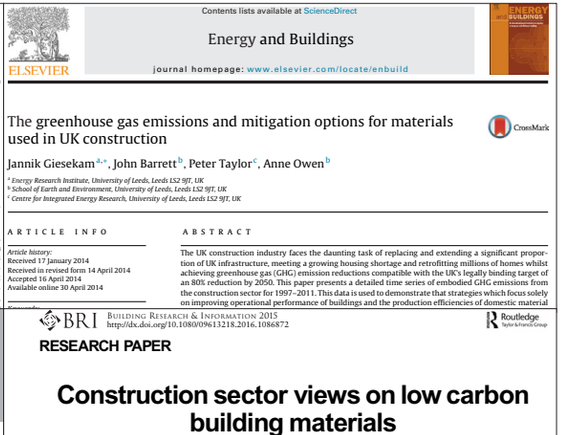
ABSTRACT
In the face of a changing climate, a growing number of construction firms are adopting carbon reduction targets on individual projects and across their portfolios. In the wake of the Paris Agreement, some firms are seeking a means of aligning their targets with sectoral, national and international mitigation commitments. There are numerous ways by which such an alignment can be achieved, each requiring different assumptions. Using data from the UK construction industry, this paper reviews current company commitments and progress in carbon mitigation; analyses the unique challenges in aligning construction targets,

Engineering Sustainability
Scenario analysis of embodied greenhouse gas emissions in UK construction
Giesekam, Barrett and Taylor
ice | proceedings
Proceedings of the Institution of Civil Engineers
Engineering Sustainability
http://dx.doi.org/10.1680/jensu.16.00020
Paper 1600020
Received 11/03/2016 Accepted 13/06/2016
Keywords: buildings, structures & design/infrastructure planning/sustainability
Published with permission by the ICE under the CC-BY license.
ice Institution of Civil Engineers publishing

Scenario analysis of embodied greenhouse gas emissions in UK construction

Jannik Giesekam MEng
Research Fellow in Energy, Materials and Climate Policy, Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds, UK (corresponding author: j.giesekam@leeds.ac.uk)
John Barrett PhD
Professor of Energy and Climate Policy, Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds, UK
Peter Taylor PhD
Professor of Sustainable Energy Systems, Centre for Integrated Energy Research, University of Leeds, Leeds, UK; Energy Research Institute, School of Chemical and Process Engineering, University of Leeds, Leeds, UK; Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds, UK

Motivated by national greenhouse gas (GHG) emissions budgets, the UK construction industry is pursuing reductions in emissions embodied in buildings and infrastructure. The current embodied GHG emissions benchmarks allow design teams to make a relative comparison between buildings and infrastructure but are not linked to sector or national GHG emissions reduction targets. This paper describes a novel model that links sector-level embodied GHG emissions estimates with project calculations. This provides a framework to consistently translate international, national and sector reduction targets into project targets. The required level of long-term GHG emissions reduction


Contents lists available at ScienceDirect
Energy and Buildings
journal homepage: www.elsevier.com/locate/enbuild

The greenhouse gas emissions and mitigation options for materials used in UK construction

Jannik Giesekam[a,*], John Barrett[b], Peter Taylor[c], Anne Owen[b]

[a] Energy Research Institute, University of Leeds, Leeds LS2 9JT, UK
[b] School of Earth and Environment, University of Leeds, Leeds LS2 9JT, UK
[c] Centre for Integrated Energy Research, University of Leeds, Leeds LS2 9JT, UK

ARTICLE INFO
Article history:
Received 17 January 2014
Received in revised form 14 April 2014
Accepted 16 April 2014
Available online 30 April 2014

ABSTRACT
The UK construction industry faces the daunting task of replacing and extending a significant proportion of UK infrastructure, meeting a growing housing shortage and retrofitting millions of homes whilst achieving greenhouse gas (GHG) emission reductions compatible with the UK's legally binding target of an 80% reduction by 2050. This paper presents a detailed time series of embodied GHG emissions from the construction sector for 1997–2011. This data is used to demonstrate that strategies which focus solely on improving operational performance of buildings and the production efficiencies of domestic material

BRI Building Research & Information 2015
http://dx.doi.org/10.1080/09613218.2016.1086872
Routledge
RESEARCH PAPER

Construction sector views on low carbon building materials

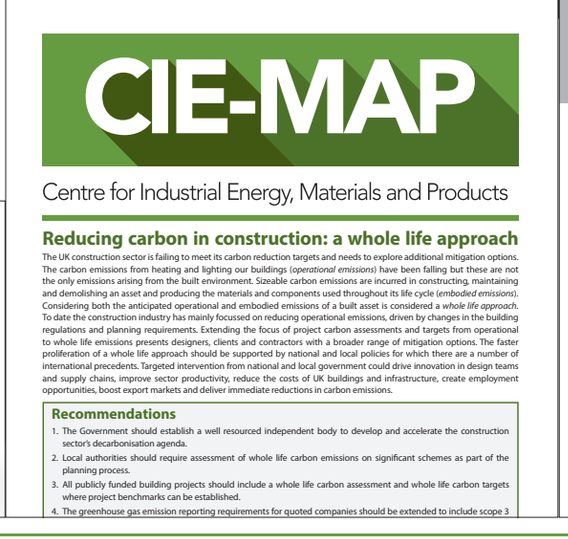
Jannik Giesekam[1], John R. Barrett[2] and Peter Taylor[3]

[1]Energy Research Institute, University of Leeds, Leeds LS2 9JT, UK
E-mail: pmjjg@leeds.ac.uk

[2]Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds LS2 9JT, UK

[3]Centre for Integrated Energy Research, School of Earth and Environment, University of Leeds, Leeds LS2 9JT, UK

As is the case in a number of countries, the UK construction industry faces the challenge of expanding production whilst making ambitious greenhouse gas emission reductions. Embodied carbon constitutes a growing proportion of whole-life carbon emissions and accounts for a significant share of total UK emissions. A key mitigation strategy is increasing the

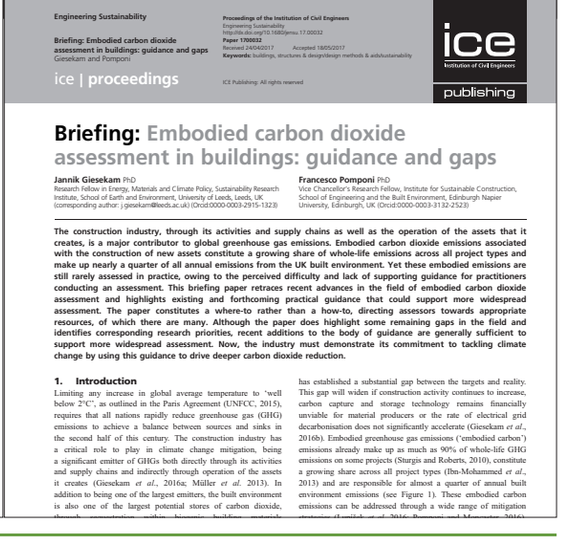

CIE-MAP
Centre for Industrial Energy, Materials and Products

Reducing carbon in construction: a whole life approach

The UK construction sector is failing to meet its carbon reduction targets and needs to explore additional mitigation options. The carbon emissions from heating and lighting our buildings (*operational emissions*) have been falling but these are not the only emissions arising from the built environment. Sizeable carbon emissions are incurred in constructing, maintaining and demolishing an asset and producing the materials and components used throughout its life cycle (*embodied emissions*). Considering both the anticipated operational and embodied emissions of a built asset is considered a *whole life approach*. To date the construction industry has mainly focussed on reducing operational emissions, driven by changes in the building regulations and planning requirements. Extending the focus of project carbon assessments and targets from operational to whole life emissions presents designers, clients and contractors with a broader range of mitigation options. The faster proliferation of a whole life approach should be supported by national and local policies for which there are a number of international precedents. Targeted intervention from national and local government could drive innovation in design teams and supply chains, improve sector productivity, reduce the costs of UK buildings and infrastructure, create employment opportunities, boost export markets and deliver immediate reductions in carbon emissions.

Recommendations

1. The Government should establish a well resourced independent body to develop and accelerate the construction sector's decarbonisation agenda.
2. Local authorities should require assessment of whole life carbon emissions on significant schemes as part of the planning process.
3. All publicly funded building projects should include a whole life carbon assessment and whole life carbon targets where project benchmarks can be established.
4. The greenhouse gas emission reporting requirements for quoted companies should be extended to include scope 3


Engineering Sustainability
Briefing: Embodied carbon dioxide assessment in buildings: guidance and gaps
Giesekam and Pomponi
ice | proceedings
Proceedings of the Institution of Civil Engineers
Engineering Sustainability
http://dx.doi.org/10.1680/jensu.17.00032
Paper 1700032
Received 24/04/2017 Accepted 18/05/2017
Keywords: buildings, structures & design/design methods & aids/sustainability
ICE Publishing: All rights reserved
ice Institution of Civil Engineers publishing

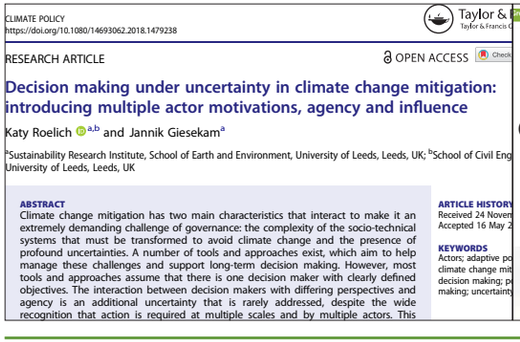
Briefing: Embodied carbon dioxide assessment in buildings: guidance and gaps

Jannik Giesekam PhD
Research Fellow in Energy, Materials and Climate Policy, Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds, UK (corresponding author: j.giesekam@leeds.ac.uk) (Orcid:0000-0003-2915-1323)
Francesco Pomponi PhD
Vice Chancellor's Research Fellow, Institute for Sustainable Construction, School of Engineering and the Built Environment, Edinburgh Napier University, Edinburgh, UK (Orcid:0000-0003-3132-2523)

The construction industry, through its activities and supply chains as well as the operation of the assets that it creates, is a major contributor to global greenhouse gas emissions. Embodied carbon dioxide emissions associated with the construction of new assets constitute a growing share of whole-life emissions across all project types and make up nearly a quarter of all annual emissions from the UK built environment. Yet these embodied emissions are still rarely assessed in practice, owing to the perceived difficulty and lack of supporting guidance for practitioners conducting an assessment. This briefing paper retraces recent advances in the field of embodied carbon dioxide assessment and highlights existing and forthcoming practical guidance that could support more widespread assessment. The paper constitutes a where-to rather than a how-to, directing assessors towards appropriate resources, of which there are many. Although the paper does highlight some remaining gaps in the field and identifies corresponding research priorities, recent additions to the body of guidance are generally sufficient to support more widespread assessment. Now, the industry must demonstrate its commitment to tackling climate change by using this guidance to drive deeper carbon dioxide reduction.

1. Introduction

Limiting any increase in global average temperature to 'well below 2°C', as outlined in the Paris Agreement (UNFCC, 2015), requires that all nations rapidly reduce greenhouse gas (GHG) emissions to achieve a balance between sources and sinks in the second half of this century. The construction industry has a critical role to play in climate change mitigation, being a significant emitter of GHGs both directly through its activities and supply chains and indirectly through operation of the assets it creates (Giesekam *et al.*, 2016a; Müller *et al.* 2013). In addition to being one of the largest emitters, the built environment is also one of the largest potential stores of carbon dioxide, has established a substantial gap between the targets and reality. This gap will widen if construction activity continues to increase, carbon capture and storage technology remains financially unviable for material producers or the rate of electrical grid decarbonisation does not significantly accelerate (Giesekam *et al.*, 2016b). Embodied greenhouse gas emissions ('embodied carbon') emissions already make up as much as 90% of whole-life GHG emissions on some projects (Sturgis and Roberts, 2010), constitute a growing share across all project types (Ibn-Mohammed *et al.*, 2013) and are responsible for almost a quarter of annual built environment emissions (see Figure 1). These embodied carbon emissions can be addressed through a wide range of mitigation


CLIMATE POLICY
https://doi.org/10.1080/14693062.2018.1479238
Taylor & Francis
RESEARCH ARTICLE
OPEN ACCESS
Check

Decision making under uncertainty in climate change mitigation: introducing multiple actor motivations, agency and influence

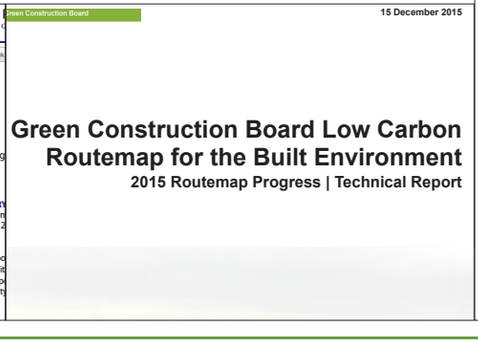
Katy Roelich[a,b] and Jannik Giesekam[a]

[a]Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds, UK; [b]School of Civil Eng
University of Leeds, Leeds, UK

ABSTRACT
Climate change mitigation has two main characteristics that interact to make it an extremely demanding challenge of governance: the complexity of the socio-technical systems that must be transformed to avoid climate change and the presence of profound uncertainties. A number of tools and approaches exist, which aim to help manage these challenges and support long-term decision making. However, most tools and approaches assume that there is one decision maker with clearly defined objectives. The interaction between decision makers with differing perspectives and agency is an additional uncertainty that is rarely addressed, despite the wide recognition that action is required at multiple scales and by multiple actors. This

ARTICLE HISTORY
Received 24 Novem
Accepted 16 May 2

KEYWORDS
Actors; adaptive po
climate change mit
decision making; p
making; uncertaint


Green Construction Board
15 December 2015

Green Construction Board Low Carbon Routemap for the Built Environment
2015 Routemap Progress | Technical Report

Giesekam et al. (2014, 2015, 2016, 2017, 2018a, 2018b); GCB (2015); Roelich & Giesekam (2018)

Agenda

General answers to 5 simple questions

» How much carbon do we currently emit?

» How much do we need to reduce our emissions by?

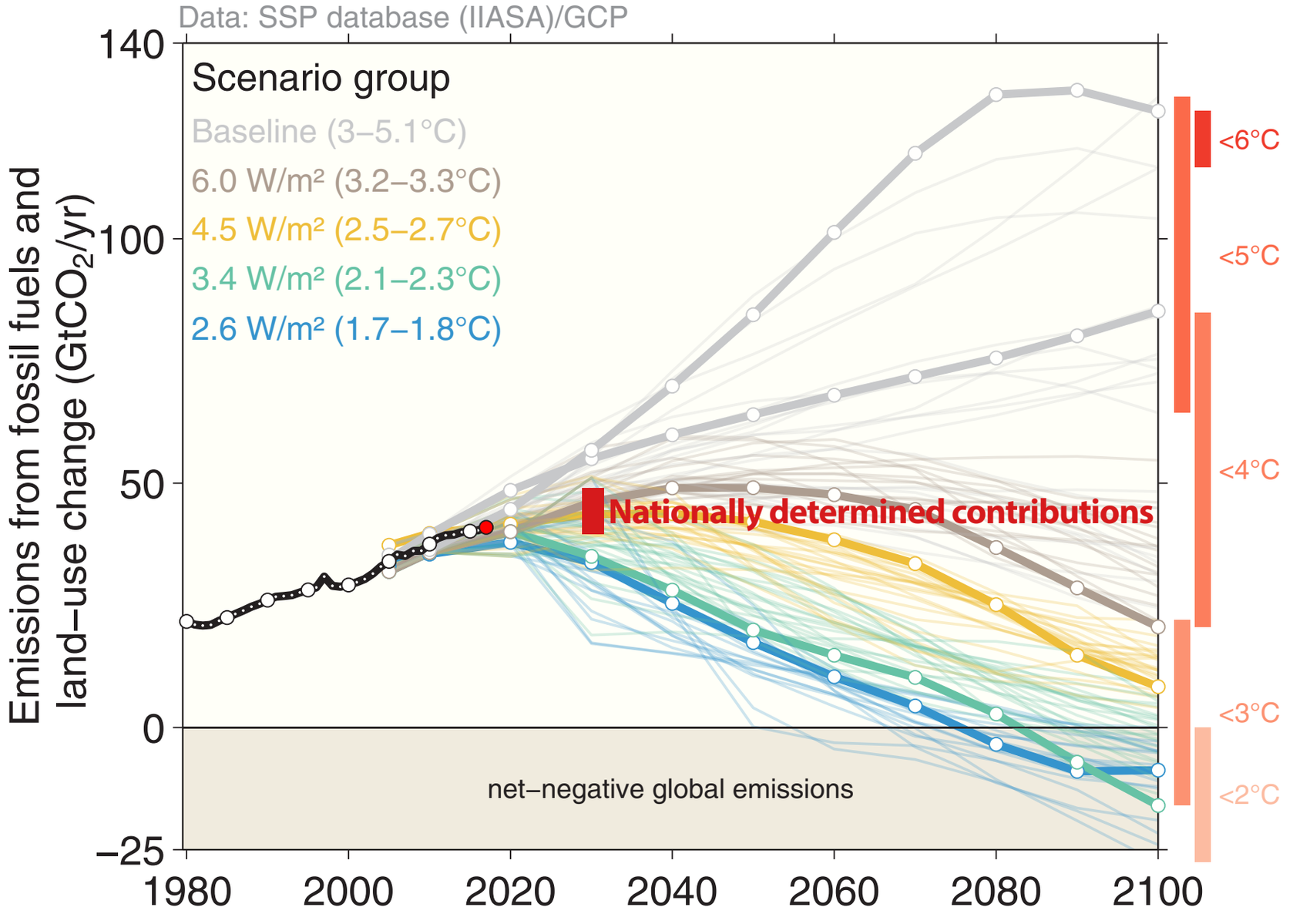
» How does using timber reduce carbon?

» How much carbon reduction can be achieved?

» What guidance and policies could support this?

Emissions scenarios to 2100

Current commitments likely to yield around 3°C increase



Global impacts of climate change

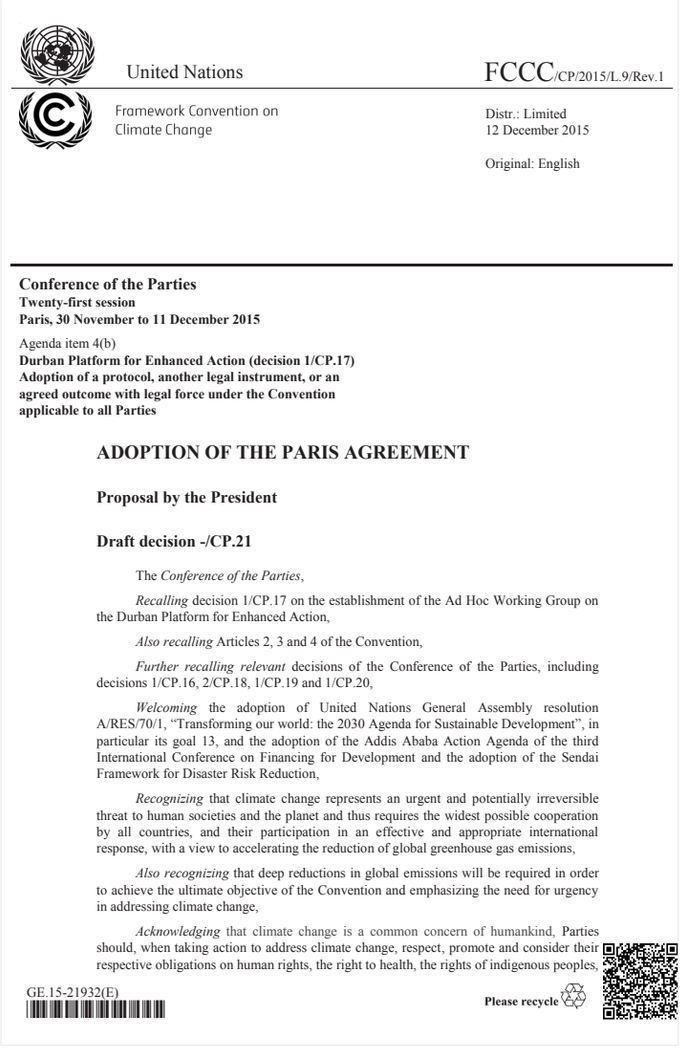
Will be "severe, pervasive and irreversible"

Image from Tuvalu courtesy of Climate Visuals. Quote from IPCC 2014 Synthesis Report.

Paris Agreement on climate change

Global agreement made in December 2015

- Came into force on 4th November 2016
- Commits to *"holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels"*
- Goal of achieving *"a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century"* **i.e. net zero emissions**
- Recognises *"common but differentiated responsibilities"* i.e. developed countries, such as EU28, should lead on carbon reduction and adopt more ambitious targets
- Commits parties to global stock-take and ratcheting up of ambitions every 5 years



United Nations

Framework Convention on Climate Change

FCCC/CP/2015/L.9/Rev.1

Distr.: Limited
12 December 2015

Original: English

Conference of the Parties
Twenty-first session
Paris, 30 November to 11 December 2015

Agenda item 4(b)
Durban Platform for Enhanced Action (decision 1/CP.17)
Adoption of a protocol, another legal instrument, or an agreed outcome with legal force under the Convention applicable to all Parties

ADOPTION OF THE PARIS AGREEMENT

Proposal by the President

Draft decision -/CP.21

The *Conference of the Parties*,

Recalling decision 1/CP.17 on the establishment of the Ad Hoc Working Group on the Durban Platform for Enhanced Action,

Also recalling Articles 2, 3 and 4 of the Convention,

Further recalling relevant decisions of the Conference of the Parties, including decisions 1/CP.16, 2/CP.18, 1/CP.19 and 1/CP.20,

Welcoming the adoption of United Nations General Assembly resolution A/RES/70/1, "Transforming our world: the 2030 Agenda for Sustainable Development", in particular its goal 13, and the adoption of the Addis Ababa Action Agenda of the third International Conference on Financing for Development and the adoption of the Sendai Framework for Disaster Risk Reduction,

Recognizing that climate change represents an urgent and potentially irreversible threat to human societies and the planet and thus requires the widest possible cooperation by all countries, and their participation in an effective and appropriate international response, with a view to accelerating the reduction of global greenhouse gas emissions,

Also recognizing that deep reductions in global emissions will be required in order to achieve the ultimate objective of the Convention and emphasizing the need for urgency in addressing climate change,

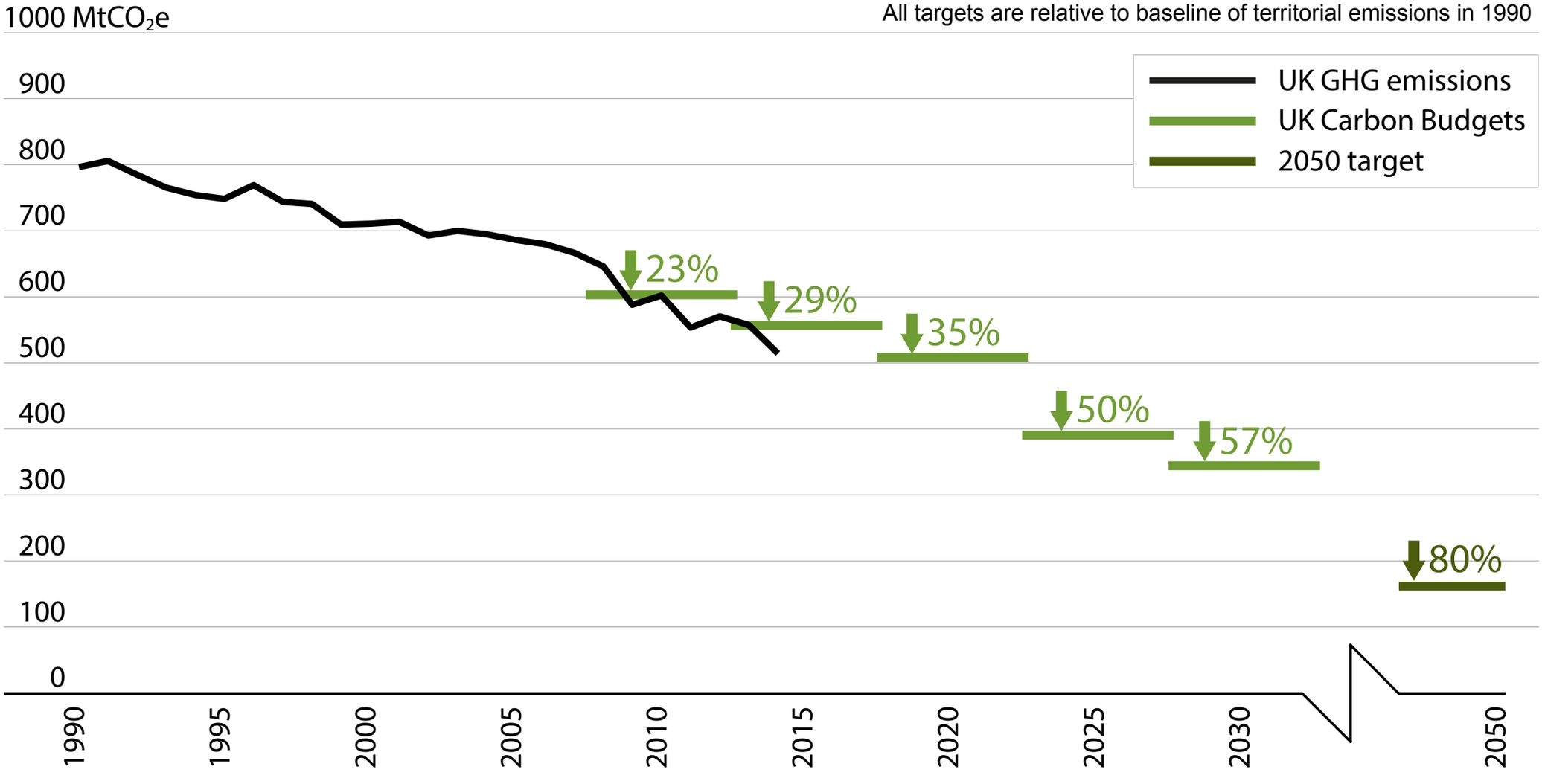
Acknowledging that climate change is a common concern of humankind, Parties should, when taking action to address climate change, respect, promote and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples,

GE.15-21932(E)

Please recycle

Current UK targets

Series of legally binding 5 year carbon budgets + 2050 target



UK carbon targets will be reviewed

In late 2018 (after October IPCC SR1.5 release)

- Minister of State for Energy and Clean Growth this April: *"I am pleased to announce that after the IPCC report later this year, we will be seeking advice from the UK's independent advisers, the Committee on Climate Change, on the implications of the Paris Agreement for the UK's long-term emissions reduction targets."*
- In 2016 the UK Government already intimated that the net zero goal must enter UK law: *"The question is not whether but how we do it"*

Claire Perry announcement on 16/04/18 at CHoG meeting
2016 quote from Andrea Leadsom, Minister of State for Energy - Hansard HC Deb vol 607 col 725 (14 March 2016)

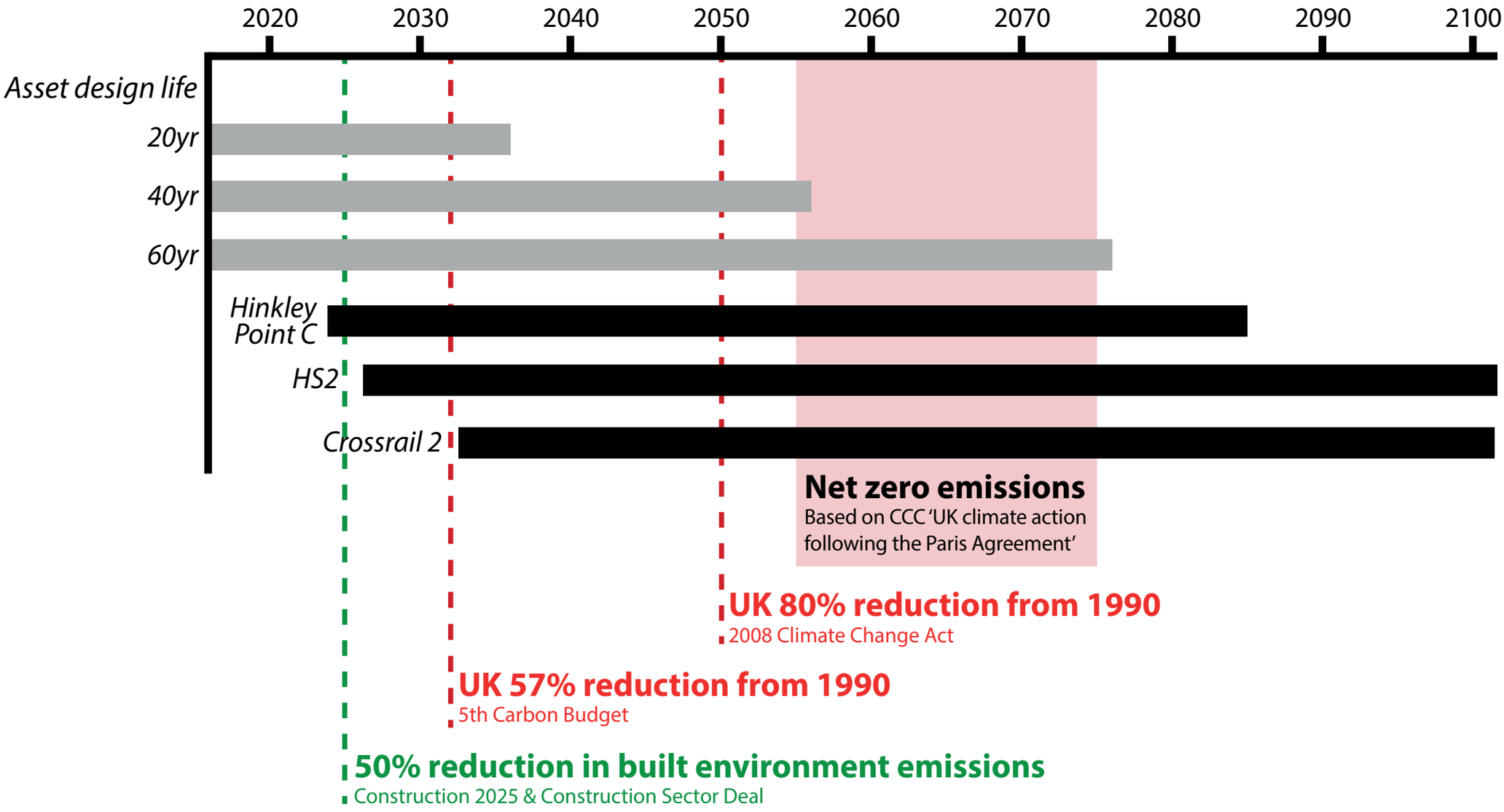
Long term goal is net zero emissions

Near the middle of this century

- In 2016 CCC acknowledged that UK targets will need to be revised in future and that *"the UK's current emissions targets are not aimed at limiting global temperature to as low a level as in the Agreement".*
- CCC advised that the UK must be **net zero CO_2 by 2055-2075** for >66% chance of achieving 2°C or before 2050 for 1.5°C

Implications for the built environment

Most assets under design now must operate in a net zero nation

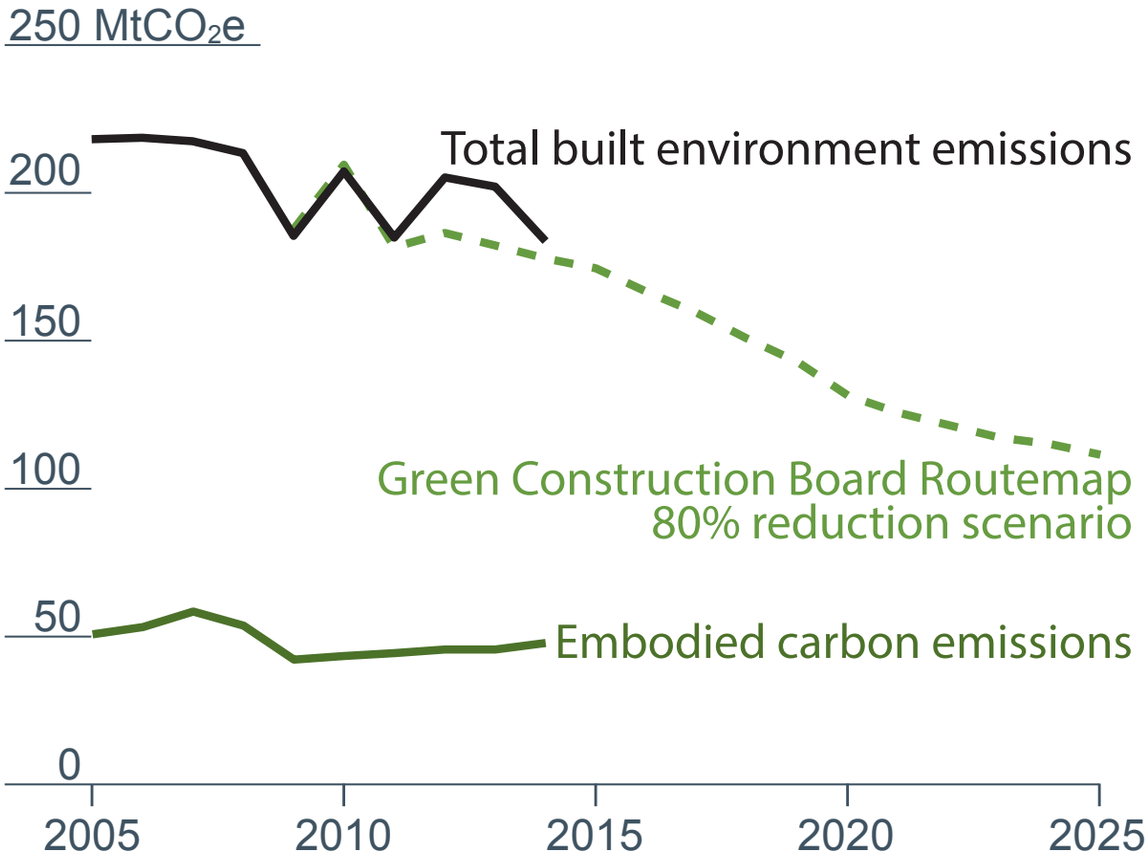


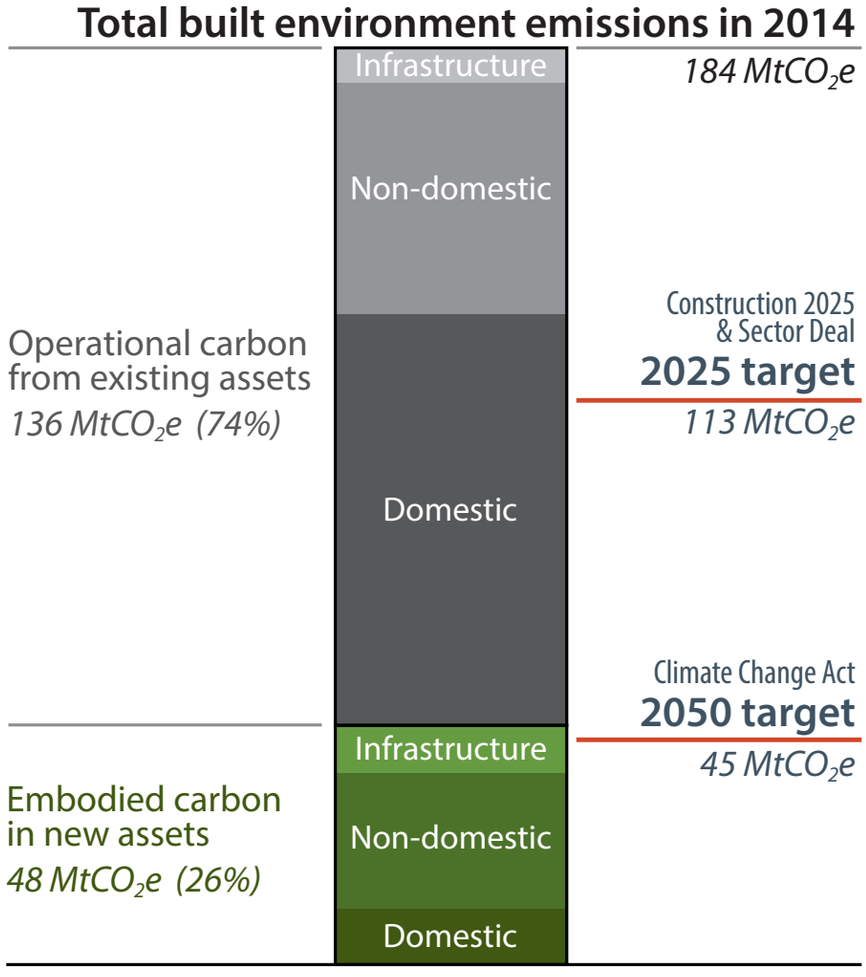
See Giesekam et al. (2018) Aligning carbon targets for construction with (inter)national climate change mitigation commitments *doi:10.1016/j.enbuild.2018.01.023* for detailed discussion

GCB Low Carbon Routemap progress

Progress towards Construction 2025 and 2050 targets

» The UK built environment is behind the target trajectory partly because of a failure to address embodied carbon emissions





Figures from Giesekam et al. (2018) Aligning carbon targets for construction with (inter)national climate change mitigation commitments *doi:10.1016/j.enbuild.2018.01.023*

The contribution from forests

Currently a net source of carbon but should be a sink

» The 4 billion ha of global forests lock up ~300 GtC *; equivalent to the carbon emitted from all fossil fuels and industry since 1973

» Deforestation causes ~4 $GtCO_2$/yr; degradation a further 0.8 $GtCO_2$/yr

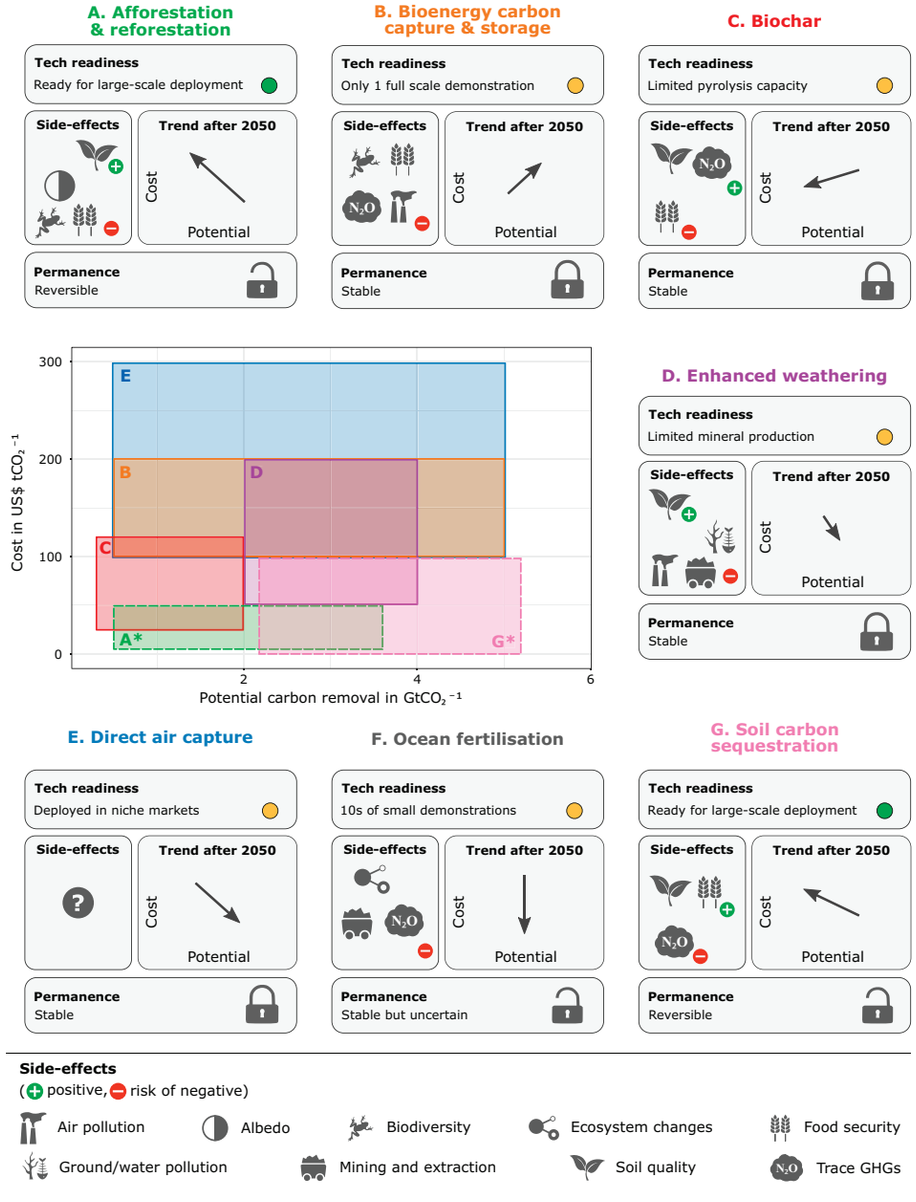
» Our remaining forests remove ~3.3 $GtCO_2$/yr

* In above and below ground biomass (total would change by up to a third if you count dead wood, litter, soil etc.)
Figures from Global Carbon Project (2017); UN FAO (2015) & Federici et al. (2015). Image courtesy of John Westrock Flickr.

Planting trees is the best option

For delivering net zero emissions

- Globally afforestation & reforestation could contribute 0.5-3.6 $GtCO_2$/yr at \$5-50/tCO_2 this century
- This is cheaper and provides greater co-benefits than all the other 'negative emissions technologies' that could deliver net zero emissions
- The more we plant the less we will depend upon these other technologies to deliver our targets



See Minx et al. (2018) in Environmental Research Letters for a 3-part review of all available negative emissions options

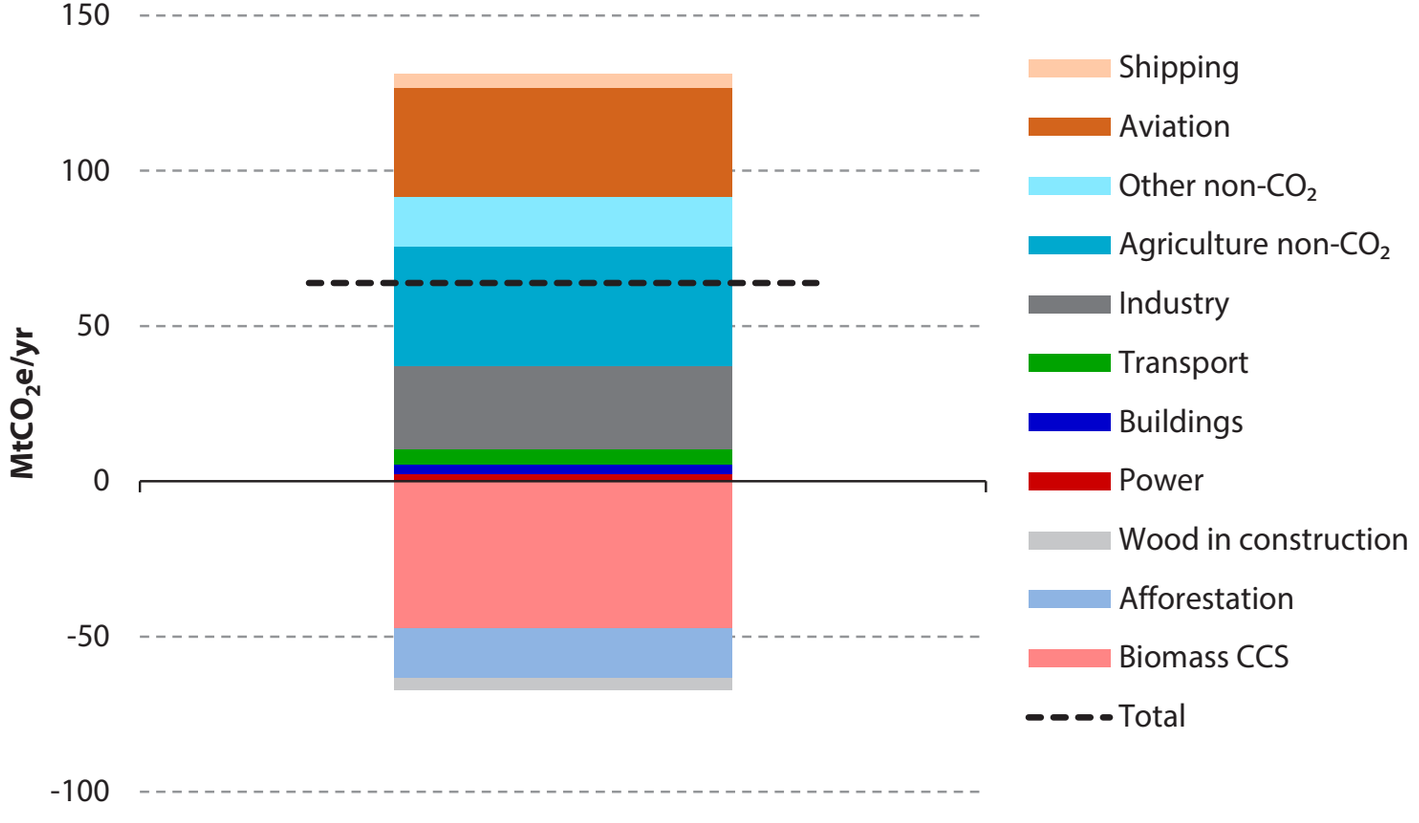
What does a net zero UK look like?

The Committee on Climate Change have some scenarios

» CCC scenarios assume up to 67MtCO_2/yr of removals from afforestation (16), wood in construction (4) and BECCS (47)

» This requires planting 30,000 ha/yr in the UK

Figure 3.1. Residual UK greenhouse gas emissions in 2050 under Max deployment across all sectors



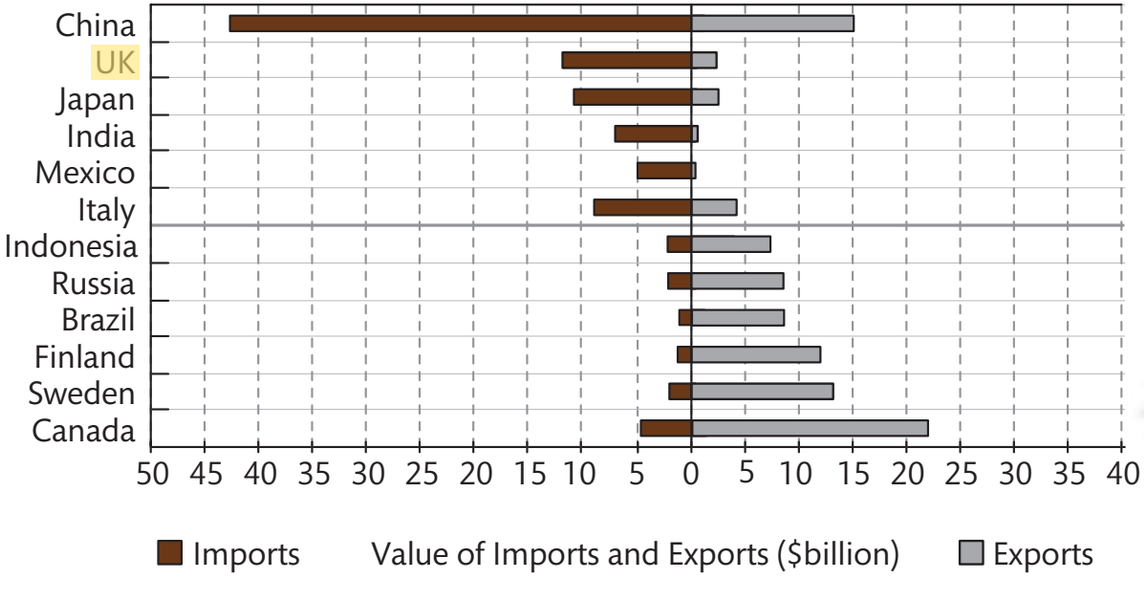
Scope for afforestation

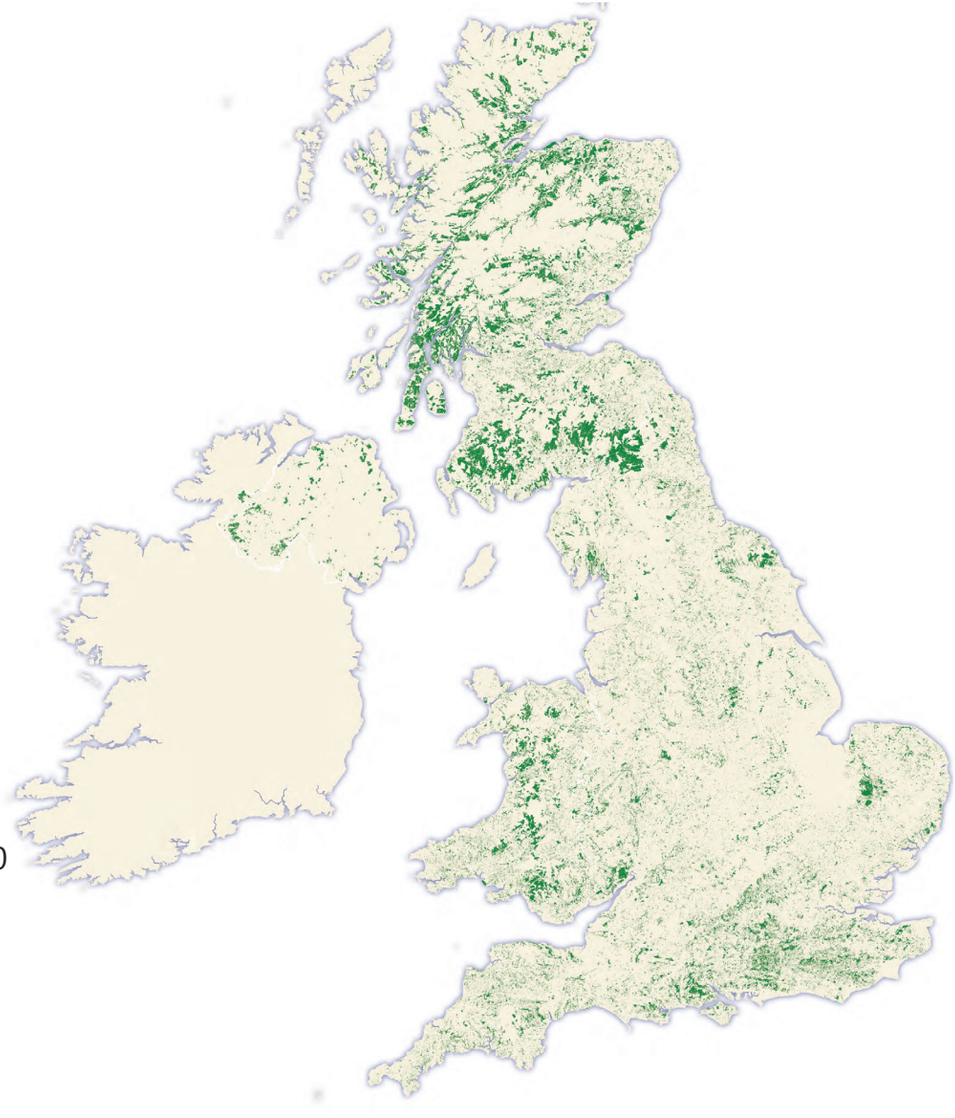
Plenty of potential

» Woodland cover in the UK is currently ~13% of total land area

» Compared with an EU average of 38%

Largest net importers and exporters of forest products 2015





How does timber use reduce carbon?

3 main ways

» **Growth** - Trees absorb carbon during growth

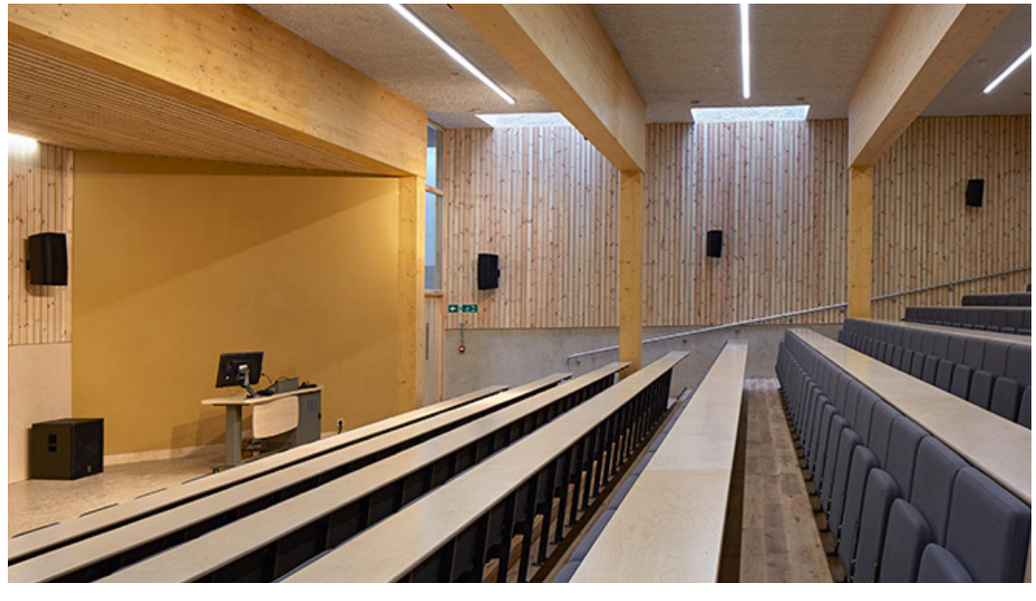
» **Sequestration** - Timber products with long lives sequester carbon

» **Substitution** - Timber can replace the use of more carbon-intensive materials

Example of effective substitution

UEA Enterprise Centre

» Embodied carbon of 193 $kgCO_2/m^2$ compared with 845$kgCO_2/m^2$ for a benchmark building



Decisions should be informed by LCA

Results for timber will depend upon factors such as:

» The climate metric for impact assessment

» The time period for the assessment

» The assumptions about reforestation/other land use after harvesting

» The uses of residues (e.g. for fuel)

» The end of life scenarios (landfill v recycling v energy recovery)

» Etc...

Remember

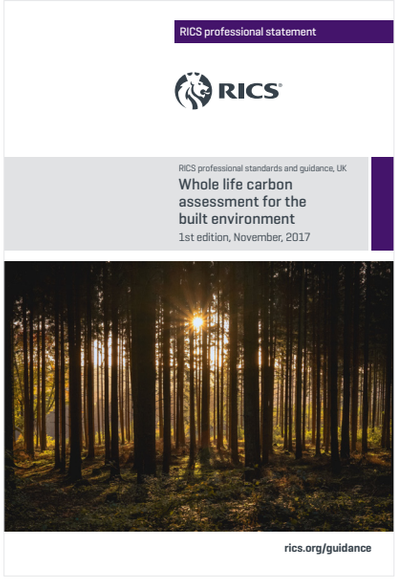
» The lowest carbon solution will always be particular to the project and the products under consideration

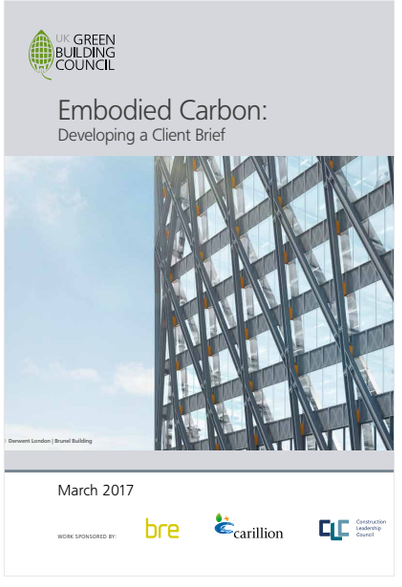
» The aim should be routinely assessing whole life carbon emissions across our projects to a common methodology using the best available data

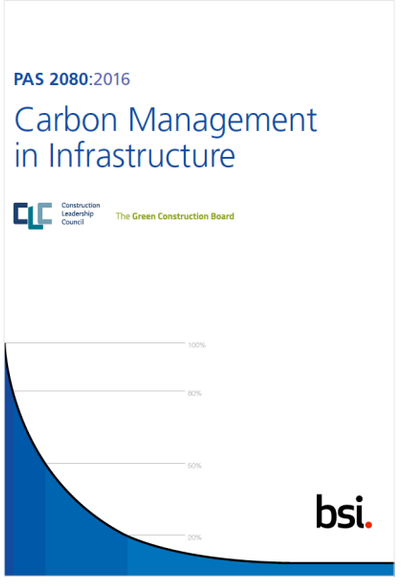
For discussion and advice see Hill & Zimmer (2018); De Rosa et al. (2018) & Moncaster et al. (2018)

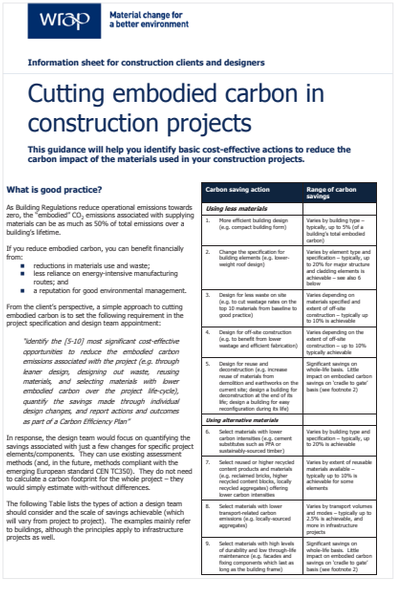
Tackling embodied/whole life carbon

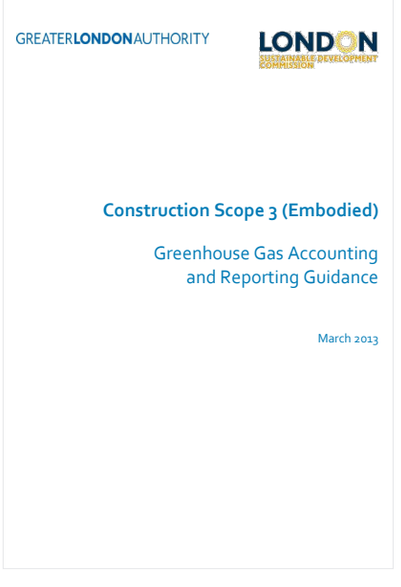
Array of recent guidance documents

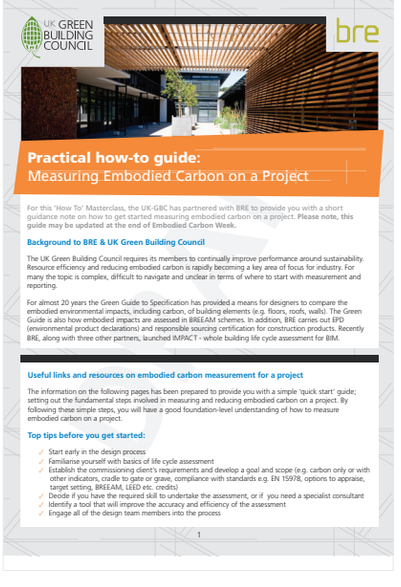


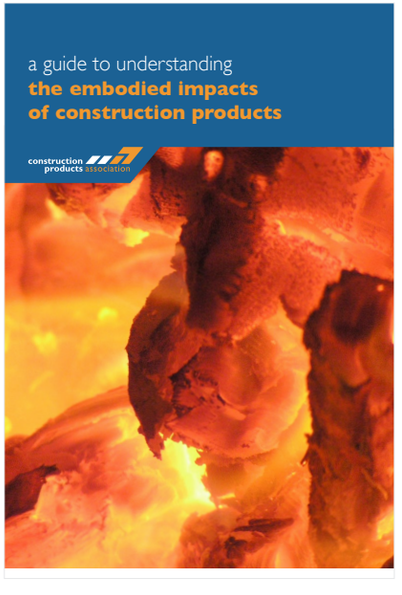












RIBA (2018); RICS (2017); UKGBC (2015, 2016, 2017); GCB & CLC (2016); Battle et al. (2014); WRAP (2014); GLA(2013); CPA (2012)

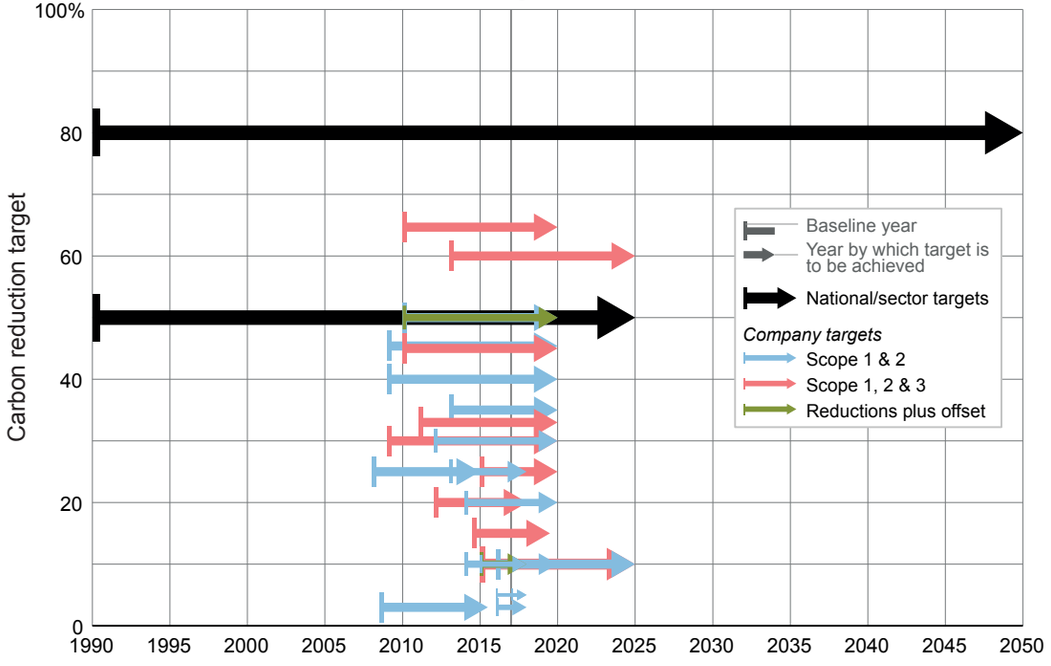
Current company carbon targets

Many up for renewal in next 18 months

» Most firms setting modest short-term targets focussed on Scope 1 & 2

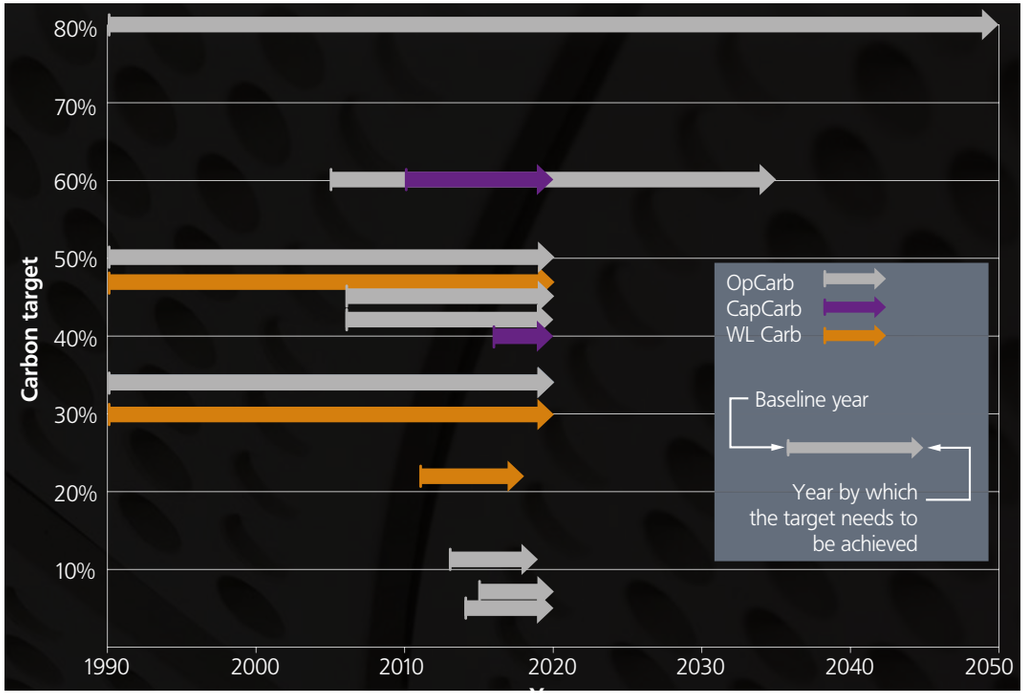
» Growing minority of firms also targeting Scope 3 reductions

Carbon reduction targets of selected UK housebuilders & construction firms *(representing total turnover of £88.4bn in 2016)*



Review conducted in July 2017

Carbon reduction targets of selected infrastructure clients



Figures from Giesekam et al. (2018) Aligning carbon targets for construction with (inter)national climate change mitigation commitments *doi:10.1016/j.enbuild.2018.01.023* & UKGBC (2017) Delivering low carbon infrastructure

Science based targets

Gaining momentum

SCIENCE BASED TARGETS

- 417 companies globally taking action through SBT initiative (113 with approved targets)
- >50 companies in construction, real estate and related industries
- 43 companies with headquarters in UK
- 17 companies involved in UK built environment
- Discussions emerging around collective science based targets for UK sectors (e.g. rail), UK infrastructure or UK built environment as a whole

Numbers accurate as of 13/06/18 - according to http://sciencebasedtargets.org/companies-taking-action/

Local authorities are taking an interest

New London Environment Strategy

Proposal 6.1.4.c Encourage the reduction of whole lifecycle building emissions (embodied carbon)

As onsite emissions continue to reduce, embodied carbon (those emissions associated with the production of building materials) will form a greater part of a development's total carbon footprint. In order to reduce these emissions, accurate measurement methodologies are needed. A survey conducted to inform the assessment of city-wide carbon footprints found no consistency in the data sources, tools or methodologies used to calculate embodied emissions.[155] Ninety per cent of construction industry professionals responded to a survey stating that they would benefit from better guidance and support.

The Mayor encourages new developments to estimate lifecycle GHG emissions and minimise embodied carbon in construction. Through the London Plan and its associated guidance, the Mayor will encourage the application of nationally recognised methods to estimate lifecycle GHG emissions. For example, the Royal Institute of Chartered Surveyors has developed a professional standard for whole lifecycle assessment of the built environment, published in November 2017.[156] In addition, the Mayor will work with the GLA group and key stakeholders such as the London Waste and Recycling Board (LWARB) to encourage embodied carbon assessments for large infrastructure projects, using an internationally recognised standard such as PAS 2080. Such an approach, which is already being piloted by TfL supports the development of a circular economy and can contribute to reducing embodied carbon by, for example, reusing materials or for new major developments to achieve a specified BREEAM credit for Responsible Sourcing of Materials.[157]

Estimates of total potential

Generally of the order of several million tonnes of CO_2e

» 2009 estimate for Forestry Commission that an expanding market for wood construction products could **store just under 4MtCO_2e/yr** and **displace a further 7MtCO_2e/yr** through substitution

» 2013 ASBP report suggested that a 3x increase in the intensity of bio-based material usage gives additional **sequestration of up to 22MtCO_2e** by 2050

» CCC 2016 estimate of an **additional 4MtCO_2** sequestered by 2050

» An up-to-date detailed UK estimate would be helpful

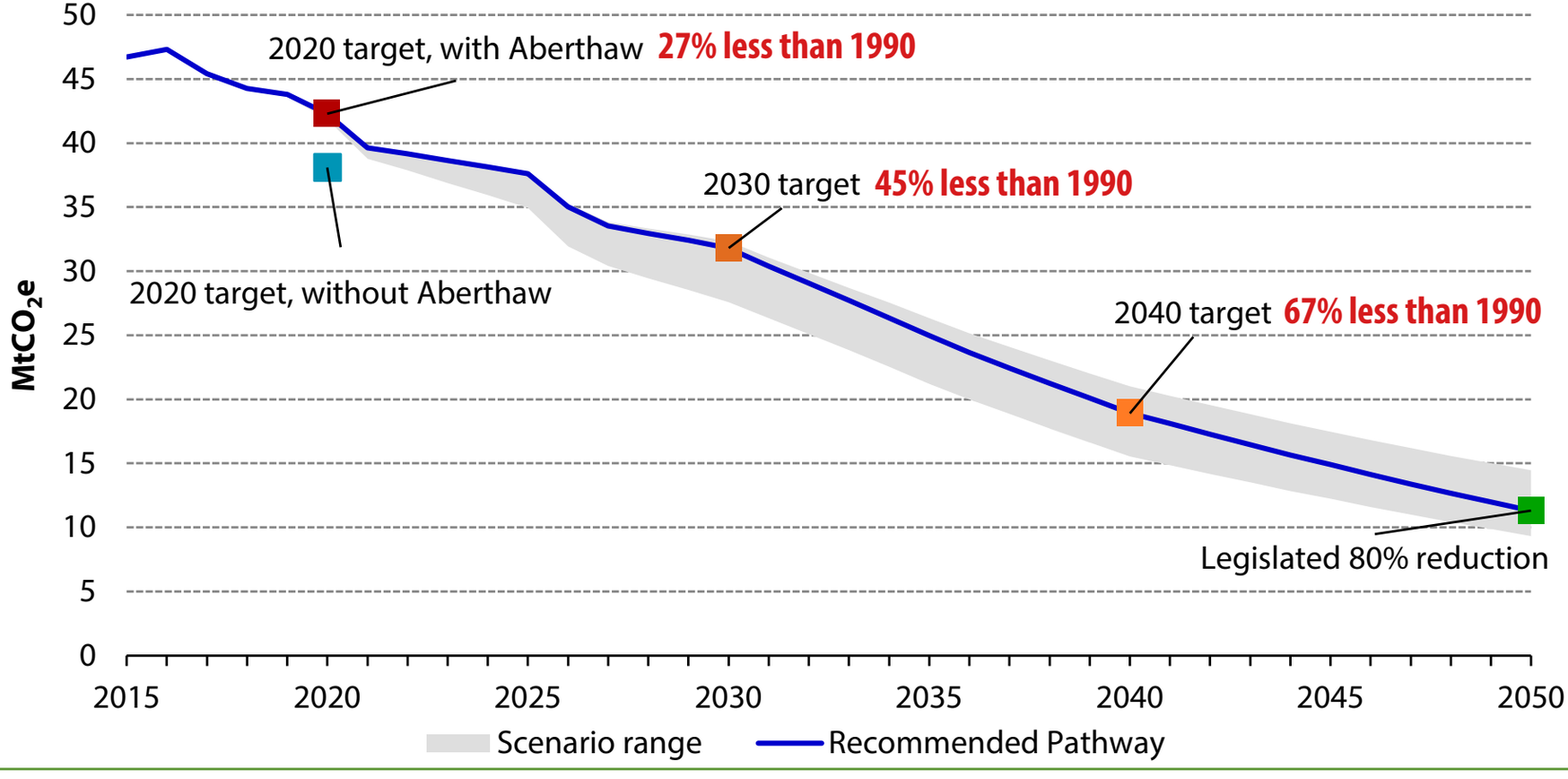
Estimates from Read et al. (2009); Sadler & Robson (2013) & CCC(2016)

Welsh carbon targets

Recommended pathway from CCC advice

» Welsh emissions will need to fall by 75% on today's levels to meet 2050 target set out in 2016 Environment (Wales) Act

» CCC recommend first two carbon budgets are consistent with average 23% reduction (2016-2020) & 33% (2021-25) against 1990 levels



Revised Welsh planning policy

Should be supportive

Sustainable Buildings

4.115 The planning system should facilitate new development that enables decarbonisation, tackles the causes of climate change, and adapts to the current and future effects of climate change through the incorporation of effective mitigation and adaptation measures.

4.116 The Welsh Government's policy is to secure zero carbon buildings while continuing to promote a range of low and zero carbon technologies as a means to achieve this.

4.117 Sustainable building design principles should be integral to the design of new development. Development proposals should:

- mitigate the causes of climate change by minimising carbon and other greenhouse gas emissions associated with their design, construction, use and eventual demolition; and
- include features that provide effective adaptation to, and resilience against, the current and predicted future effects of climate change.

4.118 Planning authorities should assess strategic sites to identify opportunities to require higher sustainable building standards (including zero carbon) to be required. In bringing forward standards higher than the national minimum, set out in Building Regulations, planning authorities should ensure what is proposed is evidence-based and economically viable.

New CIE-MAP briefing note

Summary of status quo and recommendations

CIE-MAP

Centre for Industrial Energy, Materials and Products

Reducing carbon in construction: a whole life approach

The UK construction sector is failing to meet its carbon reduction targets and needs to explore additional mitigation options. Addressing the growing carbon emissions associated with constructing new assets is essential in meeting this shortfall. Extending the focus of project carbon assessments and targets from operational to whole life emissions presents clients with a broader range of mitigation options. However, many clients will not adopt such boundaries without additional regulation or incentives. Targeted intervention from national and local government could drive innovation in design teams and supply chains, improve sector productivity, reduce the costs of UK buildings and infrastructure, create employment opportunities and boost export markets.

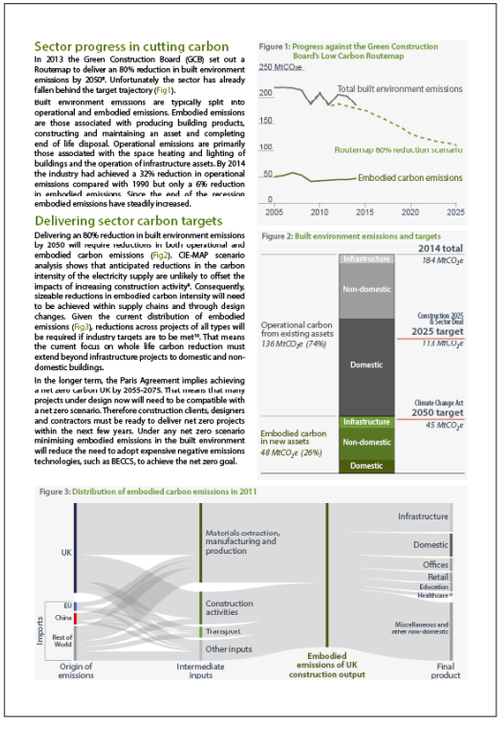
Recommendations for Government, local authorities and business

1. Require a whole life carbon assessment on all publicly funded building projects and implement whole life carbon targets where project benchmarks can be established.
2. Require Environmental Product Declarations to support the environmental claims of product manufacturers.
3. Establish a public league table of carbon reduction commitments from construction firms to improve transparency and encourage competition.
4. Extend greenhouse gas emission reporting requirements for quoted companies to include the scope 3 embodied emissions associated with developing new facilities.
5. Establish a well resourced independent body to take ownership of the construction sector's decarbonisation agenda. Their initial tasks should include: developing and maintaining a common sectoral carbon reduction trajectory from which commensurate company or project targets can be derived; compiling a national database of life cycle assessment data and Environmental Product Declarations; and developing a low carbon building skills plan.
6. Local authorities require assessment of whole life carbon on significant schemes.
7. Progressive commercial clients introduce whole life carbon targets to drive innovation.

Challenges facing UK construction

The National Infrastructure Commission has highlighted three key challenges facing the construction sector: congestion, capacity and carbon[1]. By 2050 there are expected to be an extra 14 million people living in the UK and the construction sector must deliver the housing and infrastructure that will underpin future prosperity. Domestically that requires dramatically increasing housebuilding, retrofitting one existing home every minute, and delivering an infrastructure pipeline worth in excess of £600bn. Internationally, UK firms are expected to capture an increasing share of the global market for sustainable construction and be at the forefront of delivering the Government's Clean Growth ambitions[2]. Meanwhile by 2025 the industry is expected to halve delivery time, cut costs by a third, halve the trade gap between exports and imports of construction products, and halve carbon emissions from the built environment[3]. All of this must be achieved by a highly fragmented sector with low financial margins and declining labour availability[4]. None of these targets will be met under business as usual conditions[4,5]. Therefore the construction sector must undergo a radical transformation over the next decade.

The Government has already set out some measures to transform infrastructure performance[3], and modernise the industry through the Construction Sector Deal as part of the Industrial Strategy[6]. This transformation must focus on reducing carbon whilst improving sector productivity through the adoption of more resource efficient designs, novel materials and delivery models. The successful transformation of this industry will be critical to achieving the Government's target of doubling resource productivity over the next 25 years[7] and meeting carbon targets.



Sector progress in cutting carbon

In 2013 the Green Construction Board (GCB) set out a Routemap to deliver an 80% reduction in built environment emissions by 2050[8]. Unfortunately the sector has already fallen behind the target trajectory (Fig1).

Built environment emissions are typically split into operational and embodied emissions. Embodied emissions are those associated with producing building products, constructing and maintaining an asset and completing end of life disposal. Operational emissions are primarily those associated with the space heating and lighting of buildings and the operation of infrastructure assets. By 2014 the industry had achieved a 32% reduction in operational emissions compared with 1990 but only a 6% reduction in embodied emissions. Since the end of the recession embodied emissions have steadily increased.

Figure 1: Progress against the Green Construction Board's Low Carbon Routemap

Delivering sector carbon targets

Delivering an 80% reduction in built environment emissions by 2050 will require reductions in both operational and embodied carbon emissions (Fig2). CIE-MAP scenario analysis shows that anticipated reductions in the carbon intensity of the electricity supply are unlikely to offset the impacts of increasing construction activity[9]. Consequently, sizeable reductions in embodied carbon intensity will need to be achieved within supply chains and through design changes. Given the current distribution of embodied emissions (Fig3), reductions across projects of all types will be required if industry targets are to be met[10]. That means the current focus on whole life carbon reduction must extend beyond infrastructure projects to domestic and non-domestic buildings.

In the longer term, the Paris Agreement implies achieving a net zero carbon UK by 2055-2075. That means that many projects under design now will need to be compatible with a net zero scenario. Therefore construction clients, designers and contractors must be ready to deliver net zero projects within the next few years. Under any net zero scenario minimising embodied emissions in the built environment will reduce the need to adopt expensive negative emissions technologies, such as BECCS, to achieve the net zero goal.

Figure 2: Built environment emissions and targets

Figure 3: Distribution of embodied carbon emissions in 2011

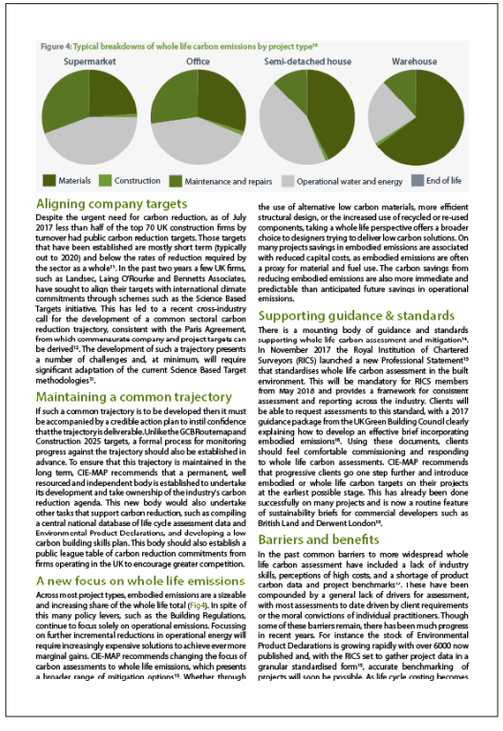


Figure 4: Typical breakdowns of whole life carbon emissions by project type[11]

Aligning company targets

Despite the urgent need for carbon reduction, as of July 2017 less than half of the top 70 UK construction firms by turnover had public carbon reduction targets. Those targets that have been established are mostly short term (typically out to 2020) and below the rates of reduction required by the sector as a whole[4,5]. In the past two years a few UK firms, such as Landsec, Laing O'Rourke and Bennetts Associates, have sought to align their targets with international climate commitments through schemes such as the Science Based Targets initiative. This has led to a recent cross-industry call for the development of a common sectoral carbon reduction trajectory, consistent with the Paris Agreement, from which commensurate company and project targets can be derived[12]. The development of such a trajectory presents a number of challenges and, at minimum, will require significant adaptation of the current Science Based Target methodologies[13].

Maintaining a common trajectory

If such a common trajectory is to be developed then it must be accompanied by a credible action plan to instil confidence that the trajectory is deliverable. Unlike the GCB Routemap and Construction 2025 targets, a formal process for monitoring progress against the trajectory should also be established in advance. To ensure that this trajectory is maintained in the long term, CIE-MAP recommends that a permanent, well resourced and independent body is established to undertake its development and take ownership of the industry's carbon reduction agenda. This new body would also undertake other tasks that support carbon reduction, such as compiling a central national database of life cycle assessment data and Environmental Product Declarations, and developing a low carbon building skills plan. This body should also establish a public league table of carbon reduction commitments from firms operating in the UK to encourage greater competition.

A new focus on whole life emissions

Across most project types, embodied emissions are a sizeable and increasing share of the whole life total (Fig4). In spite of this many policy levers, such as the Building Regulations, continue to focus solely on operational emissions. Focussing on further incremental reductions in operational energy will require increasingly expensive solutions to achieve ever more marginal gains. CIE-MAP recommends changing the focus of carbon assessments to whole life emissions, which presents a broader range of mitigation options[10]. Whether through the use of alternative low carbon materials, more efficient structural design, or the increased use of recycled or re-used components, taking a whole life perspective offers a broader choice to designers trying to deliver low carbon solutions. On many projects savings in embodied emissions are associated with reduced capital costs, as embodied emissions are often a proxy for material and fuel use. The carbon savings from reducing embodied emissions are also more immediate and predictable than anticipated future savings in operational emissions.

Supporting guidance & standards

There is a mounting body of guidance and standards supporting whole life carbon assessment and mitigation[14]. In November 2017 the Royal Institution of Chartered Surveyors (RICS) launched a new Professional Statement[15] that standardises whole life carbon assessment in the built environment. This will be mandatory for RICS members from May 2018 and provides a framework for consistent assessment and reporting across the industry. Clients will be able to request assessments to this standard, with a 2017 guidance package from the UK Green Building Council clearly explaining how to develop an effective brief incorporating embodied emissions[16]. Using these documents, clients should feel comfortable commissioning and responding to whole life carbon assessments. CIE-MAP recommends that progressive clients go one step further and introduce embodied or whole life carbon targets on their projects at the earliest possible stage. This has already been done successfully on many projects and is now a routine feature of sustainability briefs for commercial developers such as British Land and Derwent London[16].

Barriers and benefits

In the past common barriers to more widespread whole life carbon assessment have included a lack of industry skills, perceptions of high costs, and a shortage of product carbon data and project benchmarks[14]. These have been compounded by a general lack of drivers for assessment, with most assessments to date driven by client requirements or the moral convictions of individual practitioners. Though some of these barriers remain, there has been much progress in recent years. For instance the stock of Environmental Product Declarations is growing rapidly with over 6000 now published and, with the RICS set to gather project data in a granular standardised form[15], accurate benchmarking of projects will soon be possible. As life cycle costing becomes more prevalent it is also becoming easier to make the business case for a broader set of solutions.

More widespread assessment could yield a range of benefits. For instance the introduction of whole life carbon targets could increase competition between design teams to deliver the lowest carbon solutions, and increased competition within the supply chain should drive innovation as suppliers compete to provide lower carbon products. All of these low carbon products and design skills will have significant export potential as many other nations pursue deeper carbon reductions. Indeed with incoming legislation such as the Buy Clean California Act, it may soon be essential to have low carbon credentials to export into certain markets.

Encouraging assessment

A number of actions could encourage more widespread whole life assessment and carbon reduction. CIE-MAP recommends that local authorities should require whole life carbon assessments on all 'significant' schemes as part of the planning application process. The definition of a significant scheme will vary between authorities. For instance the Greater London Authority may interpret this as applying to planning applications for schemes referable to the Mayor. Comparable requirements are already in place in nations such as the Netherlands and cities such as Zurich[16]. CIE-MAP also recommends that all publicly funded projects should seek to introduce whole life carbon targets where project benchmarks can be established. The UK's mandatory greenhouse gas emission reporting requirements for quoted companies should be extended to include the scope 3 embodied emissions associated with developing new facilities. To prevent potential greenwashing, all construction product manufacturers should be required to produce an Environmental Product Declaration to support any quantifiable sustainability claims made in the marketing of their products. Equivalent requirements are already in place in France and Belgium[16].

Interventions such as these could motivate more widespread whole life carbon assessment. This in turn would support the development of low carbon expertise, accelerate data gathering and the growth of an industry with significant export potential. With design teams targeting whole life carbon reduction in countries such as Australia, Canada, China, Norway, Sweden, France, Germany, the Netherlands and even some projects in Qatar, there is growing global demand and competition to develop low carbon construction solutions. There is a clear opportunity for the UK to become world leaders in this growing industry that will support skilled jobs, develop the market for low carbon products and achieve significant reductions in carbon emissions. However, this will only be possible if swift action is taken to stimulate more widespread assessment.

References

[1] National Infrastructure Commission 2017. Congestion, Capacity, Carbon: Priorities for national infrastructure.
[2] BEIS 2017. The Clean Growth Strategy.
[3] HM Government 2013. Construction 2025.
[4] Farmer, M. 2016. The Farmer Review of the UK Construction Labour Model: Modernise or Die.
[5] Infrastructure and Projects Authority 2017. Transforming Infrastructure Performance.
[6] HM Government 2017. Industrial strategy: white paper.
[7] HM Government 2018. A Green Future: Our 25 Year Plan to Improve the Environment.
[8] Green Construction Board 2013. Low Carbon Routemap for the Built Environment 2013 Routemap Progress Technical Report.
[9] Giesekam, J., Barrett, J. & Taylor, P. 2016. Scenario analysis of embodied greenhouse gas emissions in UK construction. Proceedings of the Institution of Civil Engineers: Engineering Sustainability.
[10] Giesekam, J., Densley Tingley, D. & Barrett, J., 2016. Building on the Paris Agreement: making the case for embodied carbon intensity targets in construction, in: Jankovic, L. (Ed.), Zero Carbon Buildings Today and in the Future.
[11] Giesekam, J., Densley Tingley, D. & Cotton, I. 2018. Aligning carbon targets for construction with (inter)national climate change mitigation commitments. Energy and Buildings.
[12] WGBC. 2017. Delivering low carbon infrastructure.
[13] Giesekam, J., Barrett, J., Taylor, P. & Owen, A. 2014. The greenhouse gas emissions and mitigation options for materials used in UK construction. Energy and Buildings.
[14] Giesekam, J. & Pomponi, F. 2017. Briefing: Embodied carbon dioxide assessment in buildings: guidance and gaps. Proceedings of the Institution of Civil Engineers: Engineering Sustainability.
[15] RICS 2017. Whole life carbon assessment for the built environment. RICS Professional Statement 1st edition.
[16] WGBC 2017. Embodied Carbon: Developing a Client Brief.
[17] Giesekam, J., Barrett, J. & Taylor, P. 2016. Construction sector views on low carbon building materials. Building Research & Information.
[18] O'Connor, J. & Bowick, M. 2016. Embodied Carbon: a Building Blocks International Policy Review. Athena Sustainable Materials Institute.

CIE-MAP

Working closely with government and industry, CIE-MAP conducts research to identify all the opportunities along the product supply chain that ultimately deliver a reduction in industrial energy use. CIE-MAP brings together the four leading UK universities of Bath, Cardiff, Leeds and Nottingham Trent with a range of expertise in engineering, economics, psychology, design, political science and governance. Funded by the Research Council's Energy Programme, CIE-MAP forms one of six centres focused on reducing energy demand in the UK.

Cite this paper as: Giesekam (2018) Reducing carbon in construction: a whole life approach

For further information contact Dr Jannik Giesekam: J.Giesekam@leeds.ac.uk 0113 343 5576

www.ciemap.ac.uk

Brief prepared in April 2018

Available from ciemap.ac.uk

- Research started by CIE-MAP will continue under the new £19m Centre for Research in Energy Demand Solutions (CREDS)
- Get in touch now if you would like to be involved in, or shape, our research programme for the next 5 years (J.Giesekam@leeds.ac.uk)

Summary

In short

» The Paris Agreement means UK carbon targets must be strengthened

» The goal is net zero emissions near mid century

» Afforestation plays a key role in all scenarios that deliver our carbon targets

» The UK built environment is decarbonising at a slower rate than is required

» Timber products can be a lower carbon option for many projects

» Product choices should be informed by a whole life carbon assessment

» Clients & local authorities should drive uptake of a whole life carbon approach