CIE-MAP

Centre for Industrial Energy, Materials and Products

Research Councils UK Energy For a Low Carbon Future

Building on the Paris Agreement: making the case for embodied carbon intensity targets in construction

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CIEMAP

Our mission

- ***Working closely with government and industry, CIEMAP conducts research to identify all the opportunities along the product supply chain that ultimately deliver a reduction in industrial energy use***
- One of 6 RCUK funded centres focussing on end use energy demand in the UK
- Interdisciplinary team from the universities of Leeds, Bath, Cardiff and Nottingham Trent, plus contributions from the Green Alliance

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Paris Agreement on climate change

Global agreement in December 2015

- 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”*
- With goal of achieving *“a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century”*
- Commits parties to global stock-take and ratcheting up of ambitions every 5 years
- Signed by 180 parties, ratified by 26 so far (representing 39% of global emissions)

United Nations — FCCC/CP/2015/L.9/Rev.1

Framework Convention on Climate Change

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,

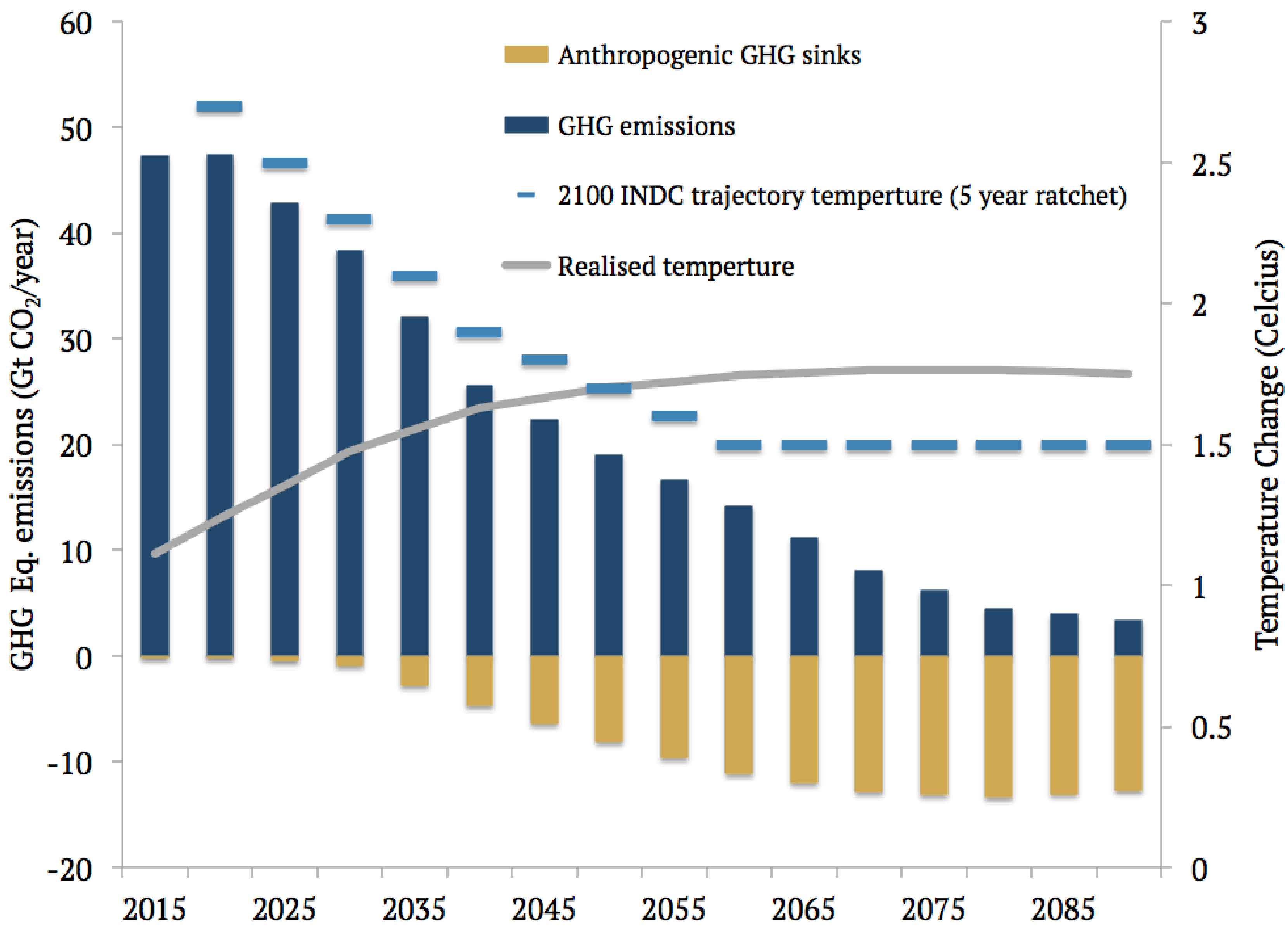
Acknowledging that climate change is a common concern of humankind, Parties should, when taking action to address climate change, respect, promote and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples,

GE.15-21932(E)

Please recycle

What might this look like?

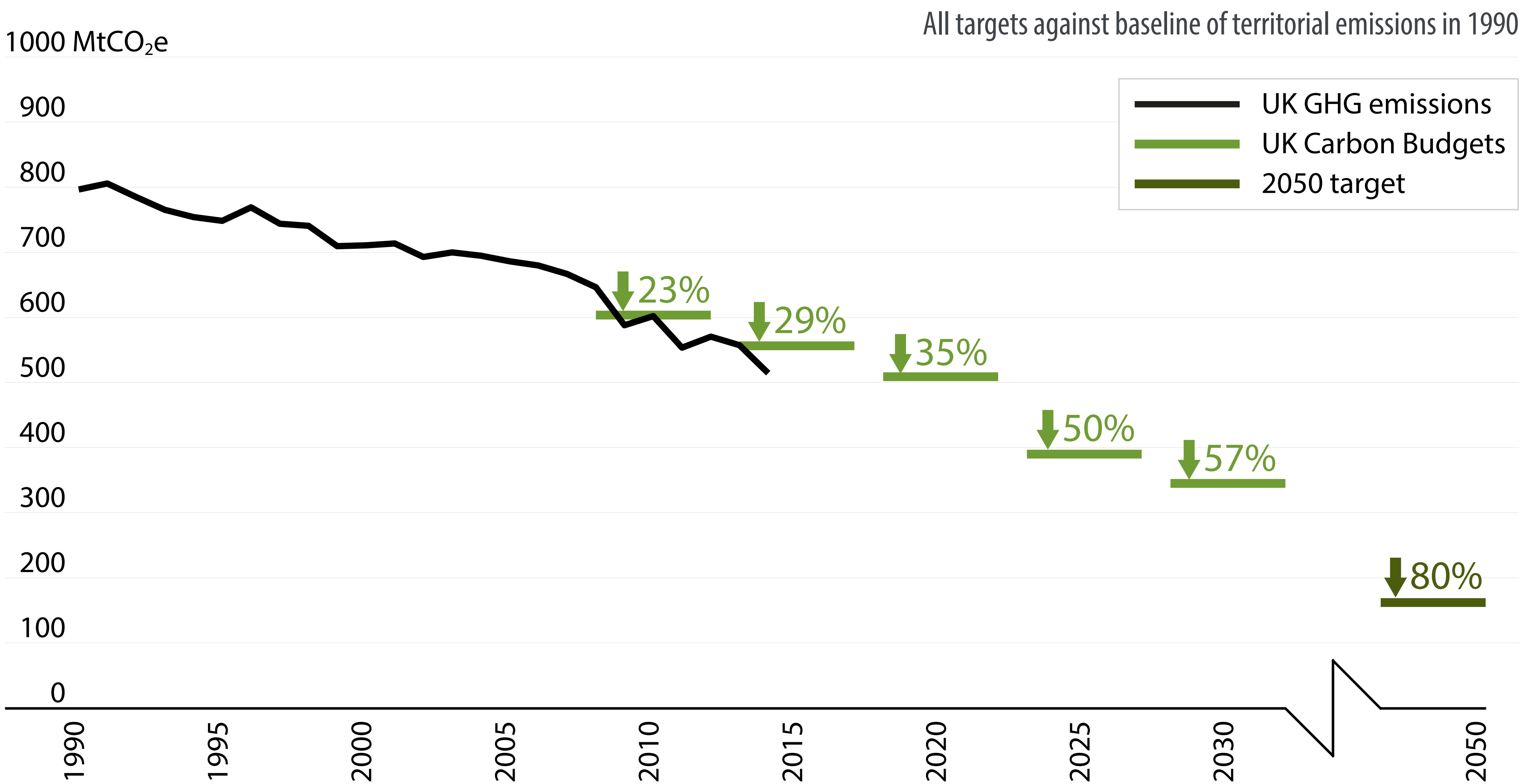
One potential pathway



Forster (2015) - more info at www.carbonbrief.org/piers-forster-1-5c-is-a-brave-new-world

Interim targets for the UK

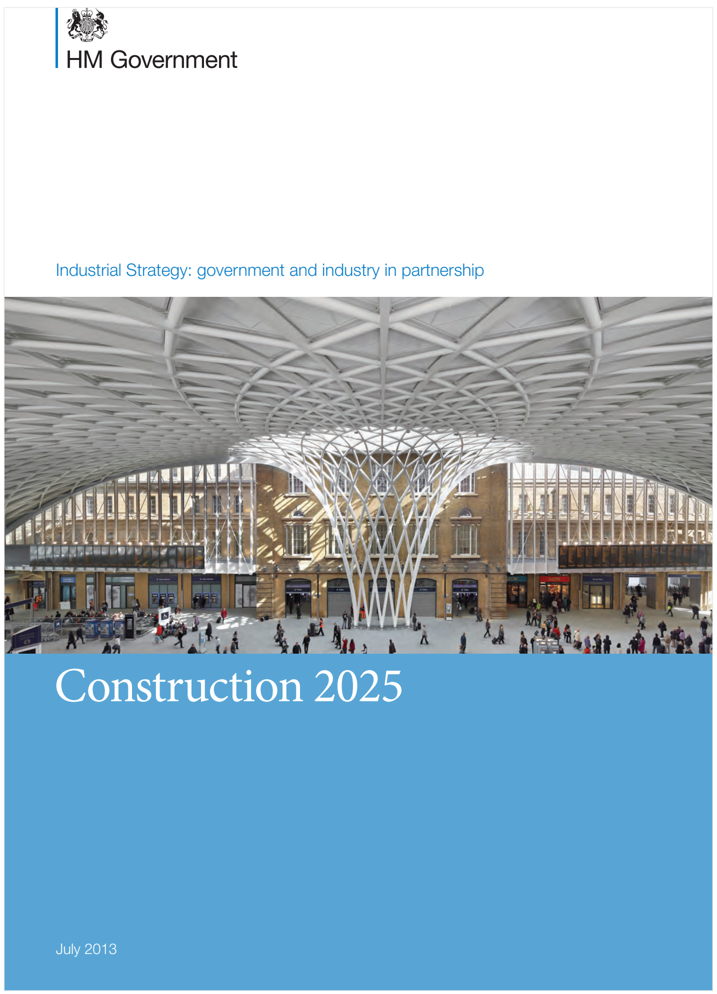
Based on series of legally binding 5 year budgets

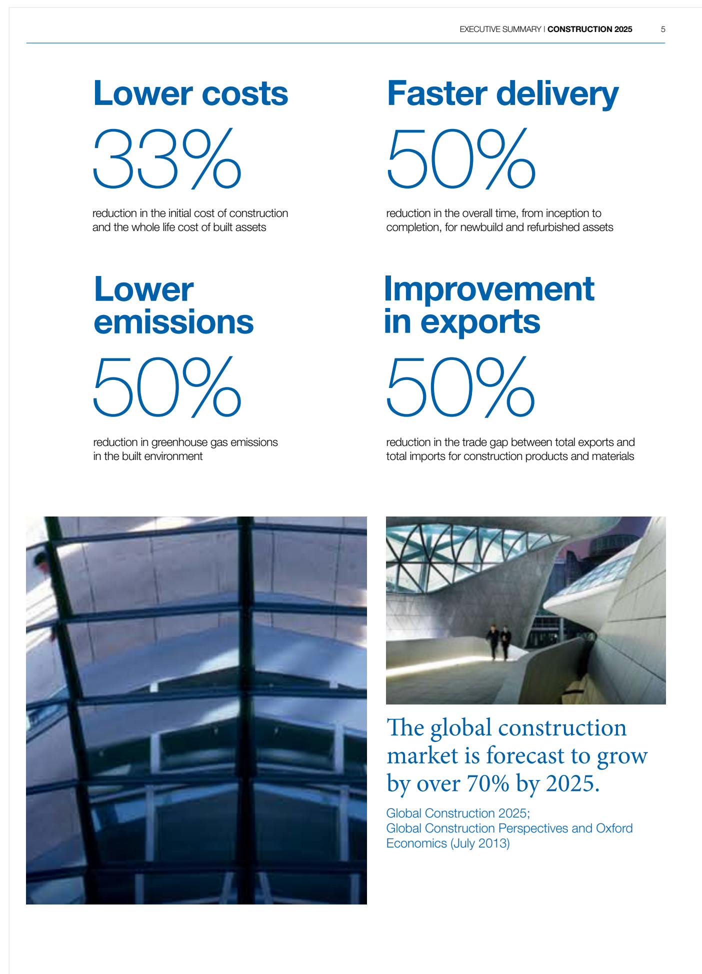


Construction 2025

Targets 50% reduction in GHG emissions in the built environment

» Envisages a sustainable industry that *“leads the world in low-carbon and green construction exports”*

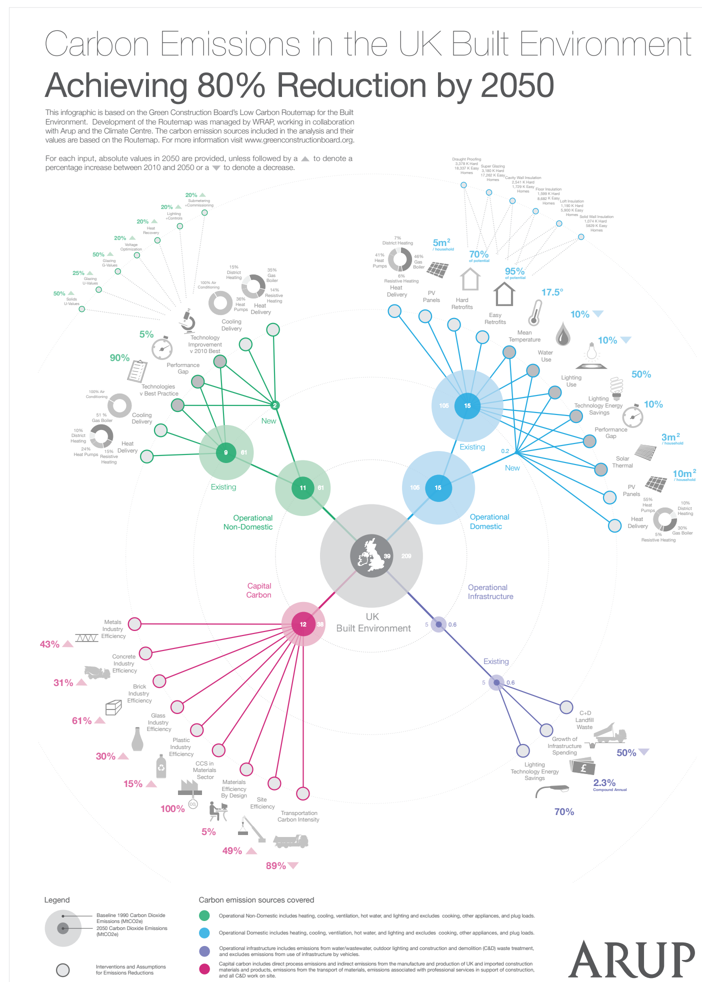




Low Carbon Routemap

Initial report set out target trajectory to 2050

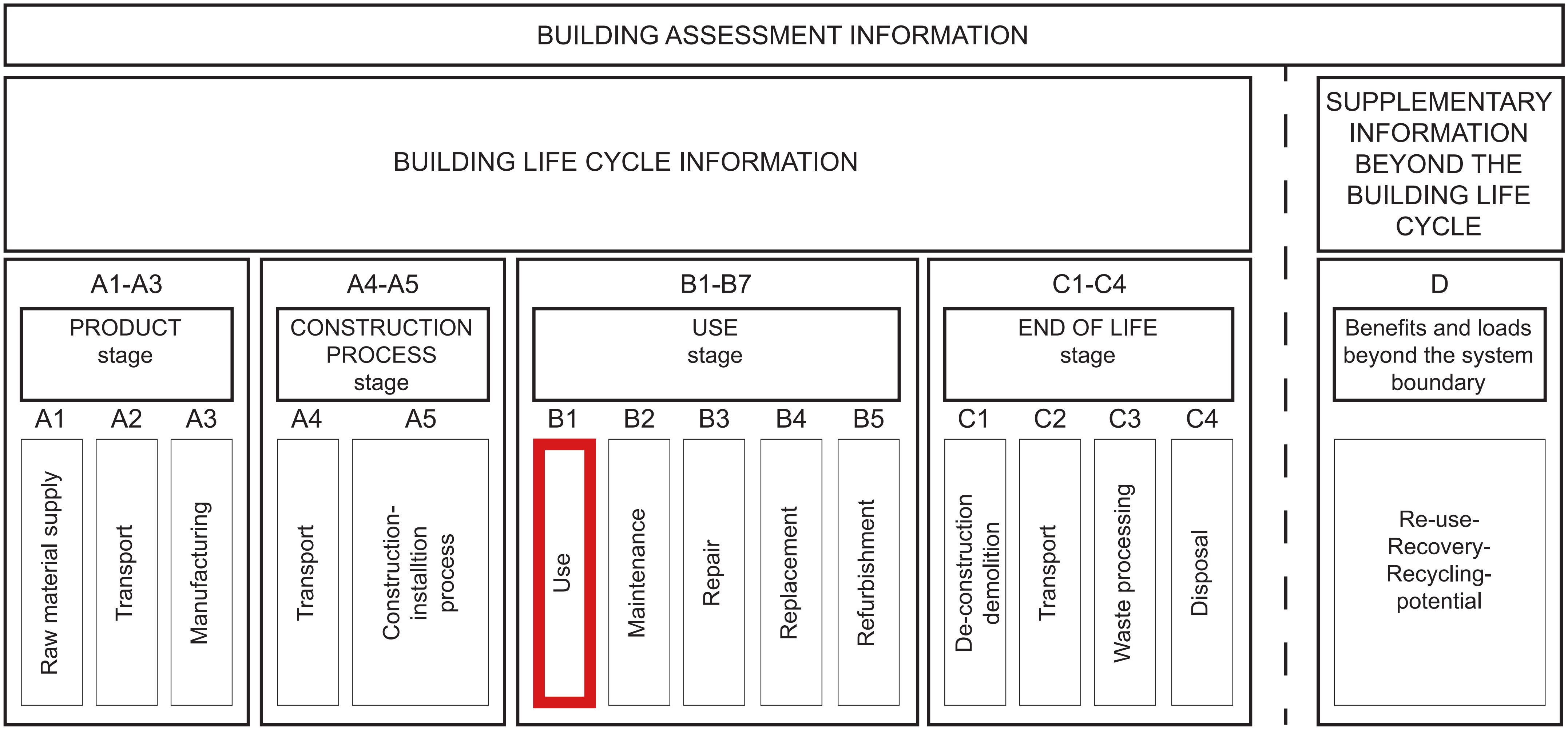
» 2013 routemap showed substantial reductions in capital carbon required **in addition to** operational reductions



Green Construction Board (2013) Low Carbon Routemap for the UK Built Environment

Life cycle emissions

Common definition

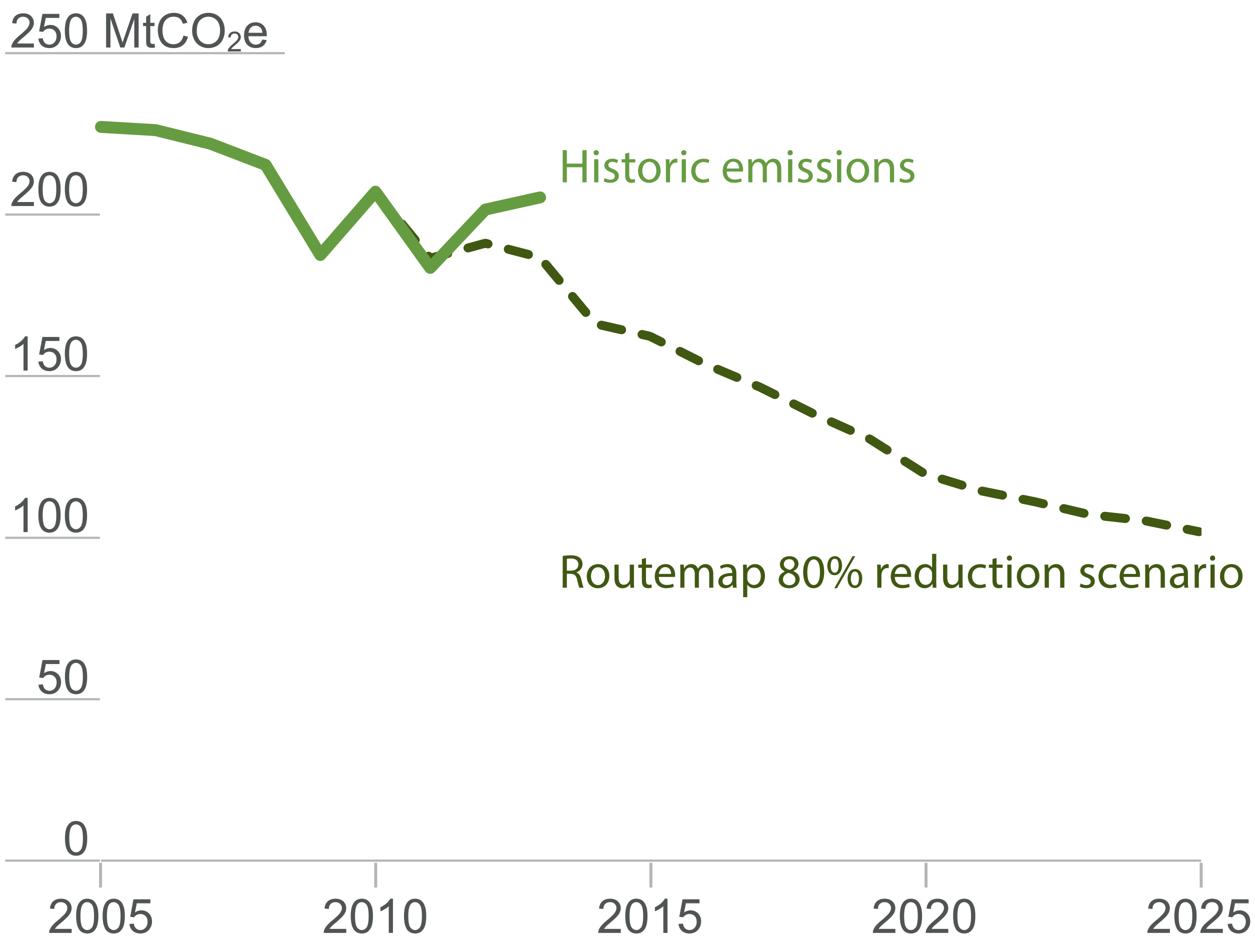


Stages from BS EN 15978:2011

Low Carbon Routemap

Progress report produced in December 2015

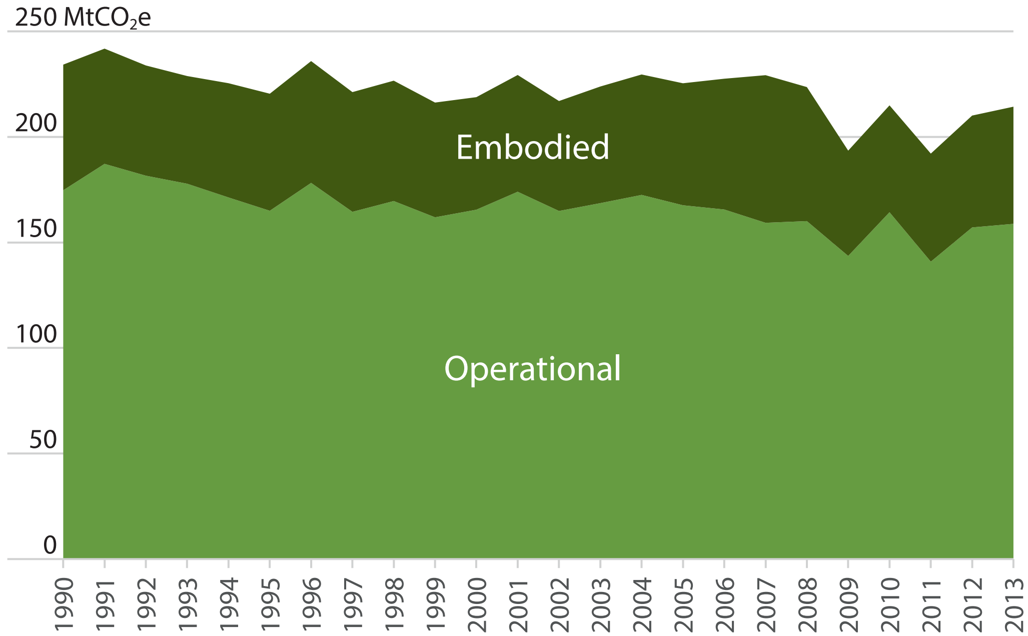
- » Progress to 2013 suggests we are not on trend to meet 2025 ambitions
- » Capital carbon emissions have increased since original report



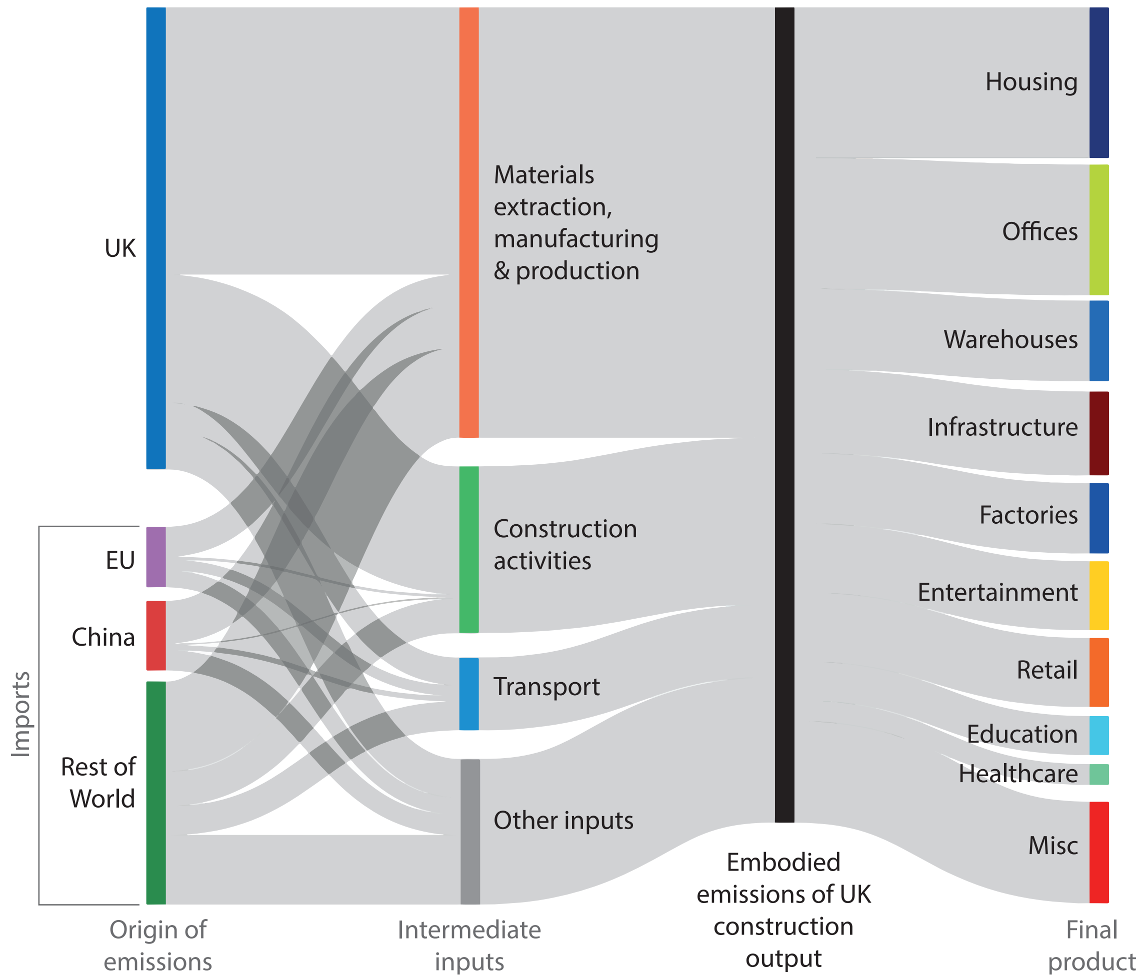
Embodied carbon in construction

Estimated carbon footprint of UK construction supply chain

» Built environment emissions 1990-2013



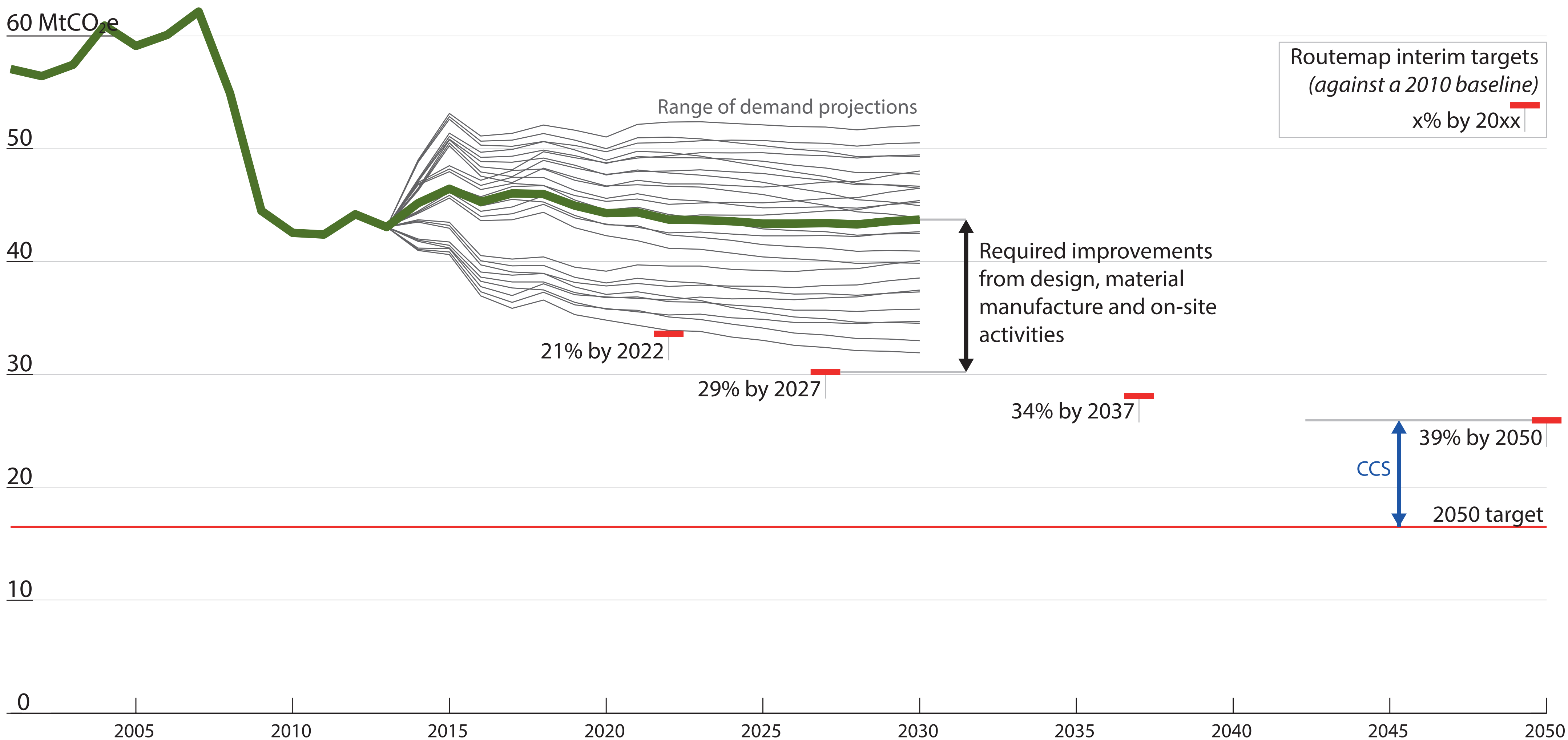
» Embodied emissions in 2007



Required reductions

Anticipated embodied emissions of UK construction 2001-2030

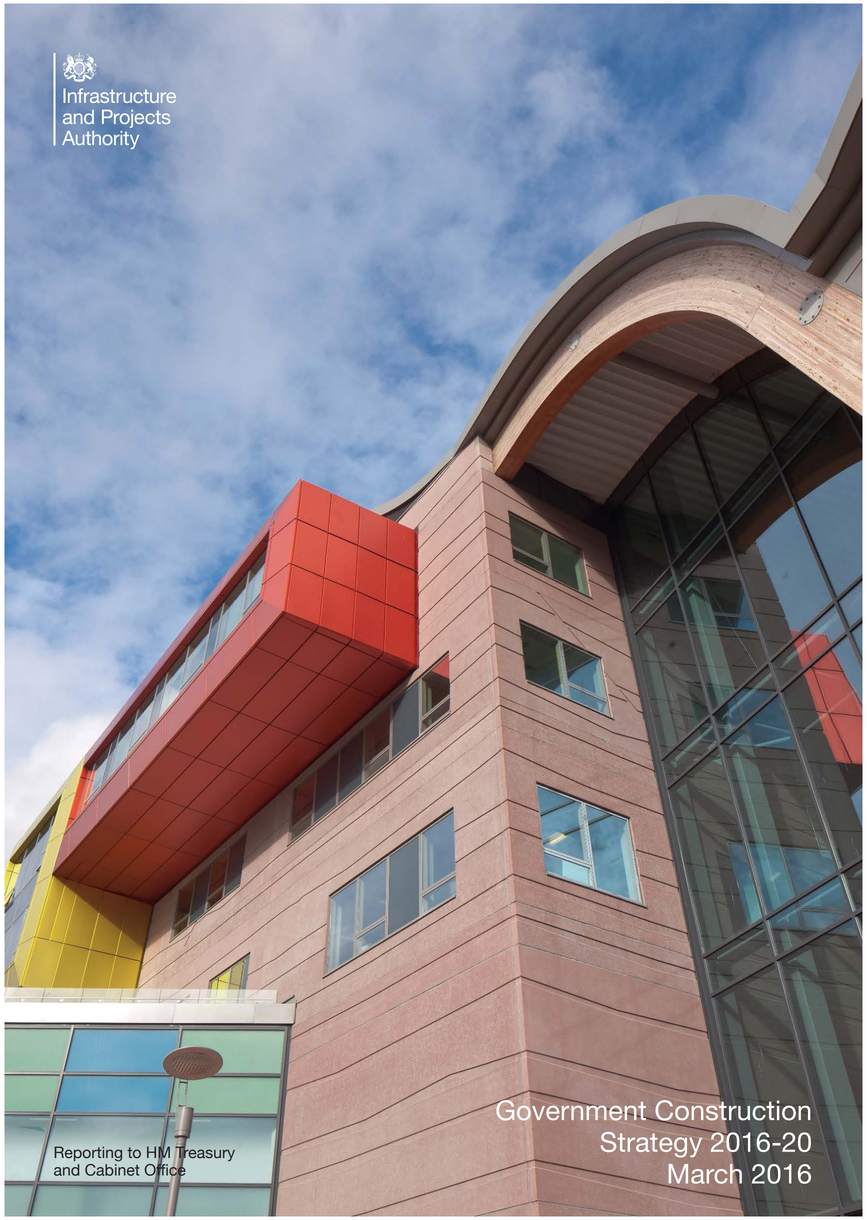
- » 27 scenarios using UK Buildings and Infrastructure Embodied Carbon model
- » **Including** improvements in grid intensity from DECC



Government Construction Strategy

For the current parliament

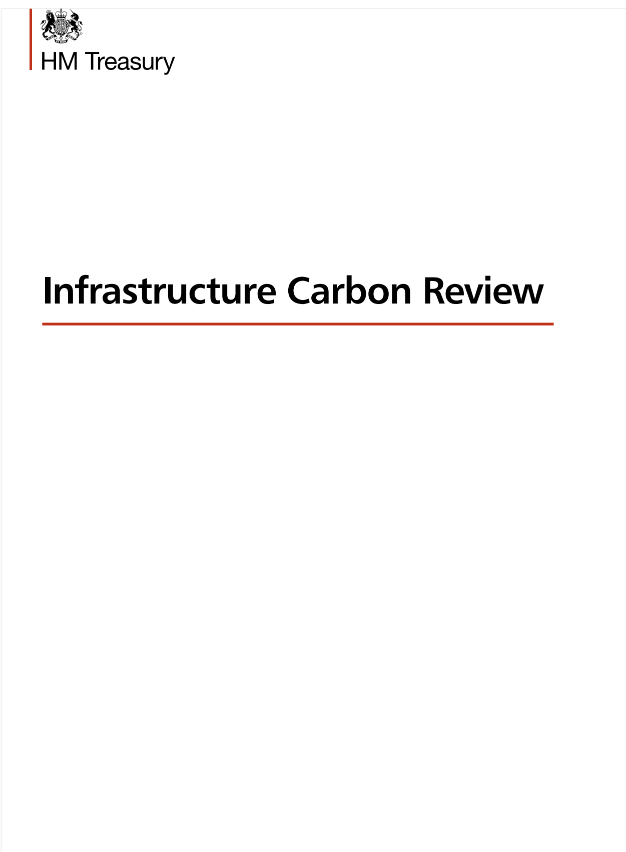
- One of the principal objectives is to *"enable and drive whole-life approaches to cost and carbon reduction"*
- Objective 3.6 is to *"Develop data requirements and benchmarks for measurement of whole-life cost and whole-life carbon (embodied and operational)"*
- *"Government contracts will encourage innovative sustainability solutions on carbon reduction where value can be demonstrated"*
- Ultimately forming *"recommendations for a future approach"*



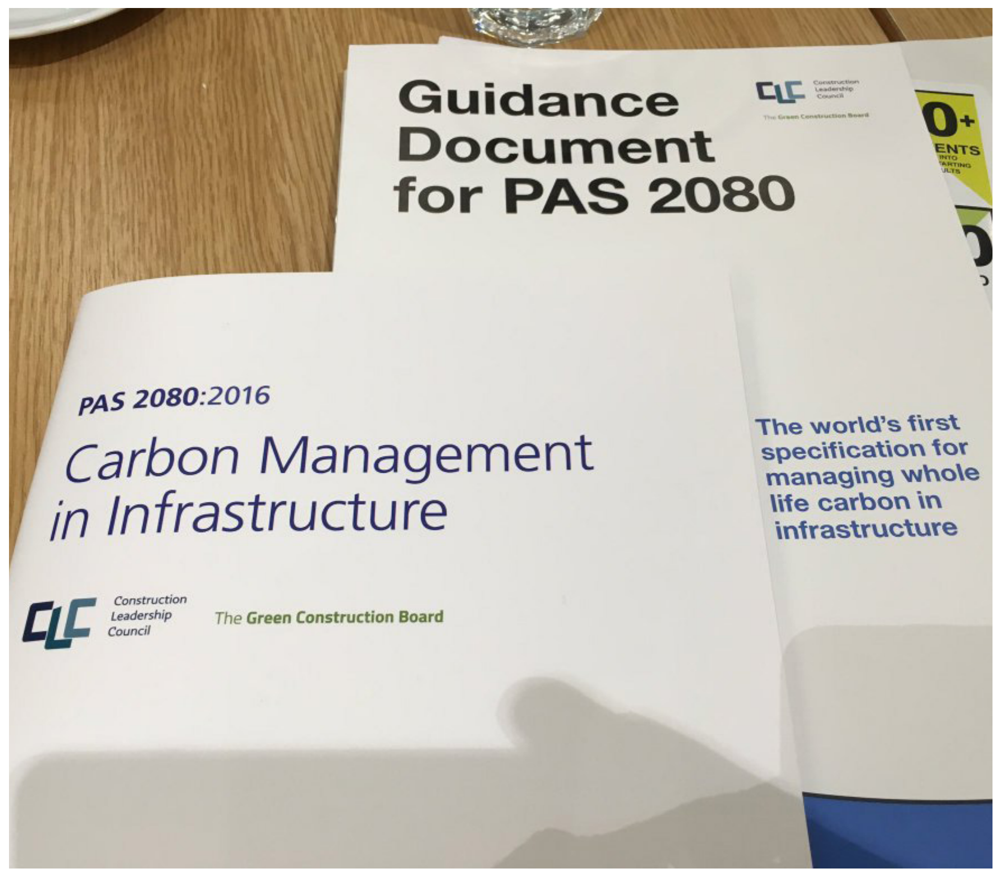
Drivers of low carbon construction

Client demands

- 50+ organisations signed up to Infrastructure Carbon Review
- 30+ organisations with commitments to measure or reduce embodied carbon in buildings
- 10+ Local Authorities interested


HM Treasury

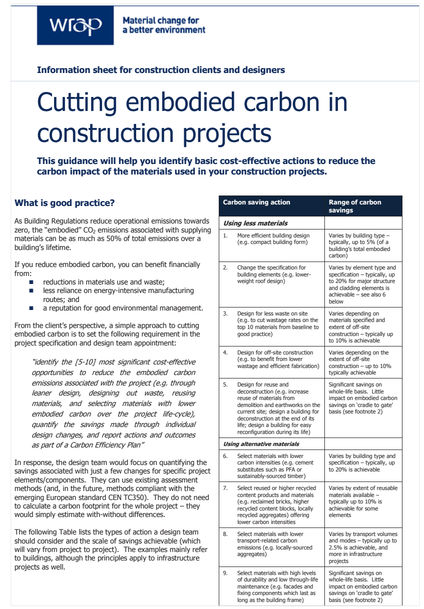
Infrastructure Carbon Review

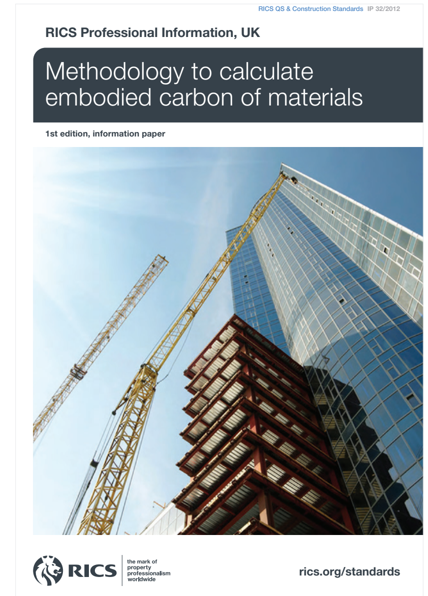


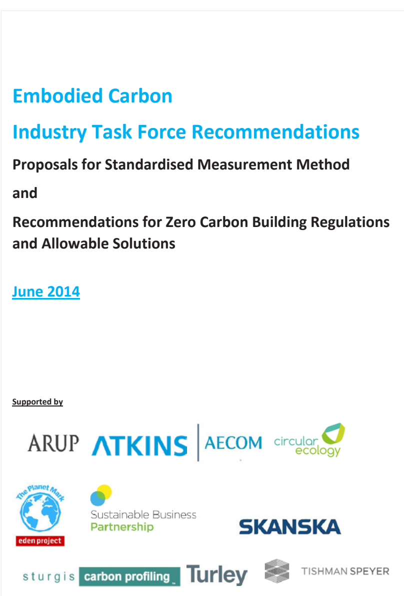
HM Treasury (2013) Infrastructure Carbon Review
BSI (2016) PAS 2080: Carbon Management in Infrastructure

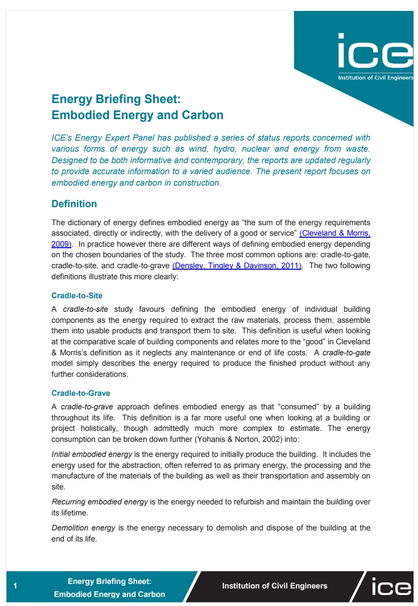
Guidance on embodied carbon

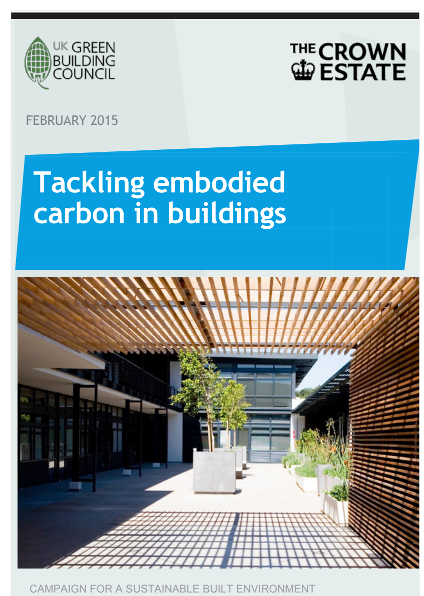
Array of recent publications

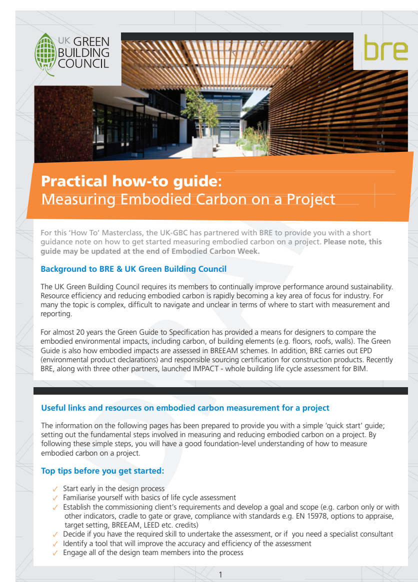


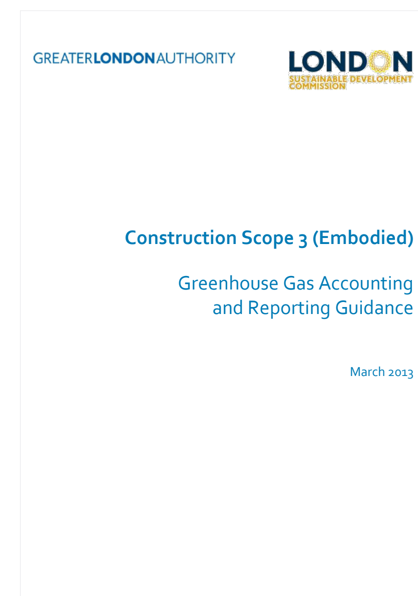












WRAP (2011, 2014); RICS (2012); Clark (2013); Battle (2014); ICE (2011); UKGBC (2015); GLA(2013)

Current assessment practice

Numerous concerns

» Assessments often retrospective and fail to inform product selection

» Different system boundaries (cradle-to-gate, cradle-to-site, cradle-to-practical completion, cradle-to-cradle etc.)

» Limited availability of product LCI data

» Little evidence to support assumed building life times

» Challenges capturing data on site

» Knowledge of embodied carbon varies widely across industry

Recent signs of progress

» Some areas of industry (e.g. water & sewerage) now making routine detailed assessments using component level databases

» Increase in EPD production

» Numerous ongoing projects to further standardise assessments e.g. Innovate UK 'Implementing Whole Life Carbon in Buildings'

Example commitments

To reduce embodied carbon in construction

» British Land target relative to concept design

>£50m: Achieve 15% reduction in embodied carbon in concrete, steel, rebar, aluminium and glass in construction, compared to the concept design

» Land Securities target

Carry out embodied carbon analysis to inform the selection and procurement of building materials to reduce environmental impacts and achieve at least a 15% reduction in embodied carbon

» M&S Plan A commitment

EMBODIED CARBON IN BUILDINGS

ON PLAN

AIM By 2020, we will reduce the embodied carbon in UK and ROI new store builds by addressing the carbon hotspots of walls, ceilings and floors where possible.

» Prologis UK have had requirements to minimise and offset remaining embodied carbon since 2009

» Anglian Water have already achieved substantial reductions since 2010

Capital (embodied) carbon emissions have reduced by 54% against our 2010 baseline. This

Medium-term target

Reduce capital carbon emissions by 60% by 2020 from a 2010 baseline.

British Land (2015); Land Securities (2016); M&S (2016); Anglian Water (2015)

Setting Carbon Intensity Targets (CITs)

Examples of different approaches

» Assess embodied carbon of concept design and then set **target for embodied carbon at practical completion** to be *x*% lower

» Set a **whole life carbon target** of *x*$kgCO_2e/m^2$/year for an assumed design life based on comparison with **benchmark data**

» Aim for an *x*% reduction in embodied carbon against the total for a **notional reference building** deemed to be typical of that building class

» Assess the operational emissions at concept design stage then aim for equivalent reductions in embodied emissions to **'offset' anticipated life time operational emissions**

» Aim for an *x*% reduction in embodied carbon (in $kgCO_2e/m^2$) **against a previous project** the client has completed

» Assess the **10 largest contributing elements** to the embodied carbon total and then achieve an *x*% reduction in those elements

» and so on...

Shortcomings of current CITs

Include

- » Different system boundaries preclude fair comparison between projects
- » Selection of CIT value often arbitrary
- » Relative comparisons with other buildings do not ensure consistency with sector or national carbon reduction targets
- » Little understanding of how these targets may change over time and the concomitant changes in materials and design
- » Targets often poorly communicated and rarely compiled

Implementing CITs

Example check points

RIBA Plan of Work 2013

Tasks / Stages	0 Strategic Definition	1 Preparation and Brief	2 Concept Design	3 Developed Design	4 Technical Design	5 Construction	6 Handover and Close Out	7 In Use
Embodied Carbon Checkpoints	Identify opportunities for re-use of serviceable elements (typically substructure, frame, façade) or on-site recycling of materials from existing buildings/brown field sites. Assess potential to deliver objectives using temporary re-usable structures. Consider potential emissions impact of site choices.	Determine project embodied carbon target (e.g. based on building type and GIA, client ambition and available benchmark data). Review building embodied carbon footprint design tools, methods and data sources and compliance with relevant standards. Identify building embodied carbon footprint certification body and discuss selection of tool, method and initial data sources.	Allocate responsibility for carbon management within project team (e.g. designate roles as per PAS 2080). Determine embodied carbon target/allocation % for each building element. Complete initial building assessment model using element-level specifications. Review initial concept design embodied carbon footprint against project target. Identify elements with high impact rate and/or high quantity in building, review alternative solutions and revise design. Work iteratively; refer to building total regularly. Also consider impact of decisions on design life and maintenance cycles. Revise building embodied carbon target (if necessary). Produce 'Concept stage' embodied carbon report.	As technical/detailed design information is produced, replace element-level specifications with product-level specifications. Identify 'significant' products/materials that are high impact and/or high quantity. For 'significant' products/materials investigate alternatives (of a different product type). Identify overdesign; reduce product/material quantities where possible. Identify on-site waste reduction opportunities. Identify products with Environmental Product Declarations and, where better than generic products, consider proprietary specification. Work iteratively; refer to building total regularly. Produce 'Design stage' embodied carbon report and footprint. Submit 'Design stage' embodied carbon footprint for certification. Submit 'Design stage' embodied carbon footprint to relevant data gathering organisations.		Ensure embodied carbon targets, reporting requirements and any stipulations on material specification and sourcing are clearly included in tender. Contractor credentials should be assessed against these requirements. Review effect of any product/material substitution requests from contactor. Work with contractor to further reduce overdesign and on-site waste.	Produce 'As constructed' embodied carbon report and final embodied carbon footprint based on 'actual' quantities. Submit 'As constructed' embodied carbon footprint for certification. Submit 'As constructed' embodied carbon footprint to relevant data gathering organisations. Ensure lessons learned are documented and communicated. Ensure handover information incudes embodied carbon report, including estimated service lives.	Periodically, ask building owner for update on actual repair and maintenance activities and submit to relevant data gathering organisations.

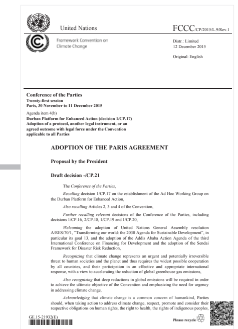
Adapted from GLA (2013) and Doran (2014)

Future determination of CITs

Ensuring consistency with sector & national targets

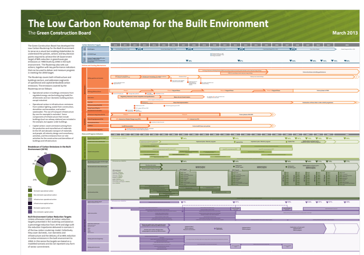
Global carbon reduction targets

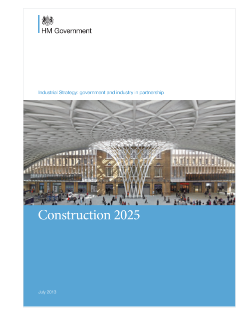
↓ Mechanisms in Paris Agreement



UK carbon reduction targets

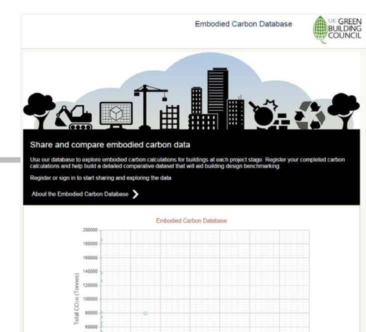
↓ GCB Routemap & Construction 2025





Construction sector carbon targets

↓ New central resource based upon WRAP ECBD & UK BIEC model



Project carbon intensity targets

For UK BIEC model see Giesekam et al. (In Press) Scenario analysis of embodied greenhouse gas emissions in UK construction

Proposed central resource

Would include

- Benchmark data from revived WRAP Embodied Carbon Buildings Database
- Suggested CITs based upon UK BIEC model outputs
- Example carbon plans for a range of standard building typologies
- Procurement guide featuring example wording for brief and contracts

Would help

- Inexperienced clients to easily specify for low embodied carbon
- Experienced clients to aim for more ambitious targets e.g. ‘2050 ready’ building
- All clients to have a common information source and reporting platform

For UK BIEC model see Giesekam et al. (In Press) Scenario analysis of embodied greenhouse gas emissions in UK construction

Securing additional drivers of CITs

Client led drivers

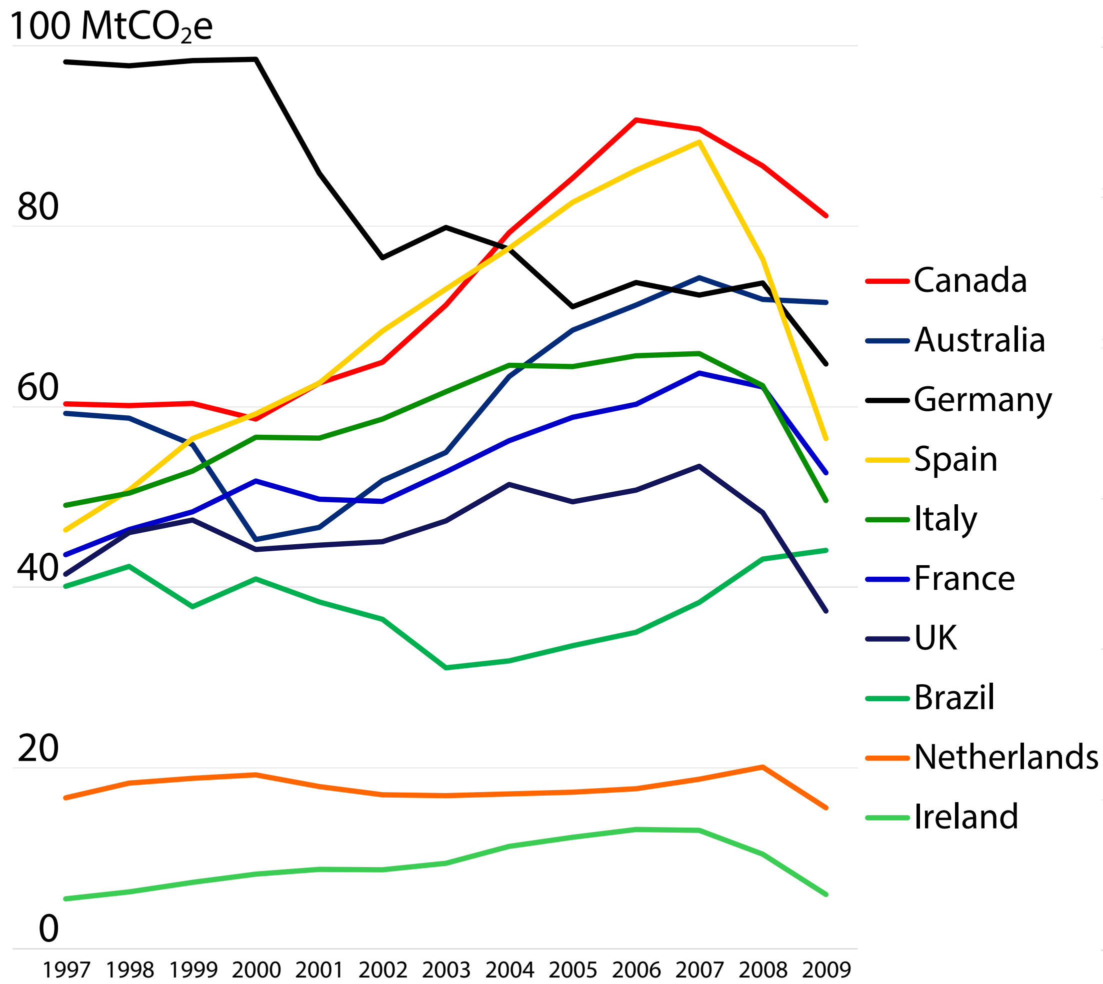
- » Requires further information on value of CITs
- » Requires stronger evidence on link between cost and carbon
- » Changes in culture required to ensure implementation
- » Voluntary initiatives a good starting point

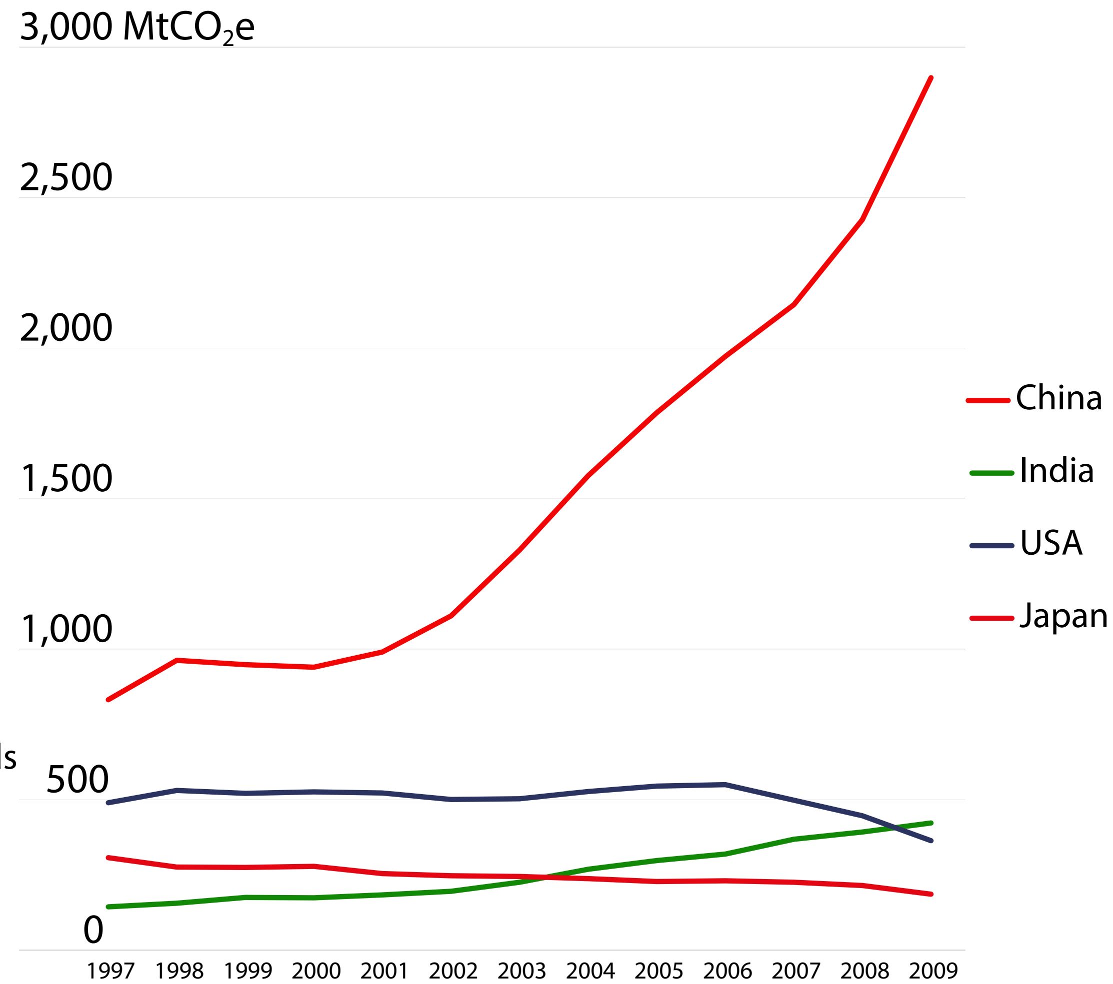
Regulation

- » Must address ownership of issue within industry and government
- » Needs collective action from broader range of advocates across value chain
- » Narrative development is critical
- » Further evidence gathering required

International scope

GHG emissions of construction sector supply chain by country





» Construction firms in these 14 countries alone influence 4.4 $GtCO_2e$ of supply chain emissions

Based upon MRIO analysis using WIOD data for 40 countries plus 'rest of world'

Summary

The case for CITs in construction

» The UK construction industry must address embodied carbon if sector carbon reduction targets are to be met

» Introduction of CITs is the best approach to motivate requisite changes in design, product selection and construction practices

» Challenges to be overcome include: standardising the approach to CITs; ensuring consistency with national and sector targets; and developing an appropriate central resource for clients and practitioners

» Additional drivers for CITs are also required

» Sizeable mitigation potential if CITs are widely adopted

» Read the conference paper for further discussion