CIE-MAP

Centre for Industrial Energy, Materials and Products

Research Councils UK Energy For a Low Carbon Future

Reducing embodied carbon in construction

Developing a UK model and policy pathways

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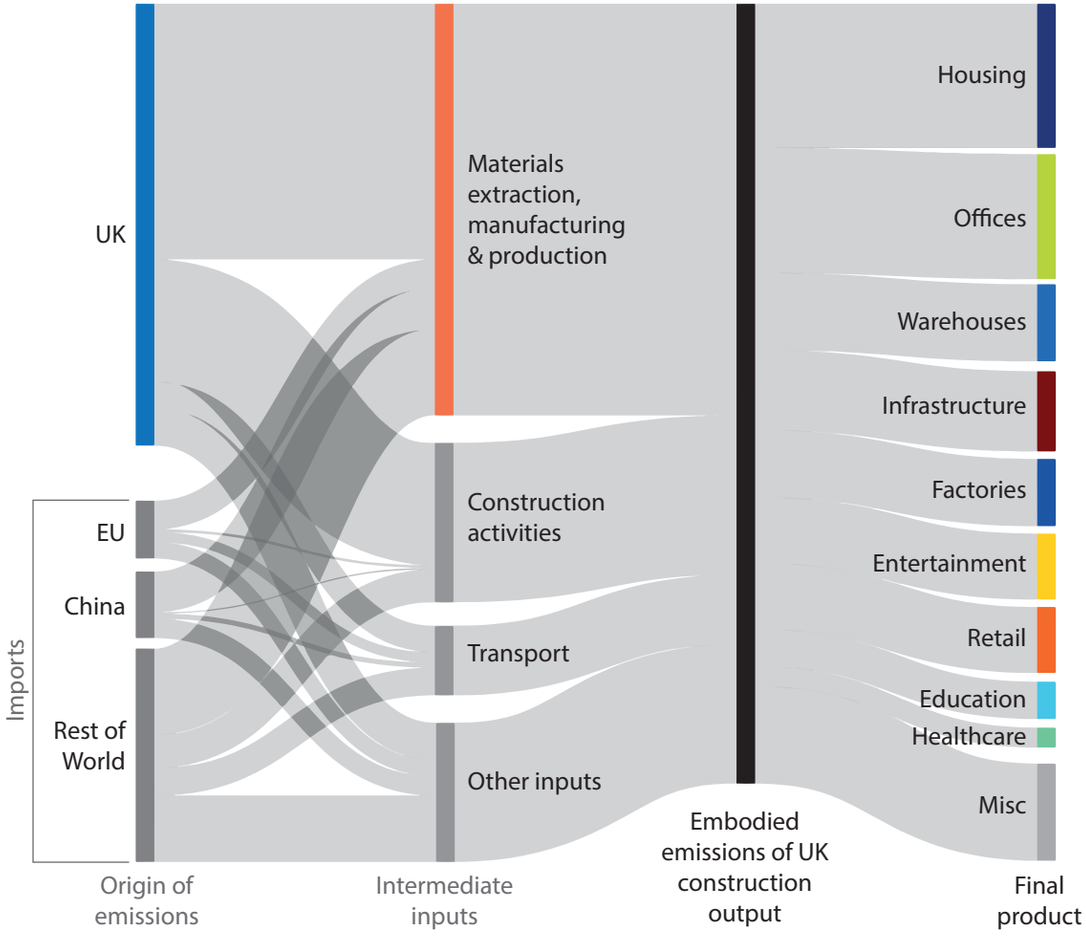
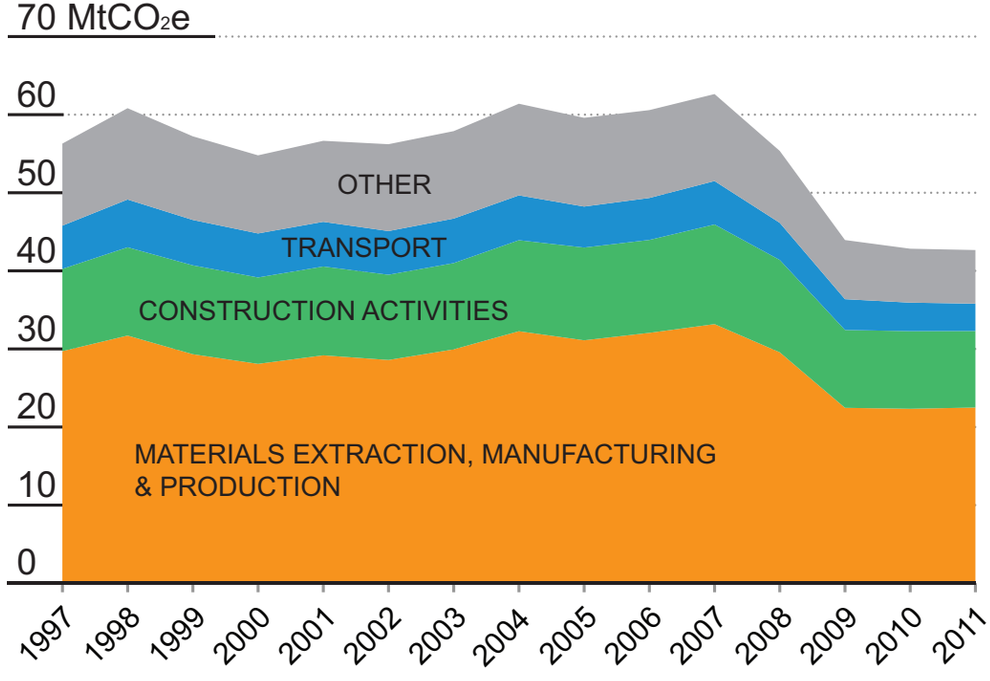
Embodied carbon in construction

Estimated carbon footprint of UK construction supply chain

» In 2007



» From 1997-2011



Right figure from Giesekam et al. (2014) *Energy and Buildings* 78 pp202-214

Construction 2025

Government strategy targets 50% reduction in GHG emissions

» Whilst reducing cost and accelerating project delivery

HM Government

Industrial Strategy: government and industry in partnership

Construction 2025

July 2013

Lower costs

33%

reduction in the initial cost of construction and the whole life cost of built assets

Faster delivery

50%

reduction in the overall time, from inception to completion, for newbuild and refurbished assets

Lower emissions

50%

reduction in greenhouse gas emissions in the built environment

Improvement in exports

50%

reduction in the trade gap between total exports and total imports for construction products and materials

The global construction market is forecast to grow by over 70% by 2025.

Global Construction 2025; Global Construction Perspectives and Oxford Economics (July 2013)

Low Carbon Construction

Building a plan through successive reports

» Sector routemap developed in 2013

» Followed by Infrastructure Carbon Review

HM Government

The **Green Construction Board**

Low Carbon Routemap for the UK Built Environment

5 March, 2013

wrap Working together for a world without waste

The Climate Centre

ARUP

HM Treasury

Infrastructure Carbon Review

Industry routemap

Requires 39% reduction in embodied carbon by 2050 (from 2010)

The Low Carbon Routemap for the Built Environment

The **Green Construction Board**

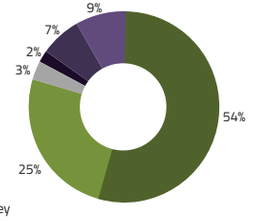
March 2013

The Green Construction Board has developed the Low Carbon Routemap for the Built Environment to serve as a visual tool enabling stakeholders to understand the policies, actions and key decision points required to achieve the UK Government target of 80% reduction in greenhouse gas emissions vs 1990 levels by 2050 in the built environment. The Routemap also sets out actions, together with key performance indicators that can be used to deliver and measure progress in meeting the 2050 target.

The Routemap covers both infrastructure and buildings sectors, and addresses segments of operational and capital (embodied) carbon emissions. The emissions covered by the Routemap are as follows:

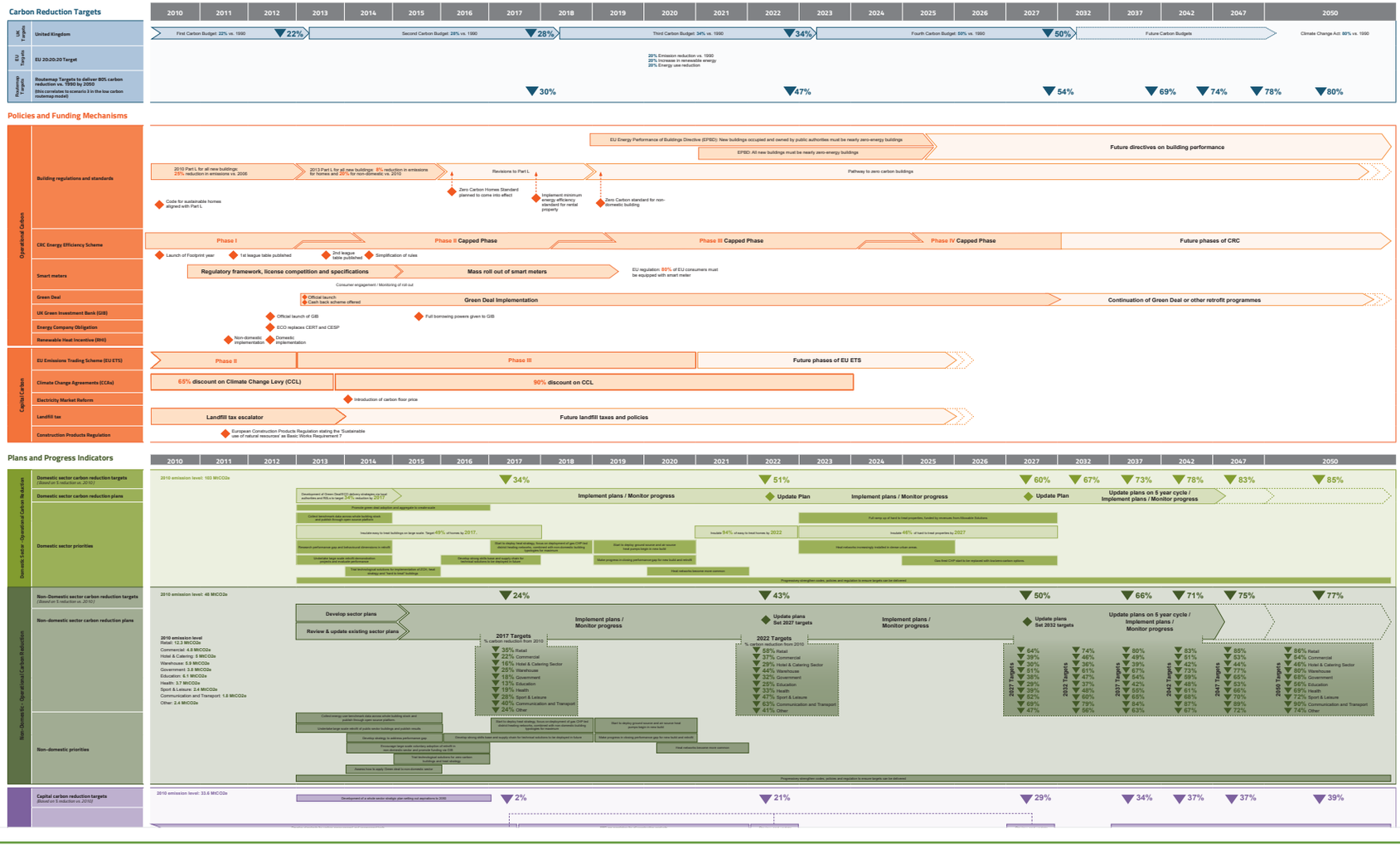
- Operational carbon in buildings: emissions from regulated energy use (excluding plug loads) for all domestic and non-domestic building sectors except industrial.
- Operational carbon in infrastructure: emissions from outdoor lighting, waste from construction, demolition and excavation, and water/wastewater. The use of transport infrastructure (by cars for example) is excluded. Some components of infrastructure that include buildings (such as railway stations) are included in the analysis, but appear under buildings.
- Capital carbon: covers emissions arising from the production and manufacture of materials (in the UK and abroad), transport of materials and people, all industry design and consultancy activities, and the emissions from on-site activities for the construction and demolition of buildings and infrastructure.

Breakdown of Carbon Emissions in the Built Environment (2010)



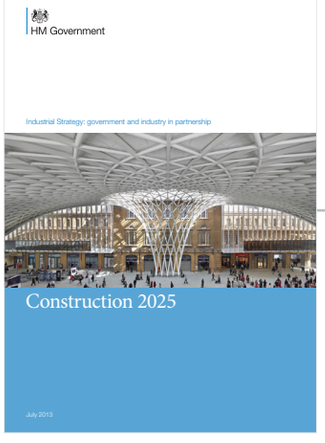
Key

- Domestic operational carbon
- Non-domestic operational carbon
- Infrastructure operational carbon
- Infrastructure capital carbon
- Domestic capital carbon

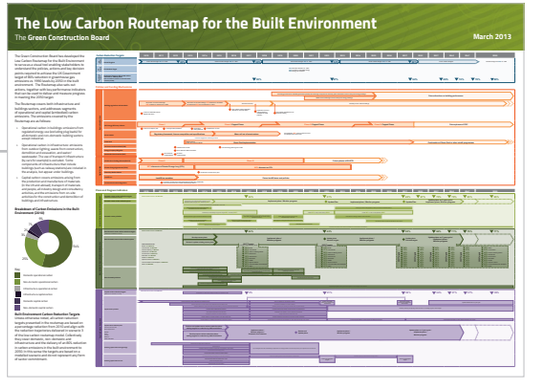


Aligning benchmarks with targets

How can UK targets be translated to project level benchmarks?



UK GHG emissions reduction targets



Construction sector GHG emissions reduction targets

?

Project level benchmarks for clients, designers and regulators

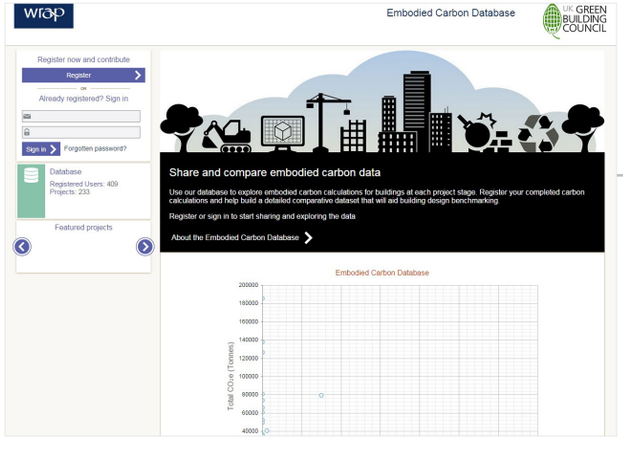
Bridging the gap

A model that integrates top down and bottom up emissions data

UK GHG emissions reduction targets

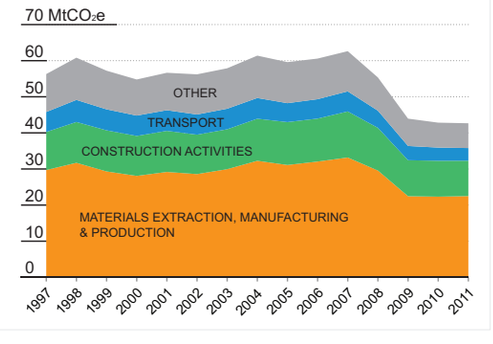
Construction sector GHG emissions reduction targets

Database of building LCA studies



UK Buildings and Infrastructure Embodied Carbon Model

UK MRIO model



Project level benchmarks for clients, designers and regulators

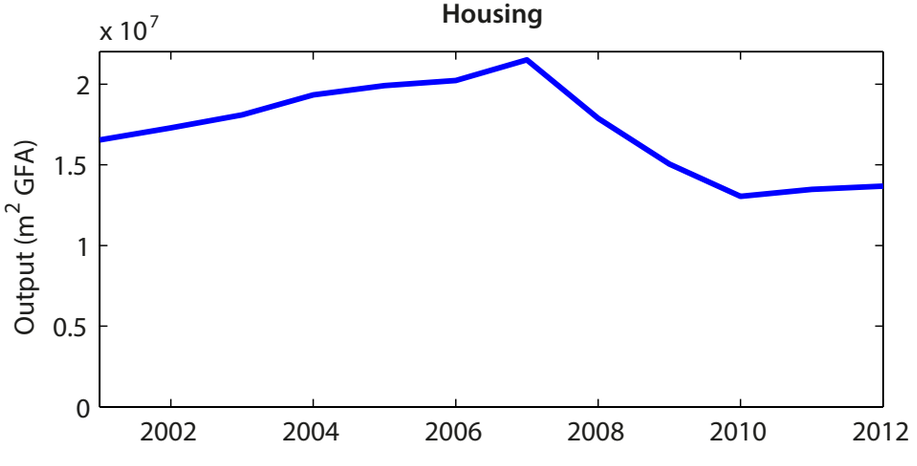
UK Buildings Embodied Carbon Model

Model structure

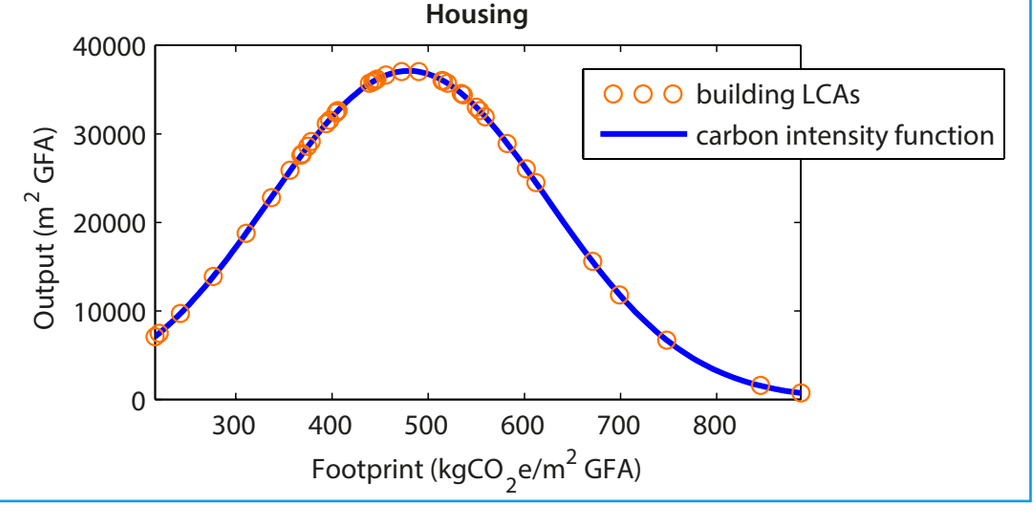
Building classes
Housing, factories, warehouses, education, health, offices, entertainment, retail, infrastructure, miscellaneous

Each building class is represented by

Output profile
Representing area of annual new build floorspace (GFA m^2).

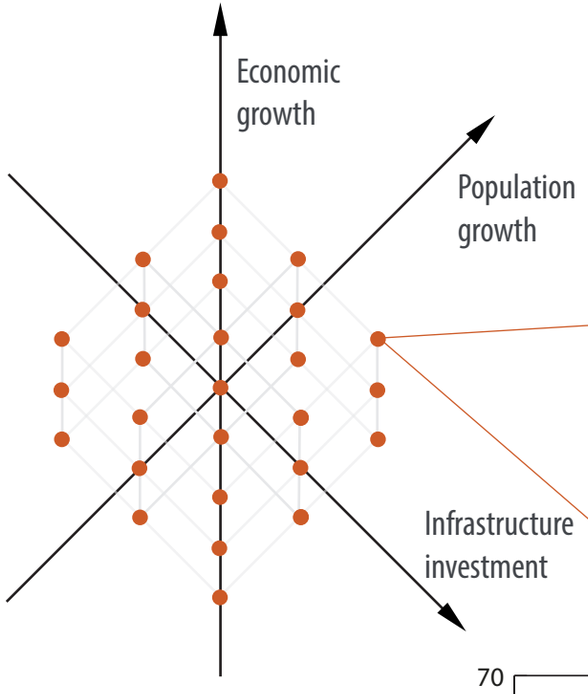


Carbon intensity function
Function representing the range of observed embodied carbon footprints amongst buildings of that class. Based upon collected case studies and entries in WRAP embodied carbon database.



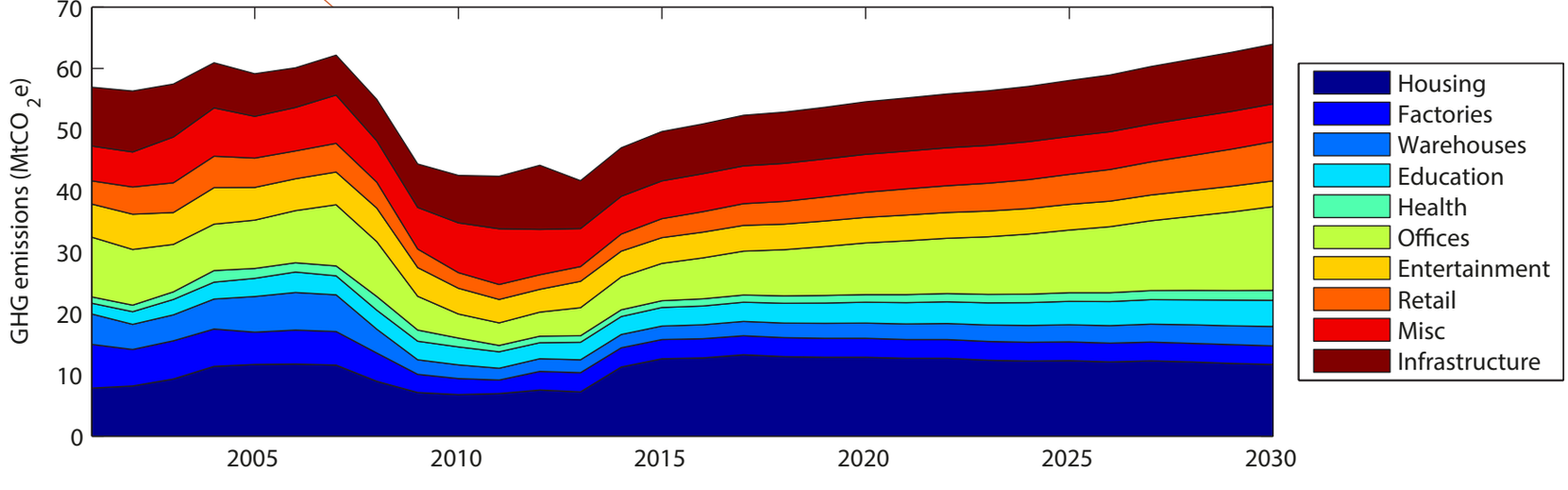
Model demand projections

27 projections (A-ZZ) for each building class up to 2030



Projection A

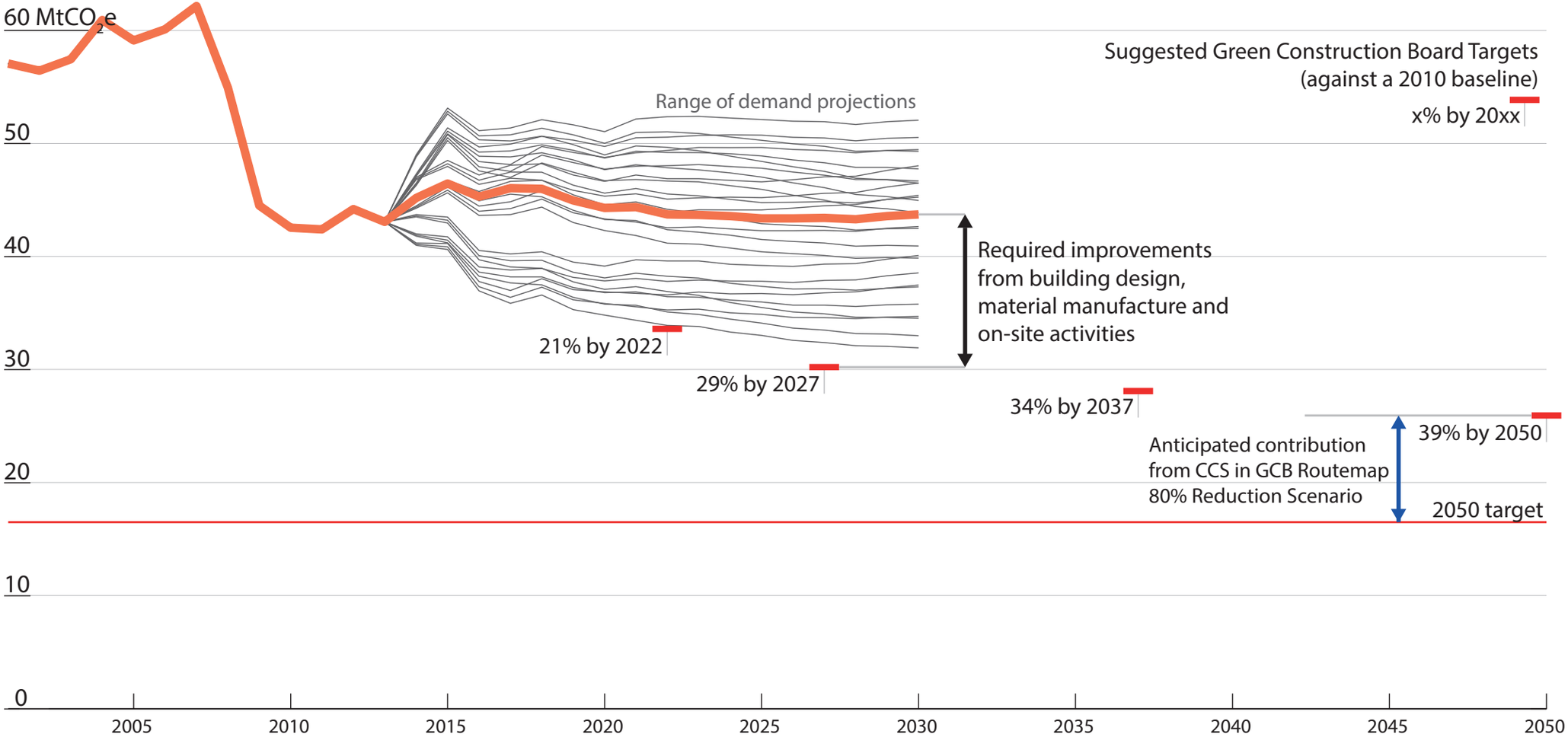
- Strong economic growth (1.7-3.1% per annum) throughout the analysis period.
- Population growth corresponding to the highest combinatorial variant of the ONS projections; household growth meets upper estimates of DCLG projections. Housebuilding increases to meet this demand.
- The increase in population is reflected in a corresponding increase in the service industry workforce with requisite increases in office and retail floorspace.
- Extensive investment in new infrastructure. All projects in the National Infrastructure Pipeline will be completed and infrastructure investment levels will be maintained through to 2030.



Uncertainty over required reductions

Anticipated embodied emissions of UK construction 2001-2030

» **Including** improvements in grid intensity from DECC



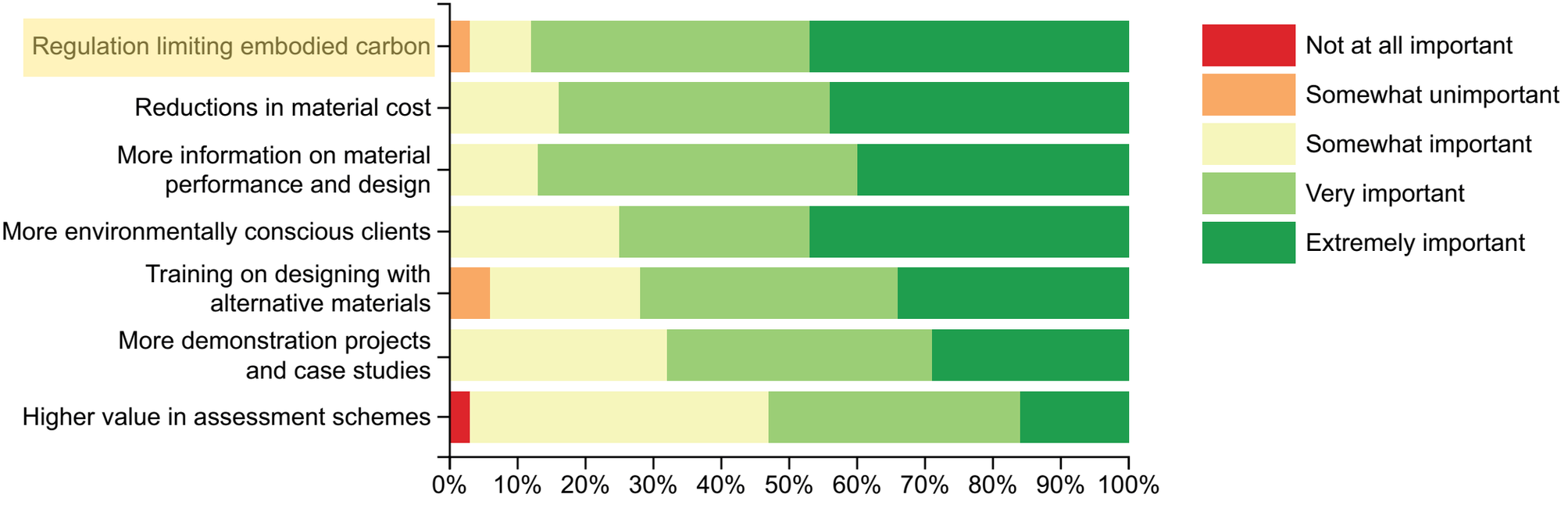
Regulation is required

According to industry survey and interviews

> "At the end of the day, the drivers will always be statutory requirements put upon them to do these things, a huge proportion of the marketplace will only respond to that."

Sustainability and LCA Expert – Research technology organisation

Responses to survey question #21:
How important do you believe the following developments could be in encouraging greater use of alternative materials and construction products?



Recent policy bonfire

Removed/weakened policies include

» Zero Carbon Homes & non-domestic equivalent

» The Green Deal

» Code for Sustainable Homes

Clichéd visual metaphor courtesy of Lee Haywood (https://www.flickr.com/photos/leehaywood/4142123452)

The problem

In short

» Embodied emissions are a significant proportion of total emissions

» We don’t know how much they will need to reduce by

» We don’t know how the system will respond to interventions

» We need actions and policy that is resilient to the political cycle

» We need an approach that connects short-term action to systemic change

» We need an approach that can be flexible in the face of deep uncertainty

» We need a forward-looking approach to create an environment that enables business decision making

Dynamic Adaptive Policy Pathways

Introducing a new approach to fill the policy void

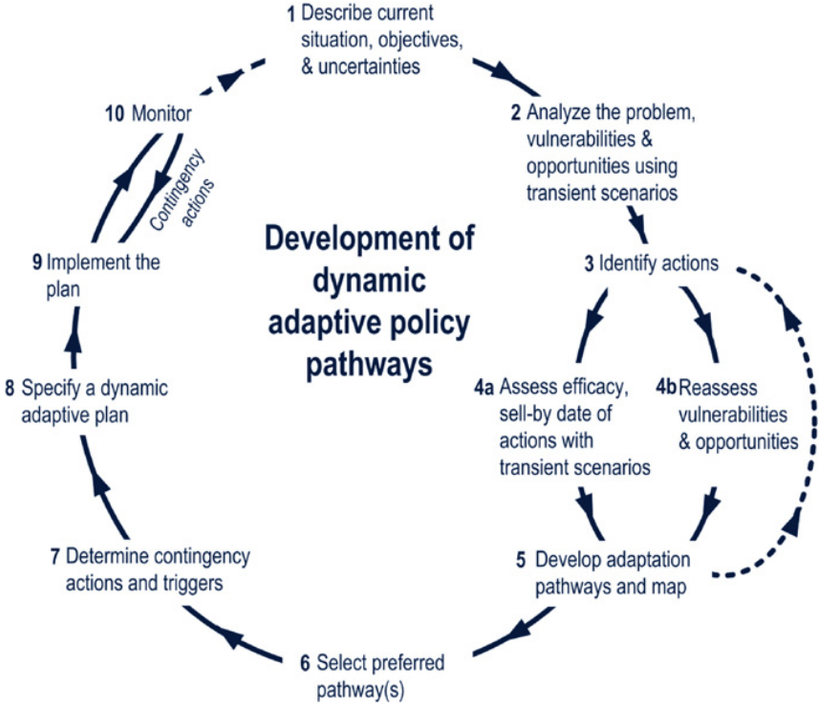


Fig. 4. The Dynamic Adaptive Policy Pathways approach.

Fig. 6. Adaptation pathways map for fresh water supply from the IJsselmeer area.

Developing the approach

Workshop with industry practitioners

» Small, focussed workshop at Royal Academy of Engineering on 11/09/15

» Session 1 - review of policy options

» Session 2 - sequencing policies, considering adaptability and implementation

» Focus upon understanding feasibility, flexibility, and responsibility

Supply chain area	Policy/action
Products	Develop UK National Embodied Carbon Database from mix of EPDs and generic LCA data that allows product **comparison**
	Support update of database
	Legislate to make production of EPDs mandatory
	Legislate to achieve minimum EPD standards with penalty for exceedance/ incentive for going under
	Develop certification systems for alternative materials
	Provide guidance and supporting training in use of alternative materials
	Promotion and advocacy for alternative materials
	Q. What support do small manufacturers of alternative materials need to reduce failure rate?
Public procurement and regulated sectors	Develop approach for performance-based specification across all sectors and construction types
	Extend the public sector green procurement framework to be more rigorous and relevant to construction
	Mandatory measurement and reporting of capital carbon on public and regulated sector construction
	Include more detailed guidance on capital carbon in Green Book and Magenta book and increase from optional to mandatory
	Include explicit calculation and reporting of capital carbon in National Infrastructure Plan
General procurement	Extend WRAP's work on Carbon Efficient Procurement to make embodied emissions mandatory and to strengthen methods
	Promote strengthened work on Carbon Efficient Procurement
	Quoted companies must report GHGs embodied in new buildings in addition to operational emissions
	Q. How do we address end user perceptions of low embodied carbon materials?
Design	Voluntary requirement for large contractors to add embodied emissions data to WRAP Embodied Carbon Database
	Mandatory requirement for public sector projects to add embodied emissions data to WRAP Embodied Carbon Database
	Planning requirement to report capital carbon
	Benchmark capital carbon for projects (by type)
	Legislate to achieve minimum capital carbon standards with penalty for exceedance/ incentive for going under
	Planning requirement to report measures to design for deconstruction
Build	Minimum efficiency standard for site accommodation
	Emissions standards for construction plant
End of Life	Mandatory labelling of products that have potential for re-use
	Develop database of materials in use that are suitable for re-use at end of life

Outcomes from workshop

Further adaptation of approach required to consider

» Compatability with multiple narratives

» Drivers from actors other than Government

» Relationship between the actions, evidence base and political influence

Next steps

» Brief report summarising approach and outcomes from workshop

» Continued engagement with practitioners

» Second workshop

» Journal paper highlighting improvements required in approach

Summary

Additional policy addressing embodied carbon is required

» Development of UK BIEC Model facilitates scenario analysis and provides link between sector level targets and project level targets

» Deep uncertainty over levels of embodied carbon reduction required

» Policy response must connect short-term action to systemic change; be responsive to uncertainty; and robust to political change

» Development of dynamic adaptive policy pathways is ongoing