CENTRE FOR RESEARCH INTO
ENERGY DEMAND SOLUTIONS

The role of low carbon construction standards

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24/05/2019

EPSRC
Engineering and Physical Sciences Research Council

slides available from **www.jannikgiesekam.co.uk**

Overview

Introduction

Precedents

Options

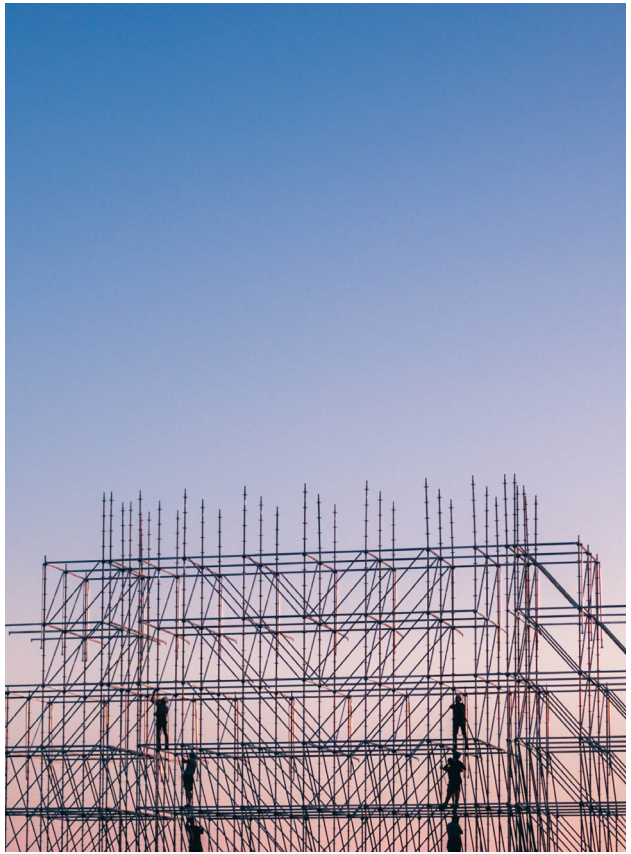
Scale

Advantages

Barriers

Enablers

Recommendation



Centre for Research into Energy Demand Solutions (CREDS)

New multi-disciplinary centre, funded by EPSRC and ESRC - £19m over 5 years.

Publications from CIE-MAP

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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 emissions associated with developing new facilities.
5. Product manufacturers should require Environmental Product Declarations to support environmental claims.

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 their future prosperity. That requires dramatically increasing housebuilding, retrofitting one existing home every minute, and delivering an infrastructure pipeline worth in excess of £600bn. UK firms are also 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[1], 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.

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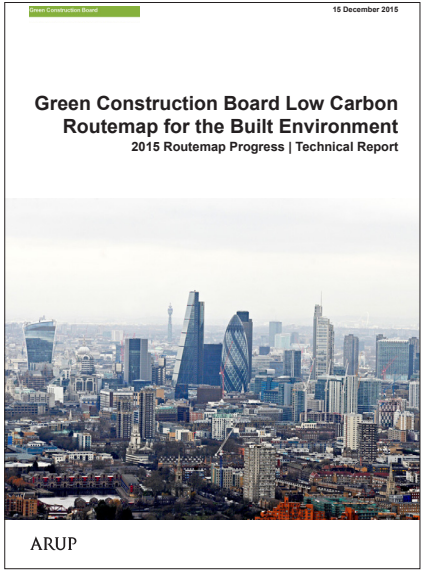
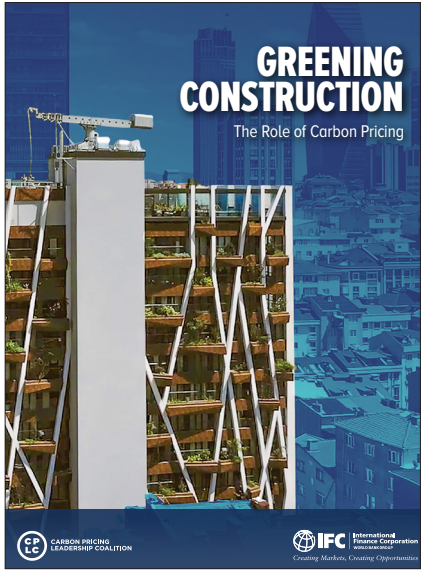
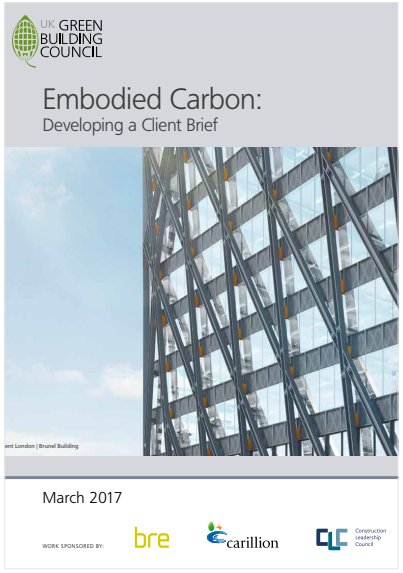
Giesekam et al. (2014, 2015, 2016, 2017, 2018a, 2018b); Roelich & Giesekam (2018)

Also involved in wide range of projects outside academia

Examples include







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GCB (2015); IFC (2019); UKGBC (2017); RICS (2017)

Leeds Embodied Carbon Living Lab

2 year programme co-created with local stakeholders addressing embodied & whole life carbon emissions on a series of live projects in Yorkshire

Trialling new approaches, conducting a city scale assessment of impacts and proposing amendments to participants' construction standards and the local sustainable construction SPD

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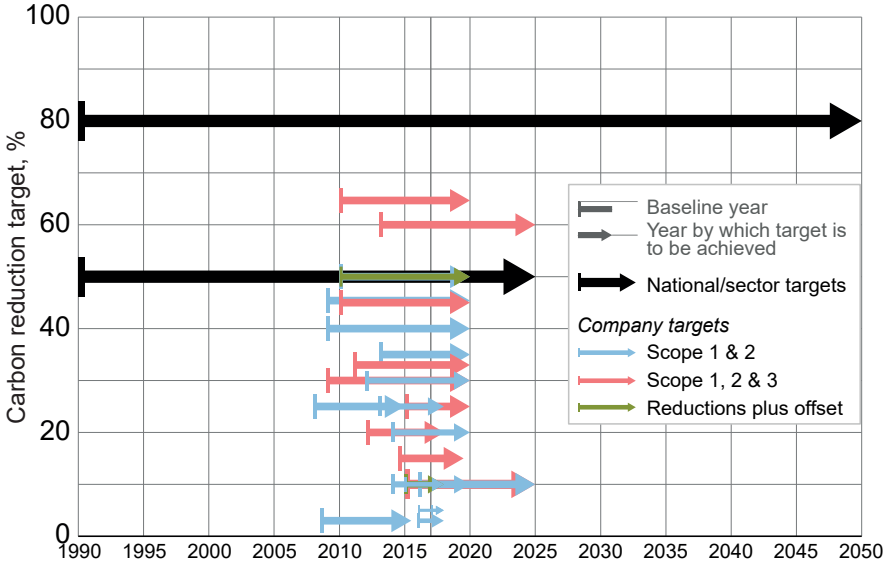
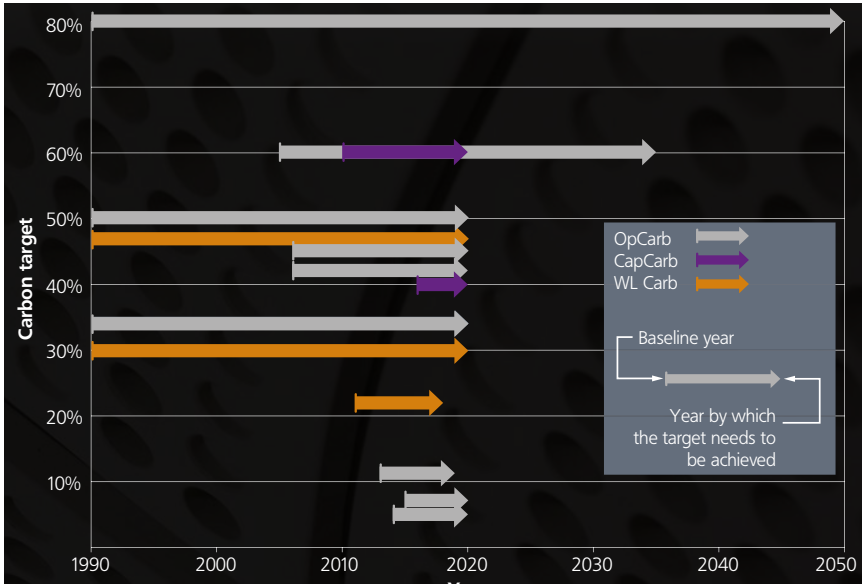
email **J.Giesekam@leeds.ac.uk** if you would like to collaborate

Starting premise: voluntary action will be grossly insufficient

Carbon reduction targets of selected UK housebuilders & construction firms (representing turnover of £88.4bn in 2016) - based on July 2017 review



Carbon reduction targets of selected infrastructure clients



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Figures from Giesekam et al. (2018) Aligning carbon targets for construction with (inter)national climate change mitigation commitments & UKGBC (2017) Delivering low carbon infrastructure

CCC: new UK policy is necessary

*"Ministry for Housing, Communities and Local Government should develop **new policies to support** a substantial increase in the use of **wood in construction**"*

*"**A new mechanism** is needed to incentivise and drive **whole-life carbon savings** for new buildings. This should cover embodied emissions and carbon sequestration."*

Overview

Introduction

Precedents

Options

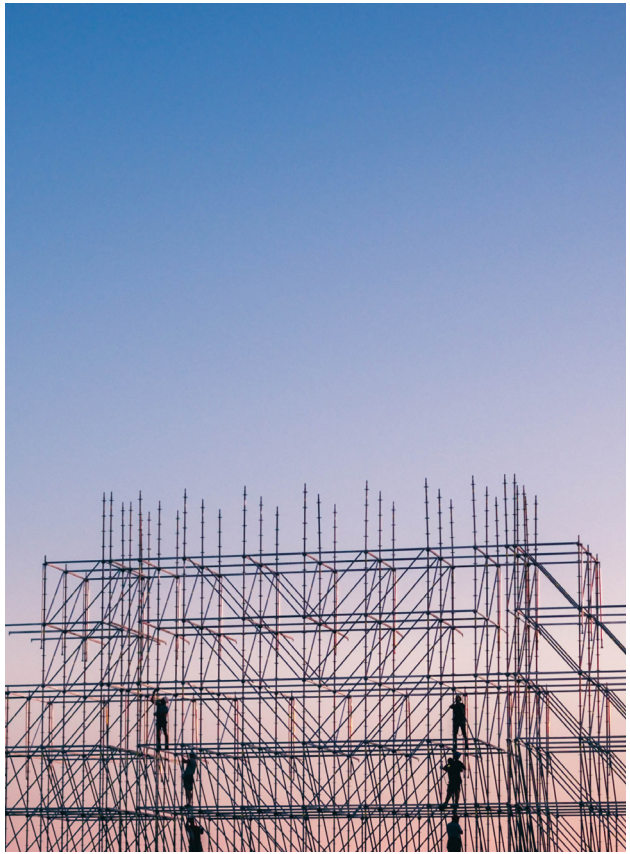
Scale

Advantages

Barriers

Enablers

Outlook



Recent international reviews

THE EMBODIED CARBON REVIEW

EMBODIED CARBON REDUCTION IN 100+ REGULATIONS & RATING SYSTEMS GLOBALLY

The Embodied Carbon Review is updated at
www.embodiedcarbonreview.com

#embodiedcarbonreview

References: The Embodied Carbon Review, 2018, Bionova Ltd, www.embodiedcarbonreview.com

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EMBODIED CARBON OF BUILDINGS AND INFRASTRUCTURE

INTERNATIONAL POLICY REVIEW

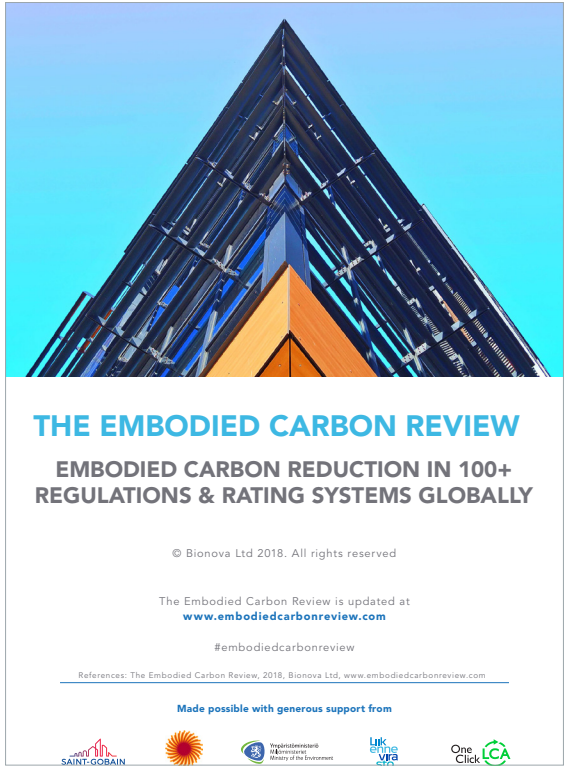
September 2017

Findings

105 systems with direct measures for embodied carbon (69% are voluntary certification systems, 14% regulations, 12% standards and 7% guidelines)

Local systems in 26 countries + 19 international systems available for adoption globally

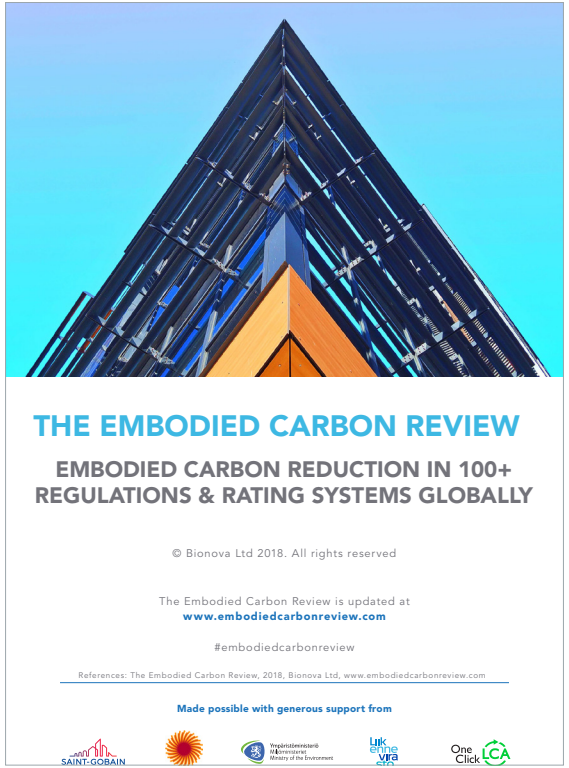
Number of systems has more than doubled in last 5 years



Approaches to reducing embodied carbon

METHOD	HOW DOES IT WORK?	EXAMPLES
1. Carbon reporting	Calculate the construction project's embodied carbon and report it	EN 15978, BREEAM Int'l
2. Carbon comparison	Compare design options for carbon; for example, design baseline and proposed designs and show improvements against a self-declared baseline value	LEED v4, Green Star, BREEAM UK
3. Carbon rating	Evaluation of carbon performance. Variable scale from best to worst on which a project's carbon is rated, but no effective maximum value applied. Fixed scale or clear methodology	DGNB, BREEAM NL
4. Carbon cap	Calculate the project's embodied carbon and prove it is not exceeding the CO2e limit	Énergie Carbone, MPG
5. Decarbonization	Reduce carbon to a minimum, then compensate all residual emissions by own energy export or buying offsets	Living Building Challenge, NollCO2

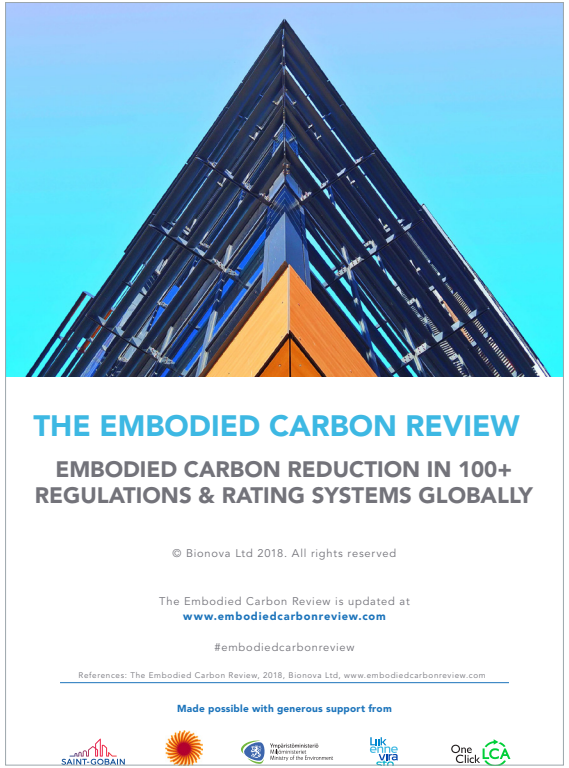
Plus other options *e.g. explicit preference or carbon thresholds for specific materials*



Incentives for achieving carbon reductions

INCENTIVE	DESCRIPTION	USED IN
1. Rating points	Systems that award rating points for the application of LCA, or achieving savings quantifiable with LCA.	LEED v4, DGNB 2018, BREEAM International 2016
2. Funding condition	Public funding program or state procurement setting it a funding condition to achieve carbon target.	State policy in Minnesota and California, United States
3. Density bonus	Meeting a carbon performance level may make a project eligible for additional gross floor area rights.	French E+C- scheme's good performance level (when enacted by city-level plan)
4. Cash impact	Either carbon offsetting funded by the constructor, thus ensuring carbon emissions lead to real cash cost for project; or a carbon performance payment.	Decarbonization e.g. Living Building Challenge, and carbon performance payment Rijkswaterstaat
5. Mandatory	Carbon criterion is a simple requirement. The criterion itself can be set up differently in different systems where it's mandatory.	Dutch MPG regulation and allowed level of the French E+C- scheme (when the law enters in vigor)

Incentives with direct financial value linked to carbon reduction are rare

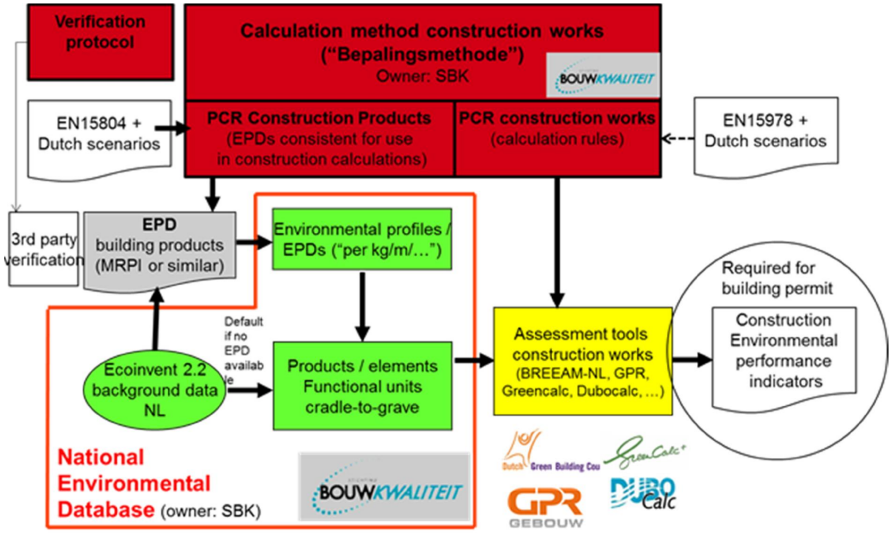


Example: The Netherlands

Since 2012 **building code requires assessment** of environmental impact of materials using a national method & database with approved tools

Impacts are monetised using a shadow price

January 2018 revision set a mandatory environmental impact **cap of 1€/m²/yr**



For English language summary of the regulations consult the brochure at:
https://www.milieudatabase.nl/index.php?q=english-documents

Overview

Introduction

Precedents

Options

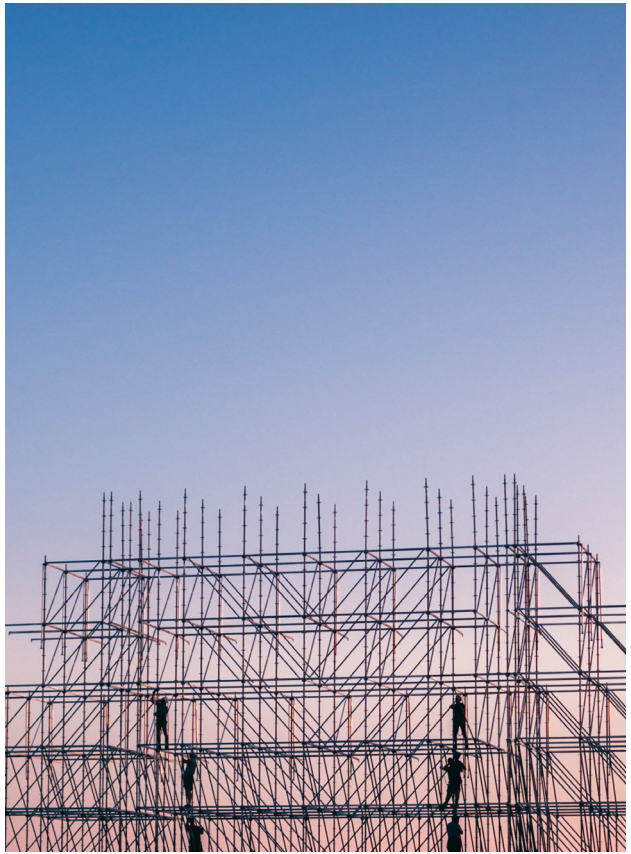
Scale

Advantages

Barriers

Enablers

Recommendation



Options

Prescription of specific design options
(e.g. timber first)

Assessment plus qualitative statements
(e.g. quantify whole life emissions & demonstrate design choices to achieve reductions)

Environmental performance-based requirements
(e.g. must be <500 kgCO_2/m² to practical completion)

Dalston Lane in London - 121 apartments in CLT - credit: Daniel Shearing

Overview

Introduction

Precedents

Options

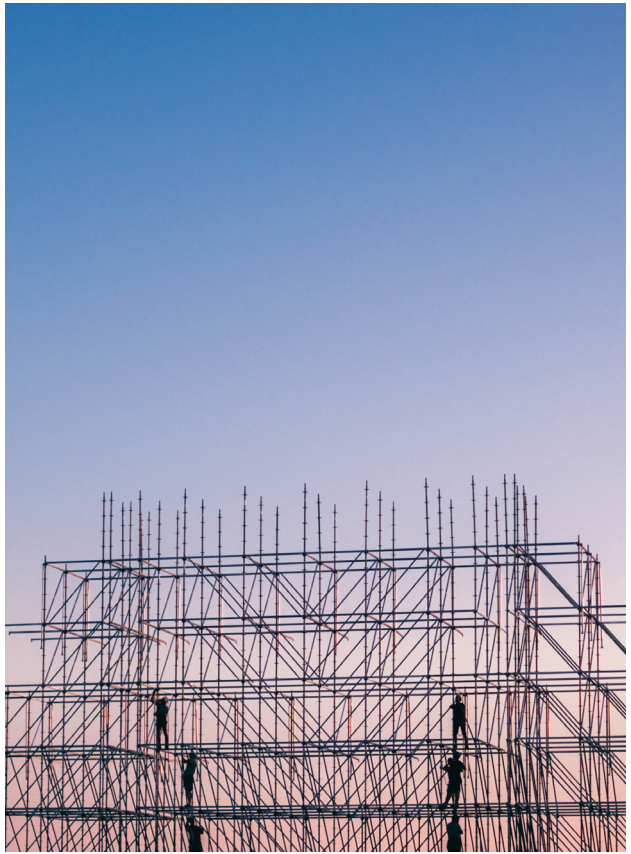
Scale

Advantages

Barriers

Enablers

Recommendation



Scale

Product vs Building

Limits for materials *(e.g. Buy Clean California)*

Limits for buildings *(e.g. Netherlands)*

Local vs National vs Supranational

Local authorities *(e.g. Greater London Authority)*

National regulations *(e.g. France)*

Supranational *(e.g. EU)*

e.g. Draft London Plan

August 2018 revisions include:

New Policy SI2 DB: *"Development proposals referable to the Mayor should* ***calculate whole life-cycle carbon emissions*** *through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions."*

This is expanded upon in new 9.2.9A section and included in the energy strategy requirements.

New Greater Manchester Spatial Framework

GMSF 2019 draft includes:

Policy GM-S 2: "*An expectation that new development will be* ***net zero carbon from 2028****"* & all developments will *"****include a carbon assessment*** *to demonstrate how the design and layout of the development sought to* ***maximize reductions in whole life CO2*** *equivalent carbon emissions*"

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GMCA (2019) Greater Manchester Spatial Framework Revised Draft - January 2019
Image from Sue Langford: https://www.flickr.com/photos/sue_langford

Bristol One City Plan

Includes ambitions that:

By 2025: "*standard practice for major developments in Bristol to be **carbon neutral**"*

By 2030: "*standard practice that major developments in Bristol are **net carbon negative**"*

Bristol City Council (2019) Bristol One City Plan
Image from FLH: https://www.flickr.com/photos/french_landscape_hunter/

Overview

Introduction

Precedents

Options

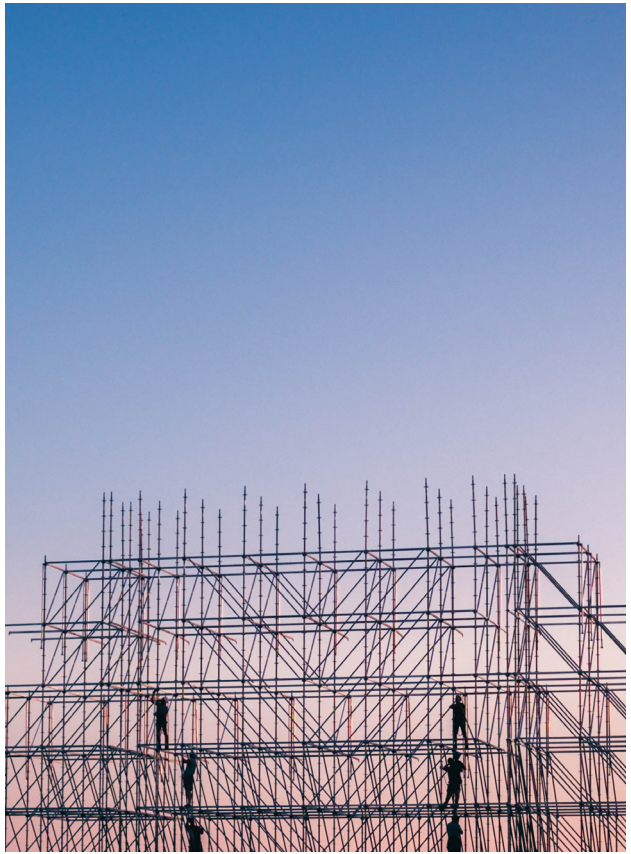
Scale

Advantages

Barriers

Enablers

Recommendation



Advantages

Greater coverage *(e.g. public procurement less than third of UK market)*

Requires consideration from project conception & drives carbon reduction through design

Aligns incentives of project participants & easier to assign responsibility through contracts

Easier to align ambition with specific local/national carbon reduction targets

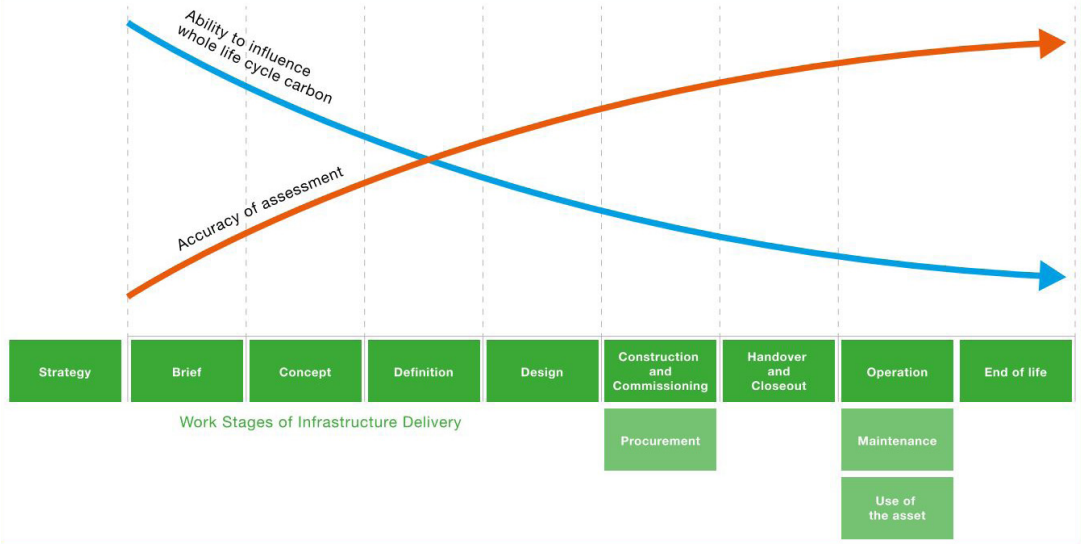


Figure 4 from PAS 2080: 2016 Carbon Management in Infrastructure - ability to influence carbon reduction across the different work stages of delivery

Overview

Introduction

Precedents

Options

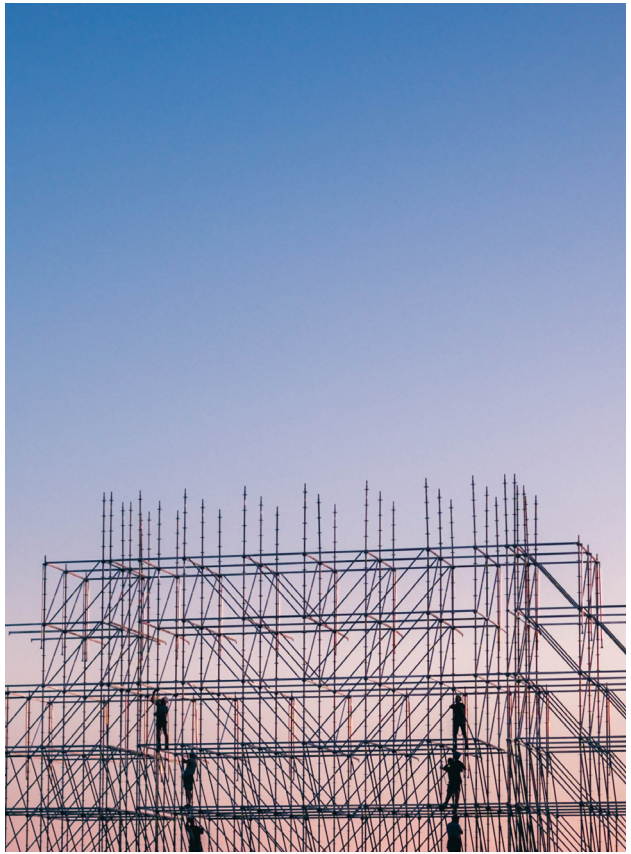
Scale

Advantages

Barriers

Enablers

Recommendation

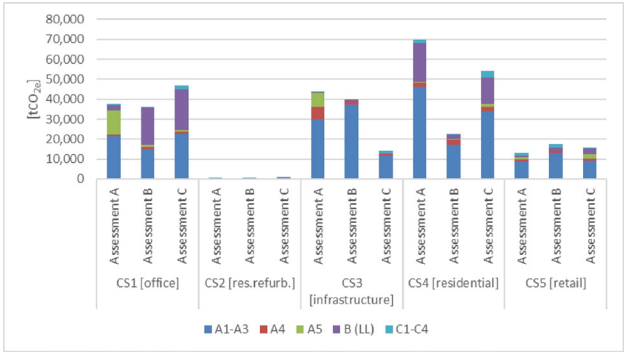


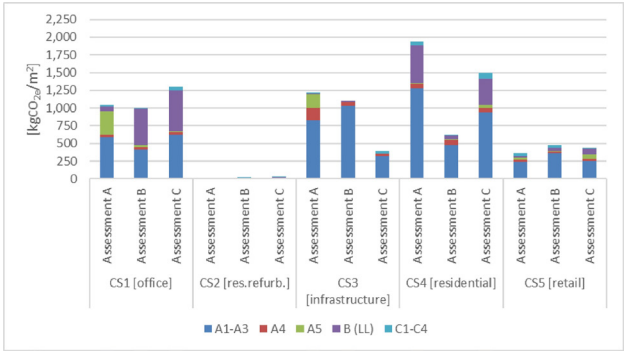
Barriers

National: lack of political awareness & support; political aversion to prescriptive options narrows solution space; lack of cross-departmental collaboration; failure to recognise policy synergies

Local: limited knowledge & resources; lack of legal clarity; start-up costs

Across all scales: availability & quality of data; inconsistencies in interpretation of standards; perceived additional costs





Example of 3 different LCA practitioners ariving at substantially different results for the same set of case studies using same project info, from Pomponi et al. (2019) doi: 10.1016/j.enbuild.2018.02.052

Overview

Introduction

Precedents

Options

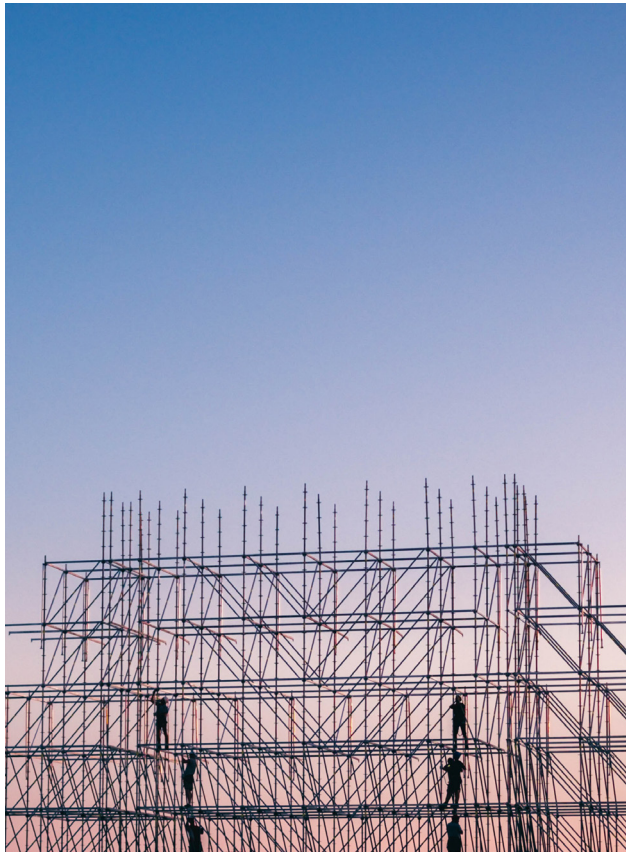
Scale

Advantages

Barriers

Enablers

Recommendation



Enablers

Common resources
(e.g. databases, tools, methodologies, guidance)

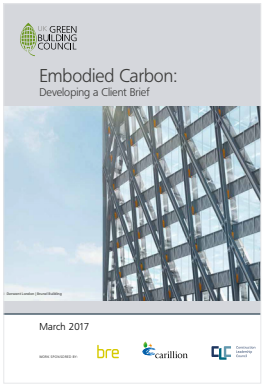
Platforms for collaboration & knowledge-sharing
(e.g. GBC programmes, living labs)

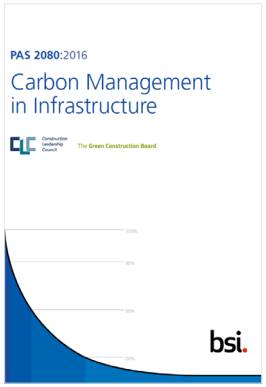
Targeted support for development/testing
(e.g. funding for leading local authorities, HAs)

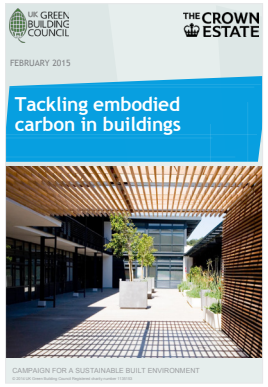
Integration with established reporting
(e.g. company reporting, city carbon budgets)

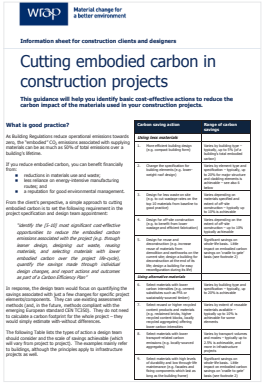
Queue round the block for recent massively oversubscribed UKGBC Net Zero Definition launch

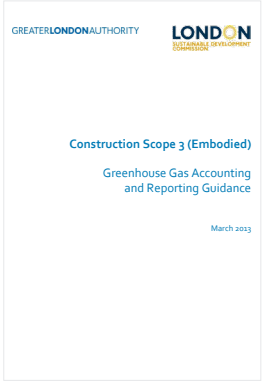
e.g. UK guidance & standards

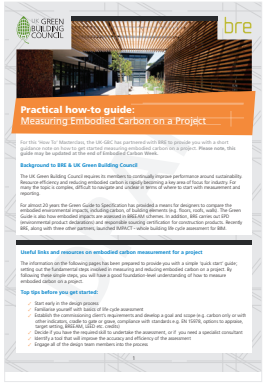


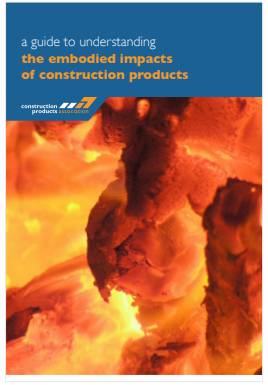












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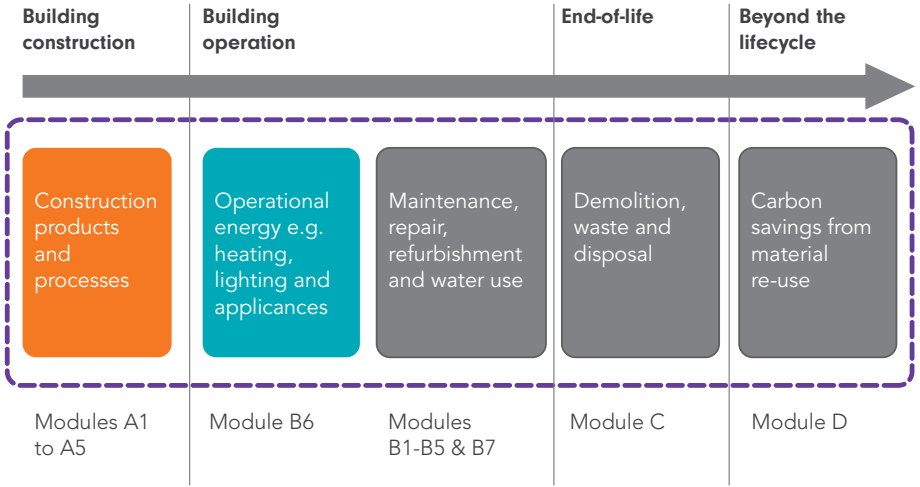
RIBA (2018); RICS (2017); UKGBC (2015,2016,2017); GCB & CLC (2016); WRAP (2014); GLA(2013); CPA (2012)

UKGBC Net Zero Framework

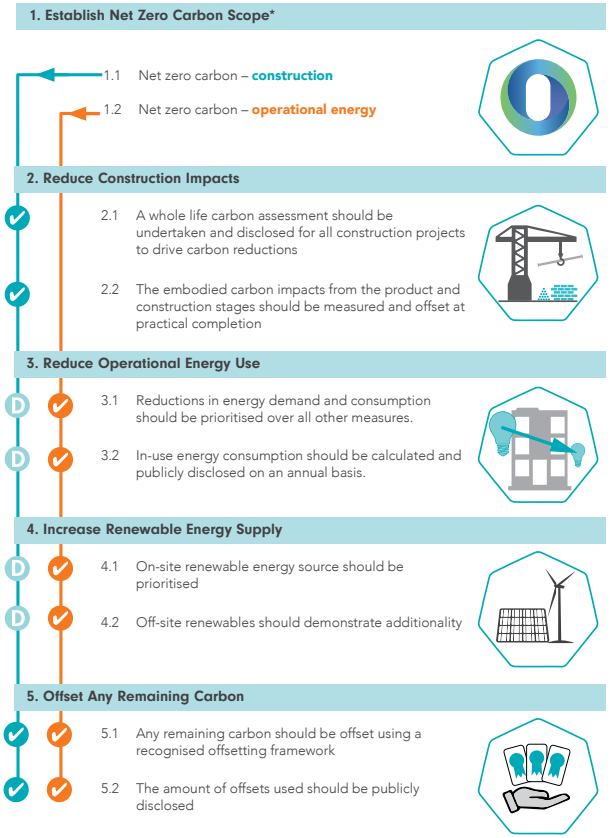


All Modules referred to are from EN15978 Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method

Net Zero Carbon – Construction (1.1)

Net Zero Carbon – Operational Energy (1.2)

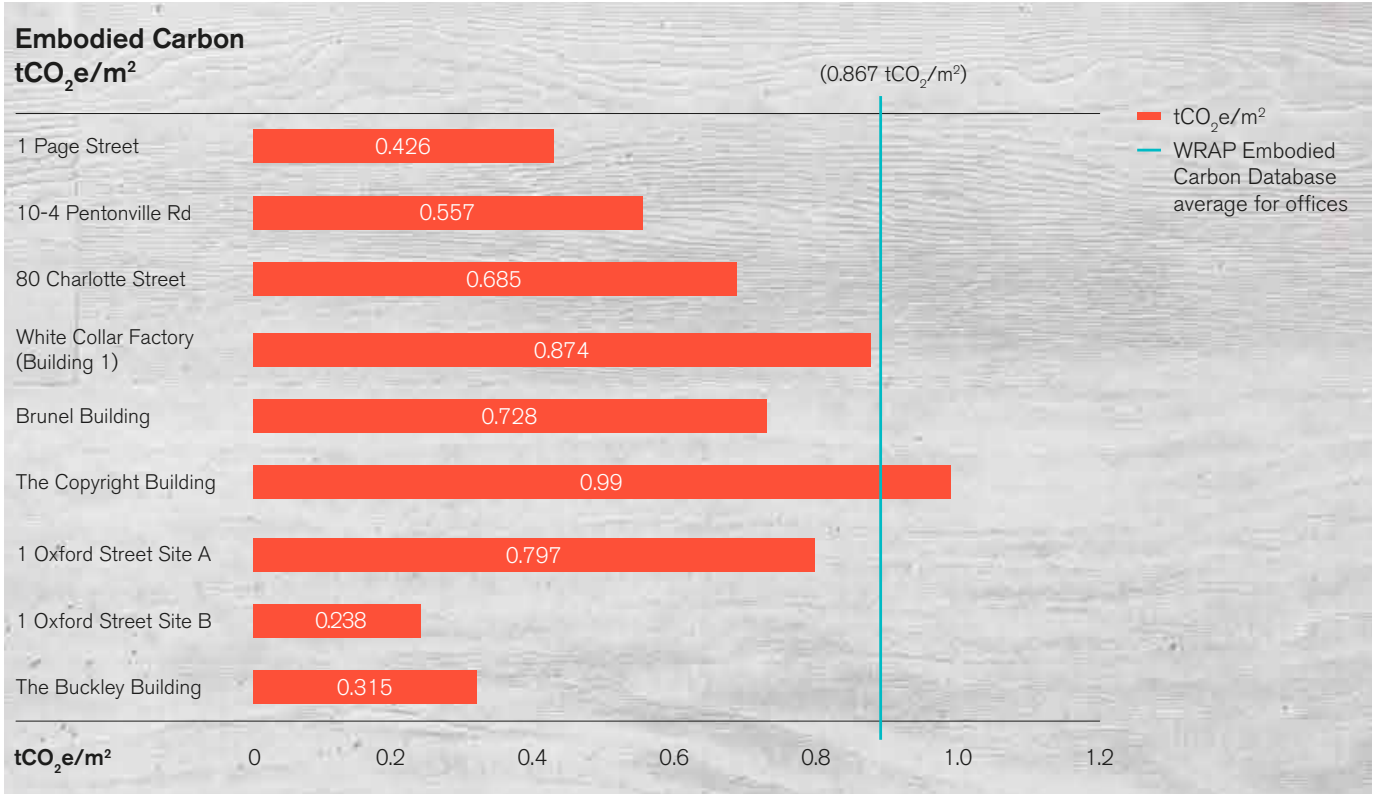
Net Zero Carbon – Whole Life (future development) (1.3)



D New buildings and major refurbishments targeting net zero carbon for construction should be designed to achieve net zero carbon for operational energy by considering these principles.

* Please also note, a further scope for net zero whole life carbon (1.3) will be developed in the future.

Developers voluntarily benchmarking embodied carbon



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See Derwent London resources at:
www.derwentlondon.com/sustainability/performance/carbon-footprint

Requirements included in development briefs

Such as:

Assessment boundaries & metrics
e.g. Cradle-to-completion, tCO_2e

Reporting requirements
e.g. use of RICS 2017 PS

Preferred design options
e.g. rapidly renewable materials like timber

Emission intensity targets
e.g. 900 $kgCO_2/m^2$

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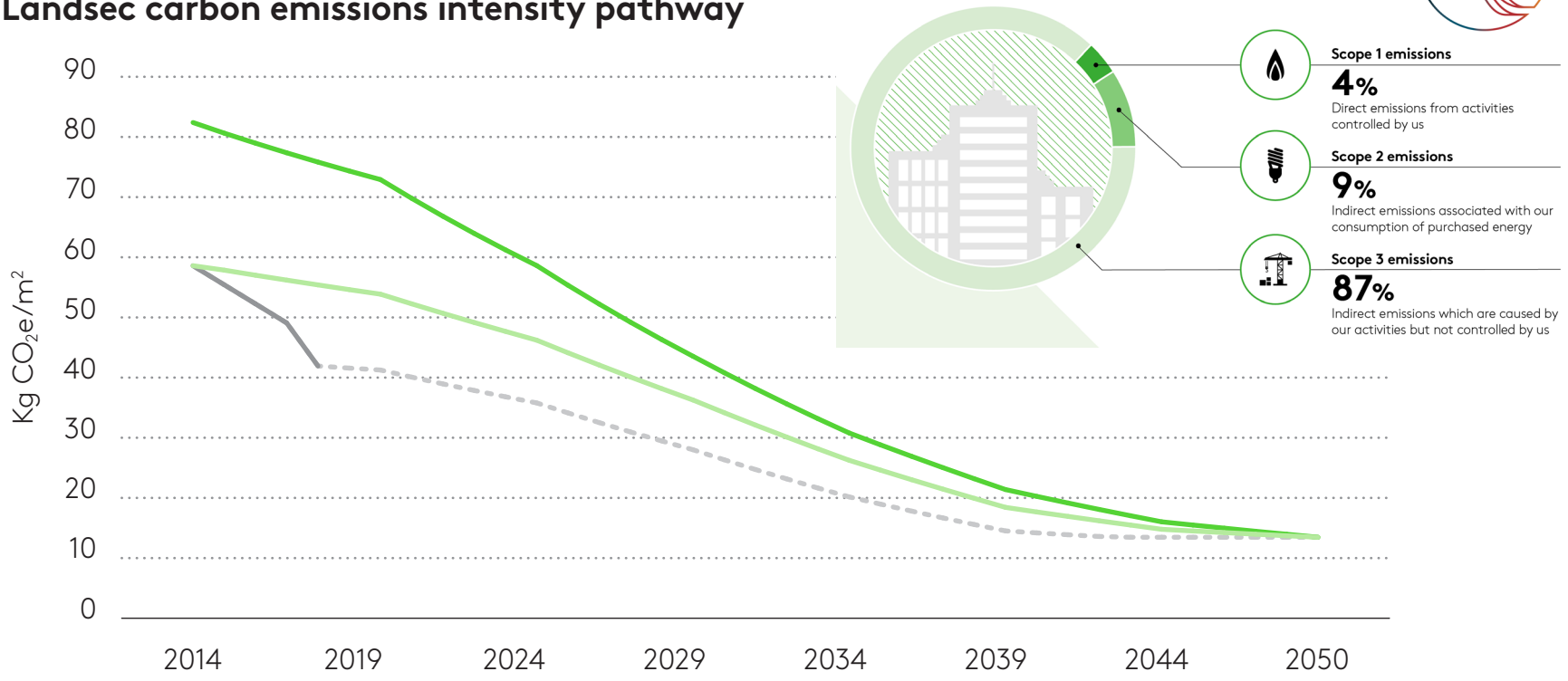
landsec.com/sites/default/files/2018-02/SGP_Landsec_Sustainability_Brief.pdf &
www.derwentlondon.com/sustainability/performance/carbon-footprint

Reducing carbon in line with Science Based Targets

Landsec carbon emissions intensity pathway



Scope 1 emissions

4%

Direct emissions from activities controlled by us

Scope 2 emissions

9%

Indirect emissions associated with our consumption of purchased energy

Scope 3 emissions

87%

Indirect emissions which are caused by our activities but not controlled by us

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See Landsec performance at: landsec.com/sustainability

Project carbon targets

Client set ambitious targets which drove exploration of novel material options
e.g. development of thatch cassette cladding

Ultimately delivered embodied carbon of 193 $kgCO_2/m^2$ compared with benchmark of 845$kgCO_2/m^2$

Overview

Introduction

Precedents

Options

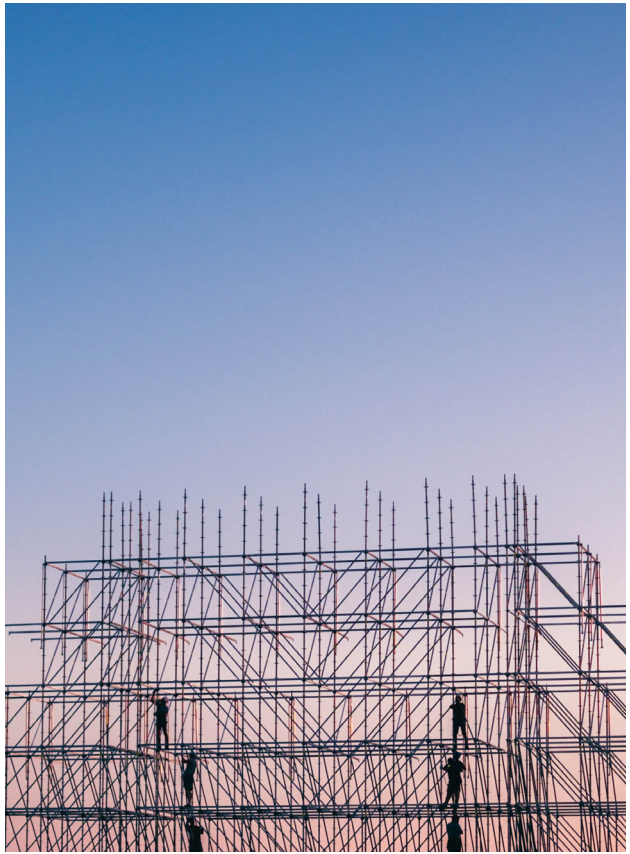
Scale

Advantages

Barriers

Enablers

Recommendation



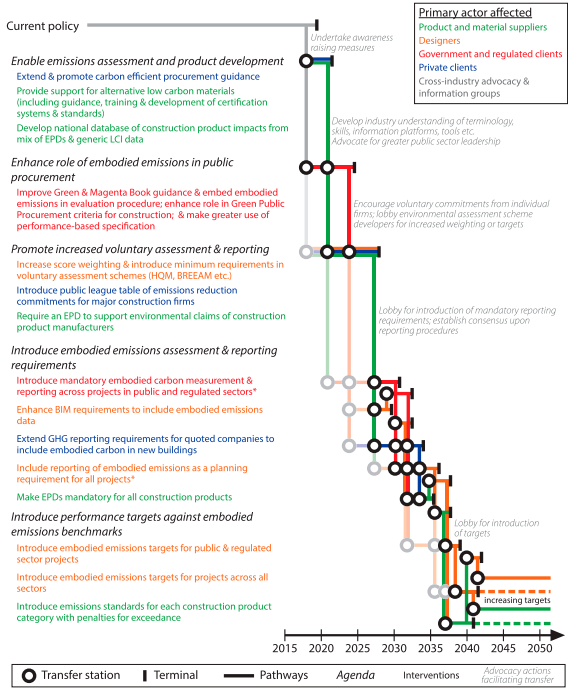
Recommendation

Priority should be developing enablers

Then introduction of mandatory reporting for largest schemes

Followed by caps to remove highest carbon options

Followed by ratcheting of ambition



* All data to be uploaded to common repository to facilitate benchmarking (likely facilitated by organisation such as RICS)

Note: numerous other measures were considered such as the development of a material re-use database & platform; the introduction of material passports; requirements to design for deconstruction; requirements to design for adaptability; and the mandatory labelling of re-usable construction products but these options have been omitted from this figure. Although such measures may deliver emissions savings over multiple product uses, these savings will be delivered over a timeframe that extends beyond this analysis.

Figure 2. Initial pathways map for embodied emissions reduction in the UK construction sector.

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Example of dynamic adaptive policy pathways for UK construction sector from Roelich & Giesekam (2018) doi: 10.1080/14693062.2018.1479238

CENTRE FOR RESEARCH INTO
ENERGY DEMAND SOLUTIONS

Thank you

Please get in touch with any queries

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slides available from **www.jannikgiesekam.co.uk**