CIE-MAP

Centre for Industrial Energy, Materials and Products

Research Councils UK Energy For a Low Carbon Future

# The material demand of buildings:

## Insights from the UK & challenges for a global model


Dr Jannik Giesekam

J.Giesekam@leeds.ac.uk @jannikgiesekam

Research Fellow in Energy, Materials and Climate Policy

University of Leeds

# My background

## Embodied/whole life carbon reduction in UK 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
- Developing guidance for practitioners
- Practitioner and public perceptions of low carbon building materials

# Presentation outline

## A few slides on each

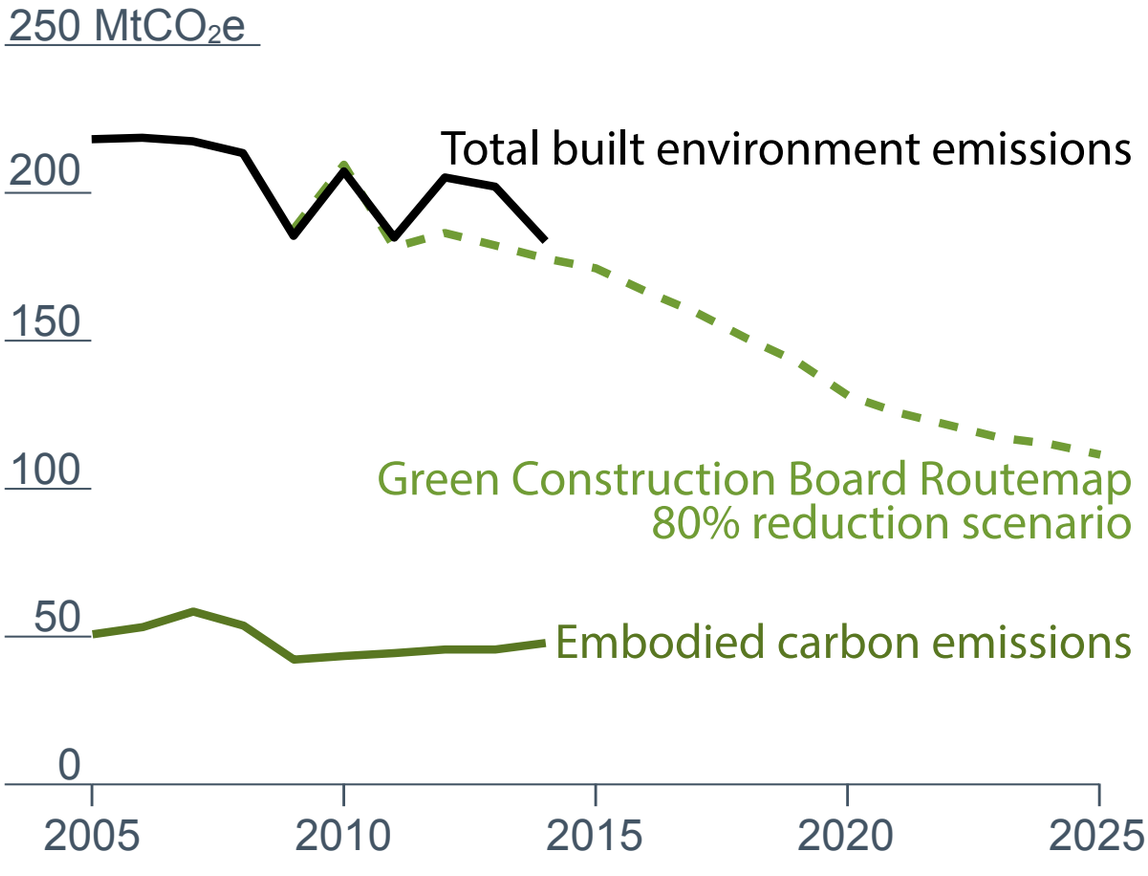
Part 1: The UK experience of reducing material use & embodied carbon emissions

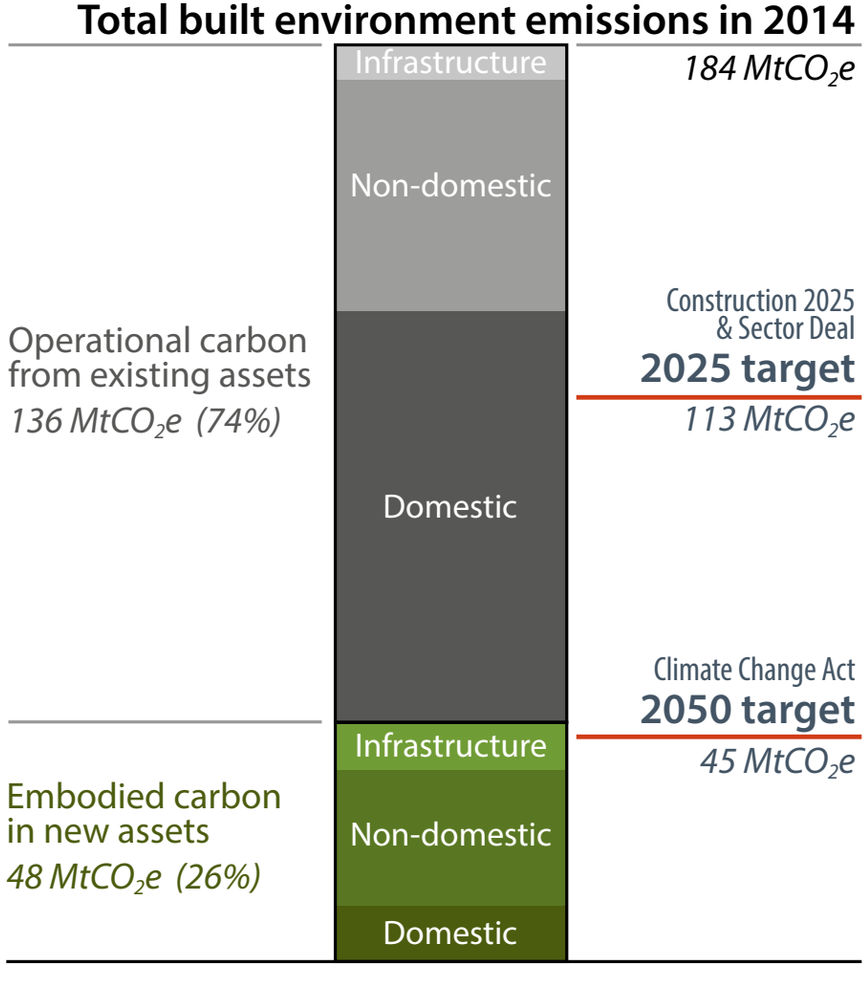
Part 2: 5 key challenges for this project & some suggestions

# UK progress on carbon reduction

## Progress updates from December 2015 & September 2017

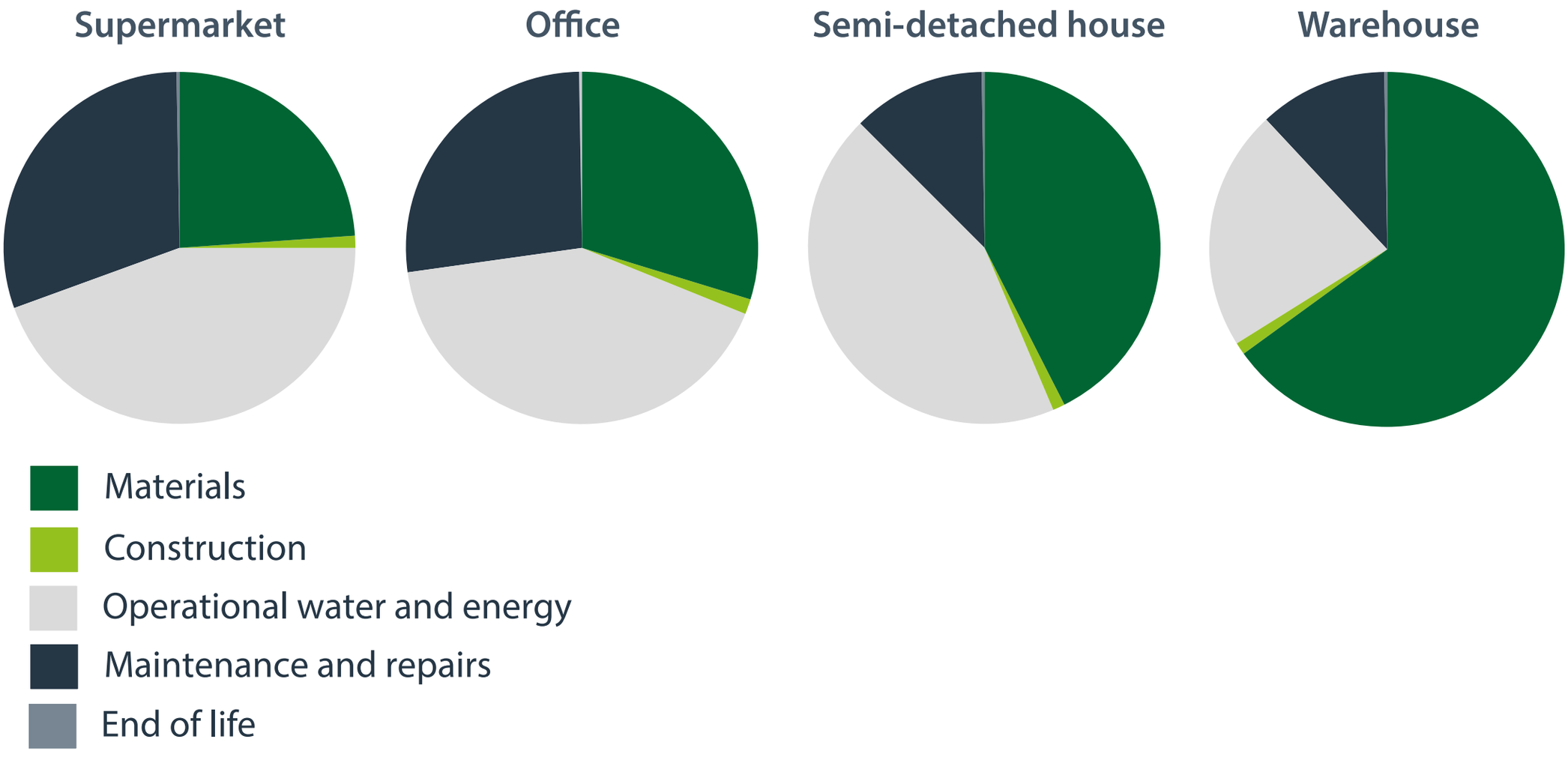
» The UK is behind on its carbon reduction targets for the built environment partly because of a failure to address embodied emissions in materials



# CapCarb as a share of whole life emissions

## Is already greater than OpCarb on many UK building projects




Adapted from UKGBC (2017) Embodied carbon: developing a client brief - based on project life cycle assessments from 2014

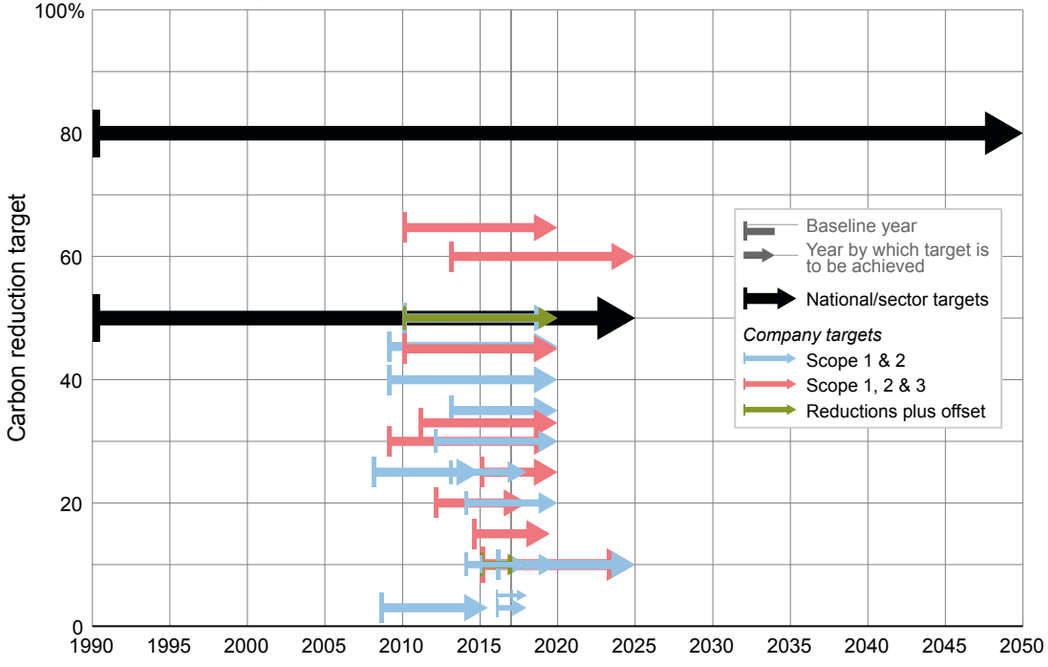
# UK construction industry carbon targets

## Are currently insufficient but due for change

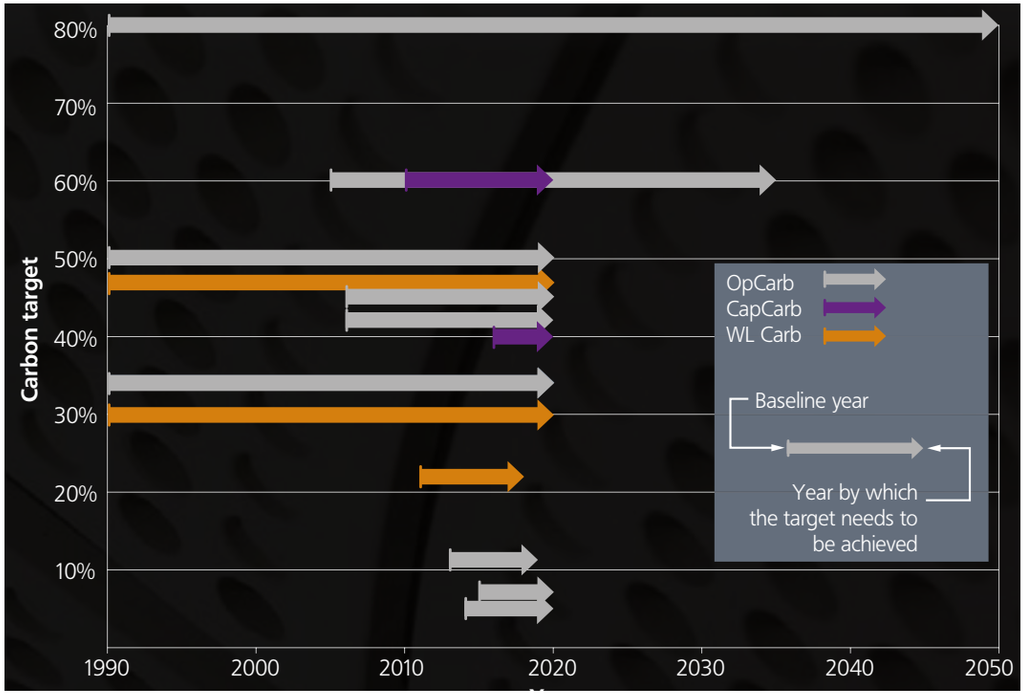
» Mostly short-term targets focussed on operational emissions

» Though there is a growing minority of firms assessing embodied emissions and attempting to make reductions through improved material efficiency, material substitution etc.

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




Carbon reduction targets of selected infrastructure clients



# Example commitments

## To reduce embodied carbon in UK 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


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 are targeting a 70% reduction by 2030 from a 2010 baseline

**Medium-term target**

Reduce capital carbon emissions by 60% by 2020 from a 2010 baseline.
Reduce gross operational carbon emissions by 7% in real terms by 2020 from a 2015 baseline.

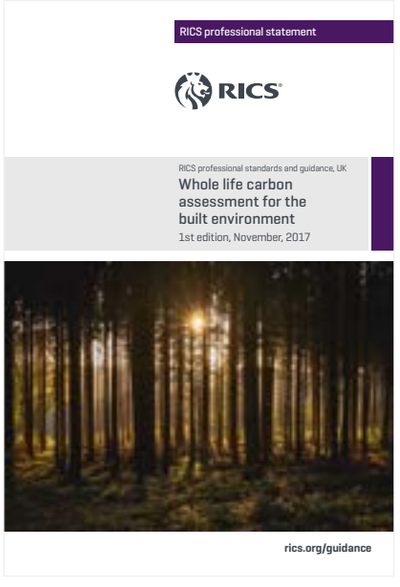
↓55% Delivered by 2017

REDUCTION IN CAPITAL CARBON FROM A 2010 BASELINE

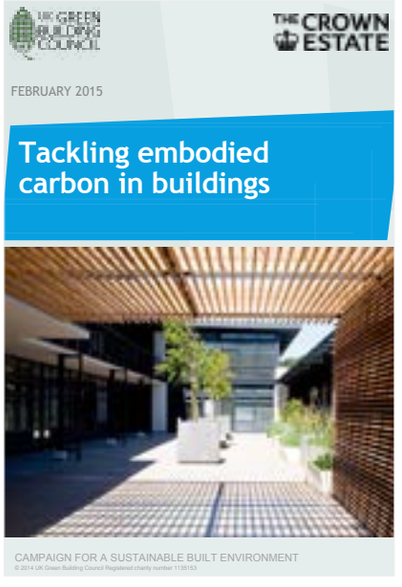
British Land (2015); Land Securities (2016); M&S (2016); Anglian Water (2016)

# UK guidance on embodied carbon

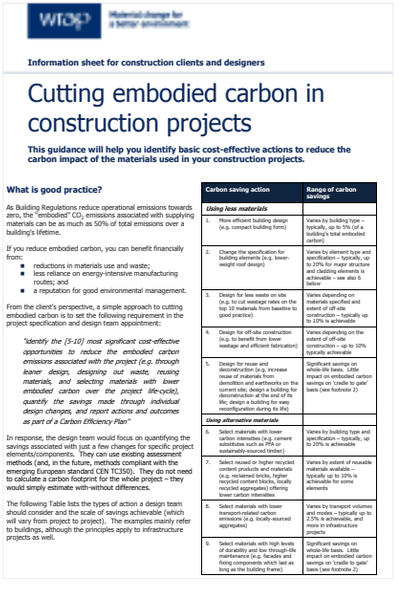
## Array of recent standards and guidance

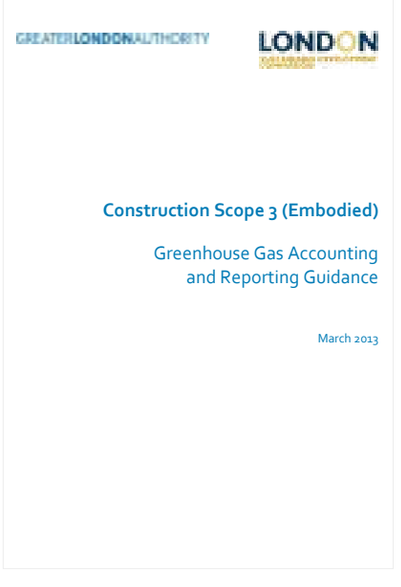





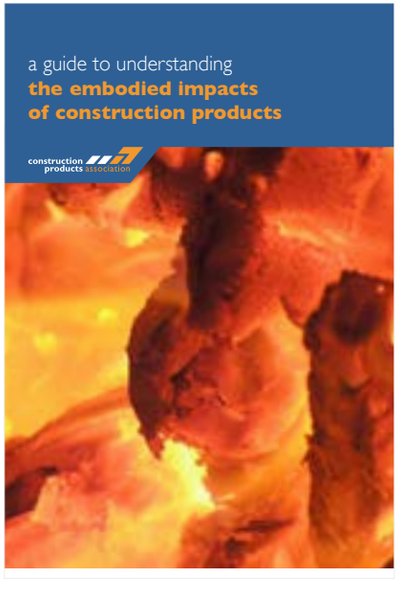












RIBA (2018); RICS (2017); UKGBC (2015, 2016, 2017); GCB & CLC (2016); Battle et al. (2014); WRAP (2014); GLA(2013); CPA (2012)

# Challenges for this project

## Include

1: Representing Africa

2: Securing representative sources of material intensity coefficients

3: Determining maintenance requirements and service lives

4: Modelling the dynamics of changing material use

5: Harnessing new approaches

# *Challenge 1:* Representing Africa

## On the project and in the model

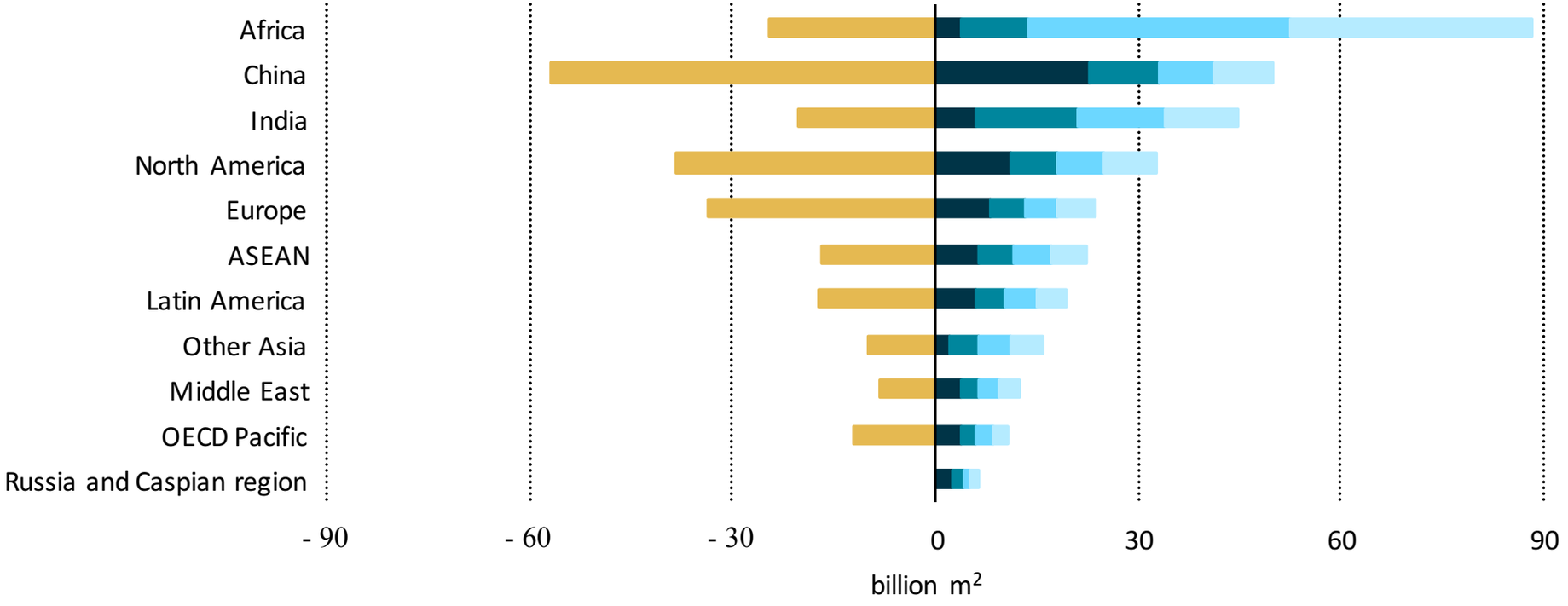
» High share of projected global growth in stock

» Limited range of African studies in literature *(e.g. Johannesburg[1])*

» Extreme inhomogeneity of stock

» Limited scope for transfer of past studies between contexts

Project floor area additions to 2060 by key regions[2]




[1] Göswein et al. (2017) Embodied GHGs in a Fast Growing City *doi:10.1111/jiec.12700*

[2] UN Environment & IEA (2017) Towards a zero-emission, efficient and resilient buildings and construction sector. Global status report

# 2: Material intensity coefficients

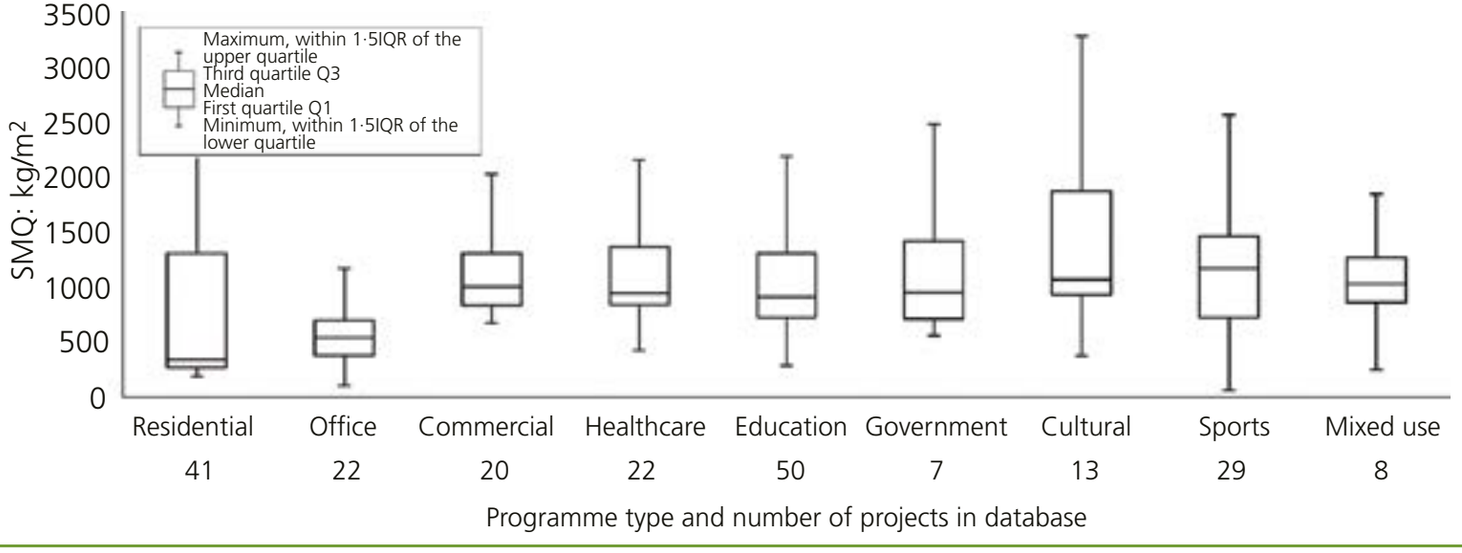
## Improving on current practice

» Which data from current literature, models & databases provides the best starting point and who should synthesise it?

» Can the modelling community move from depending upon case studies and donated company data to regularly updated anonymised data (or distributions) from samples of BOQs compiled by third parties? (*e.g. RICS BCIS returns)*

» Is there scope to commission work assessing coefficients for developing countries that are currently poorly represented?

Structural material quantities from DeQo database compiled by De Wolf et al.[1]




[1]De Wolf et al. (2015) Material quantities and embodied carbon dioxide in structures *doi: 10.1680/ensu.15.00033*

# *3:* Maintenance & service lives

## Improving upon current practice

» Maintenance requirements of existing stock will be the key driver in industrialised countries *(e.g. non-metallic mineral use in the EU25[1])*

» Non-residential buildings are crucial yet there are few detailed attempts at stock characterization in the literature *(e.g. study of Rhine-Main area[2])*

» Better data informing central estimates & distributions of service lives is required[3]

» Is there scope to form archetypes based on assembly/component based building inventories[4] that can inform a refurbishment database[5]?

[1] Wiedenhofer et al. (2015) *doi:10.1111/jiec.12216* [2] Schebek et al. (2017) *doi:10.1016/j.resconrec.2016.06.001* [3] Miatto et al. (2017) *doi:10.1016/j.resconrec.2017.01.015* [4] Stephan et al. (2018) *doi:10.1016/j.resconrec.2017.09.022* [5] Ostermeyer et al. (2017) *doi:10.1111/jiec.12616*

# *4:* Capturing the dynamics of change

## Uptake will not be smooth and incremental

» Material preferences and drivers of change are sub-regional and sub-national

» Changes in material palettes occur in parallel with changes in business model

» Change in mature markets requires a break with path dependent development[1] - this will not be incremental change and tipping points may be encountered

*Example: changing materials in the UK housing market*

Some typical UK homes under construction in 2015

Legal & General Homes CLT mega-factory in 2018

[1]Jones et al. (2016) Adoption of unconventional approaches in construction *doi: 10.1016/j.conbuildmat.2016.08.088*

# *5:* Harnessing new approaches

## Incorporating novel data sources and methods

» Correlating light from night time satellite imagery with stock *(e.g. steel[1])*

» Integration of local data on activities (energy use, EPCs etc.) with DEMs and envelope areas in GIS to generate 3D stock models *(e.g. several UK cities[2])*

» Vehicles/drones with mobile sensors used to conduct automated scanning of buildings; results combined with machine learning algorithms to estimate real façade materials quantities etc. *(e.g. Sheffield Urban Flows Observatory)*

**The deluxe approach of the future?**

1. Remote automated assessment of sample areas (from selected cities across regions)
2. Results passed through machine learning algorithms to identify materials
3. Results then attached to LiDAR data in GIS to create 3D stock models
4. Sample city results extrapolated to other locations based upon floor areas obtained from night time satellite imagery

[1] Hsu et al. (2013) *doi:10.1080/01431161.2012.712232*

[2] Evans et al. (2017) 3D Stock *doi:10.1177/0265813516652898*