The University Of Sheffield.

Fionn Stevenson

Carbon illusions: resources and reality

A WORLD TOP 100 UNIVERSITY

SSoA

Who am I ?

- Professor of Sustainable Design at The University of Sheffield
- Architect/academic/consultant for 35 years
- Deputy Chairperson of British Standards Committee BS40101 Building Performance Evaluation
- Founder member and former chairperson of Scottish Ecological Design Association
- Campaign Director for Building Performance Network UK

What this talk will cover

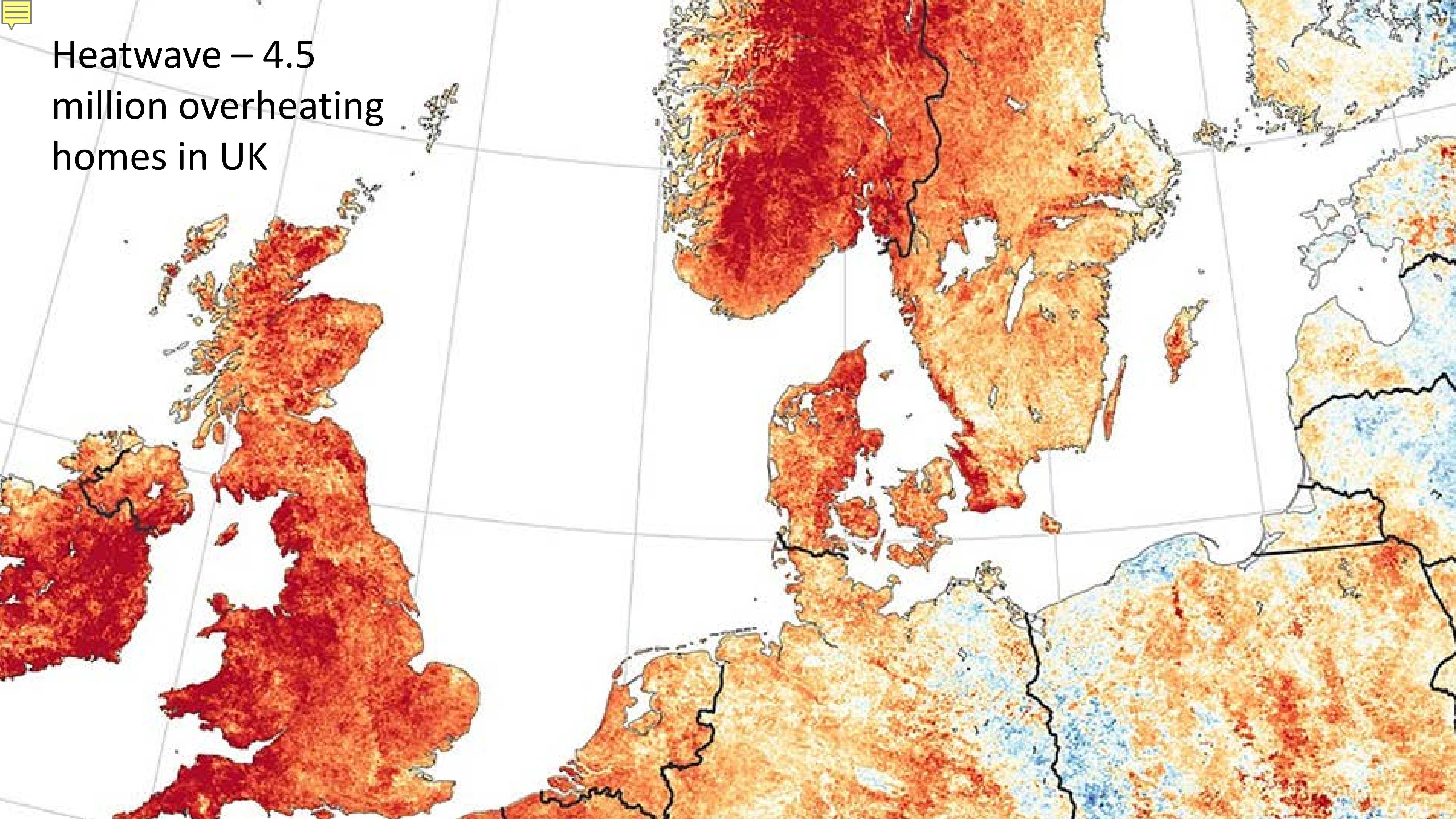
- Climate change and buildings
- ‘Meeting’ standards in construction
- Modelling v reality
- Feedback for improvement
- Resource use contraction
- Education and training

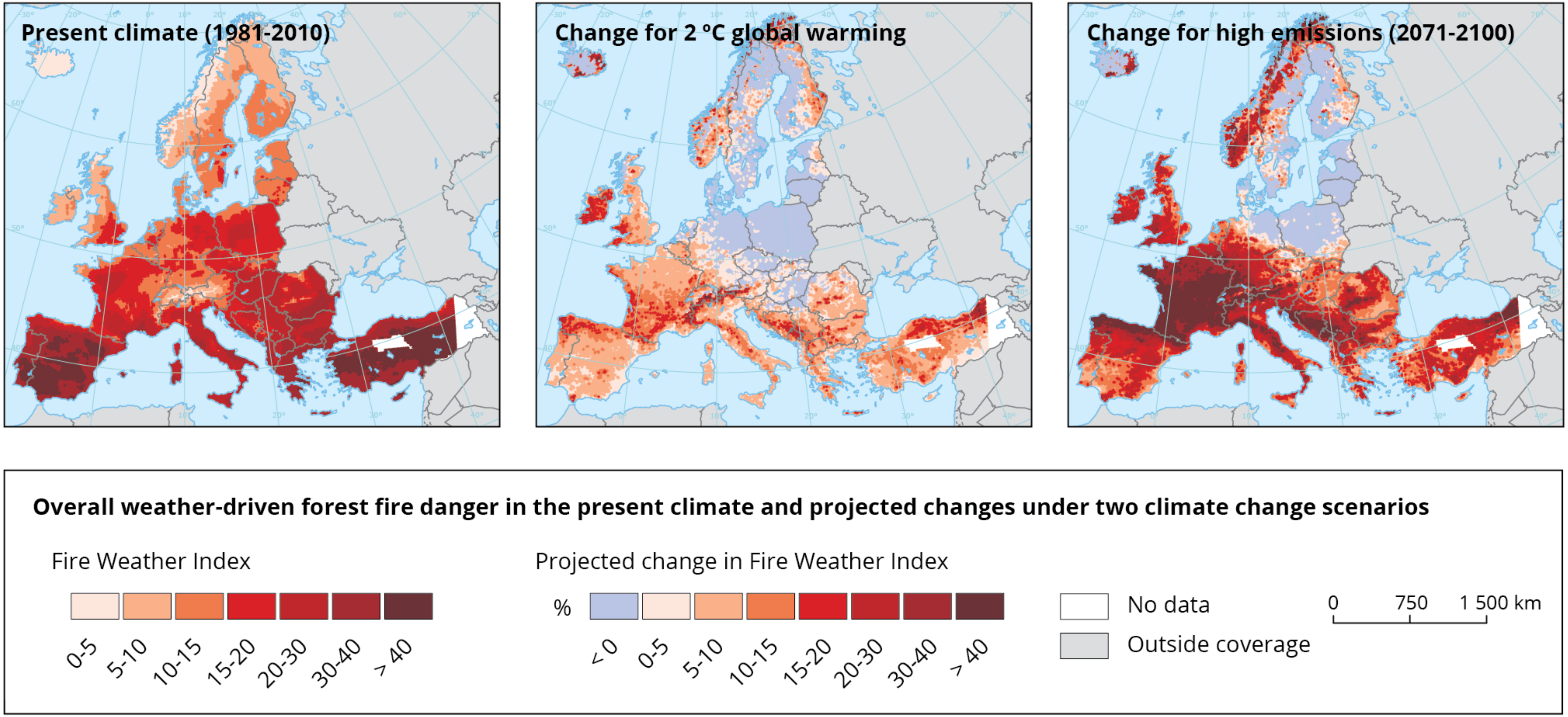
CLIMATE CHANGES EVERYTHING

Around 36% of all EU carbon emissions come from the built environment…


fat face
THE WEBB STREET COMPANY

Heatwave – 4.5 million overheating homes in UK



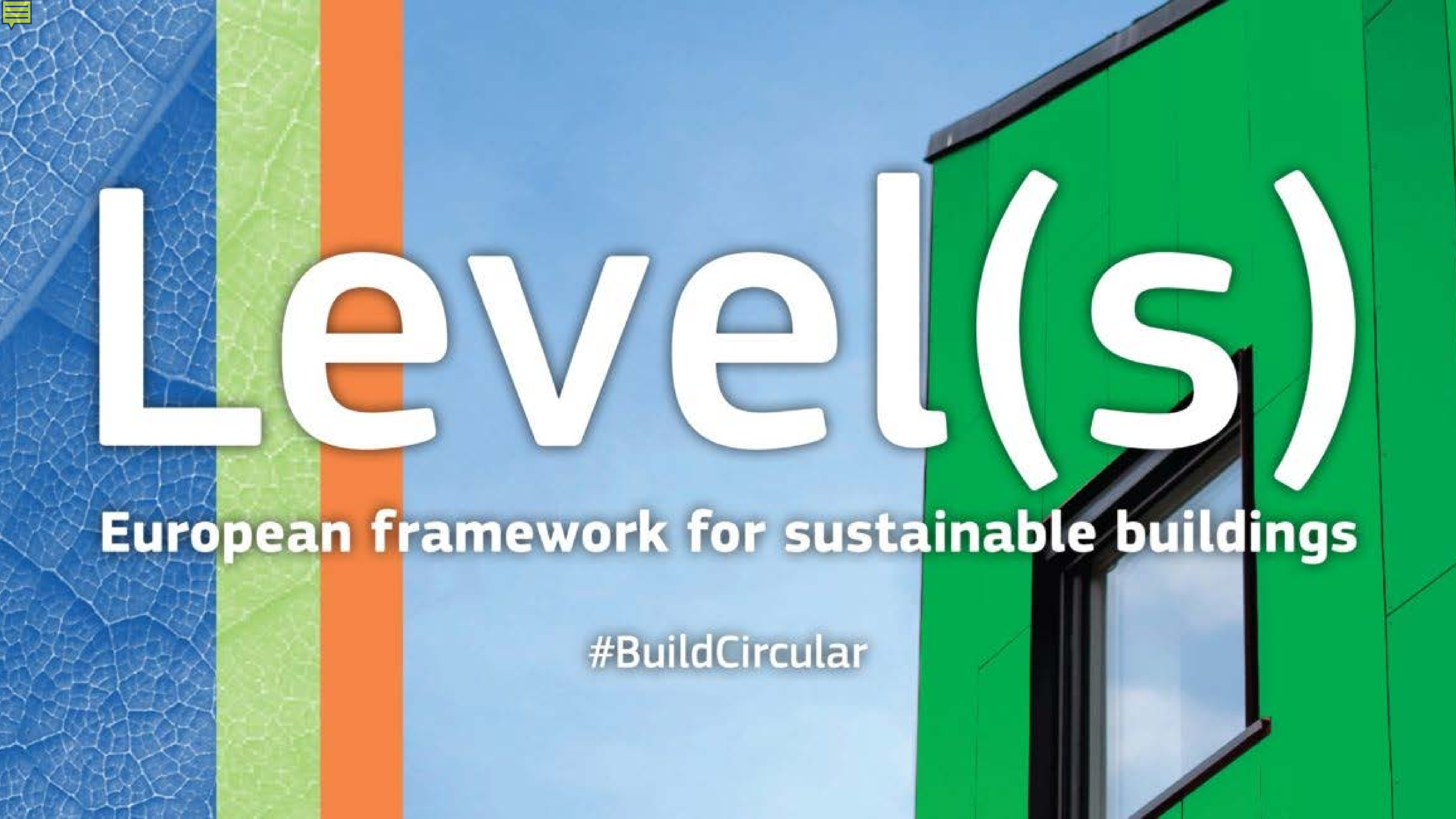

Present climate (1981-2010)
Change for 2 °C global warming
Change for high emissions (2071-2100)
Overall weather-driven forest fire danger in the present climate and projected changes under two climate change scenarios
Fire Weather Index
0-5
5-10
10-15
15-20
20-30
30-40
> 40
Projected change in Fire Weather Index
%
< 0
0-5
5-10
10-15
15-20
20-30
30-40
> 40
No data
Outside coverage
0
750
1 500 km

The impact of climate change on buildings

- Extreme storm, fire and flood damage
- Extreme temperatures and swings
- Overheating internally
- Extreme snowfall
- Increase in mould inside
- Increased fabric destruction over time




CARBON STANDARDS FOR BUILDINGS


Level(s)
European framework for sustainable buildings
#BuildCircular

What does ‘Level(s)’ do?

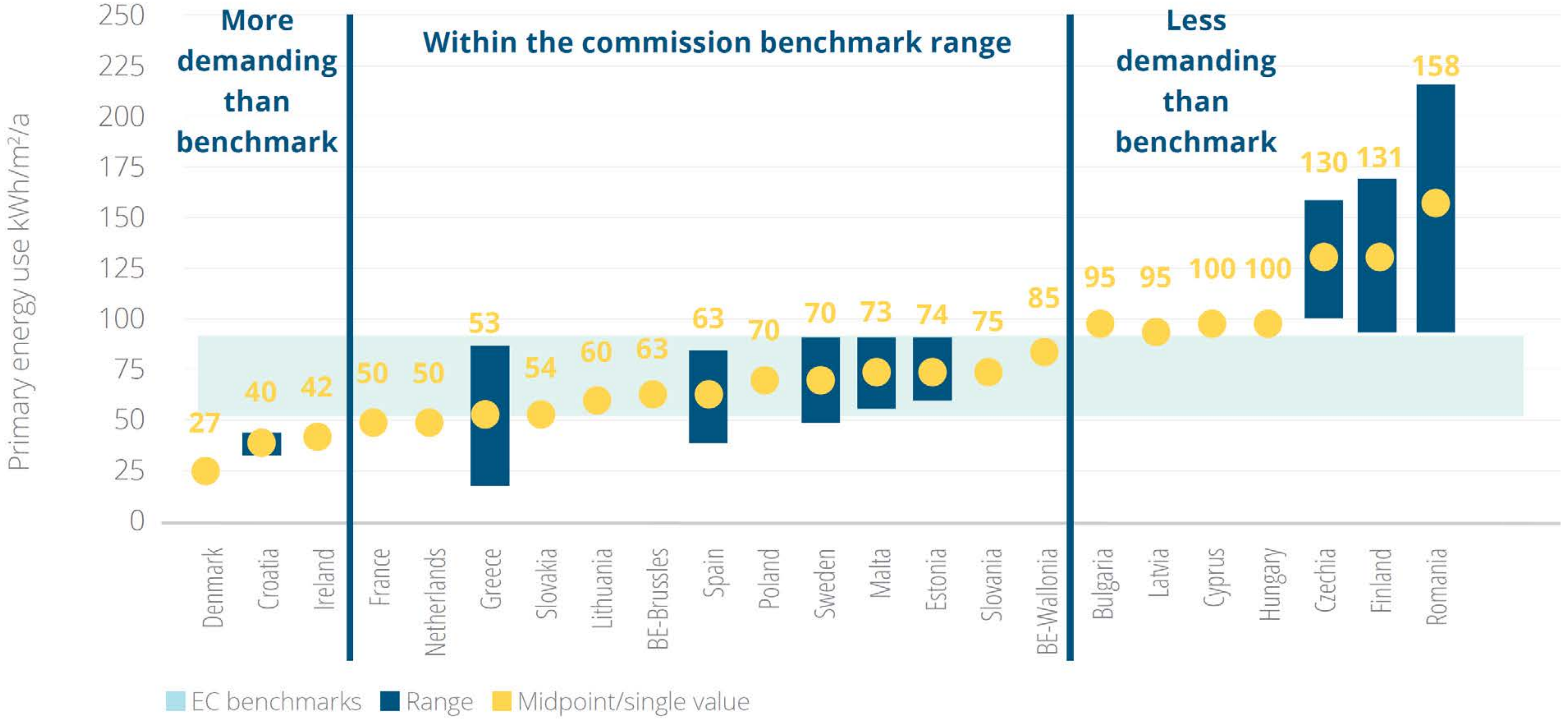
- Level(s) is a European framework to assess and monitor the sustainability performance of buildings
- Launched in 2020
- Aims to harmonise national certification schemes and standards
- Carbon, materials, water, health, comfort and climate change impacts

Where are we at with national standards?

- Since January 2021, all new buildings in EU must be nearly zero-energy buildings (EU Energy Performance of Buildings Directive)
- Wide range of national building standards in EU
- Few are fully conforming to EU Directive

https://www.bpie.eu/wp-content/uploads/2021/06/Nearly-zero_EU-Member-State-Review-062021_Final.pdf.pdf

EU variation in energy use per home



Country/Region	Was nZEB legislation in place for public buildings by January 2019?	Was nZEB legislation in place for all buildings by January 2021?	Is there a numerical indicator of primary energy use expressed in kWh/m^2 per year?	Are renewable energy requirements clearly specified?
Austria	✓	✓	✗	✓
BE - Brussels	✓	✓	✓	✗
BE - Flanders	✓	✓	✗	✓
BE - Wallonia	✓	✓	✓	✗
Bulgaria	✗	✗	✓	✓
Croatia	✓	✓	✓	✓
Cyprus	✓	✓	✓	✗
Czechia	✓	✓	✓	✗
Denmark	✓	✓	✓	✓
Estonia	✓	✓	✓	✗
Finland	✓	✓	✓	✗

New approach to regulation needed

Carbon metrics – internationally defined

Delivery – harmonise zero carbon instruments

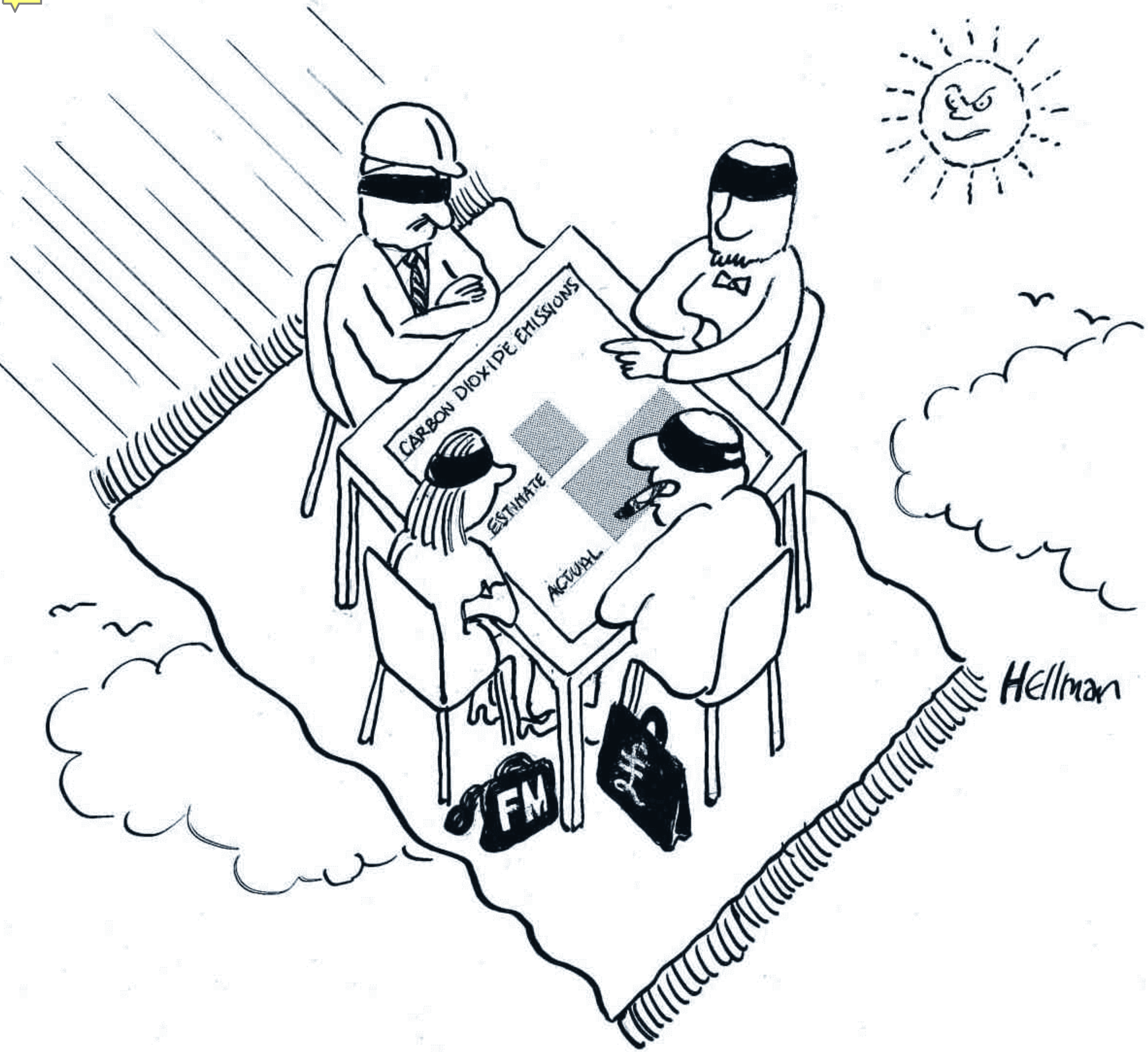
Whole life emissions – transparent and absolute reporting

Performance guarantees - mandatory

Retrofit – mandatory with fiscal incentives

Enforcement – random, independent inspections

THE ILLUSION OF MEETING STANDARDS



The game…

- Model the performance
- Make cuts to the design
- Build the building
- Don’t measure reality

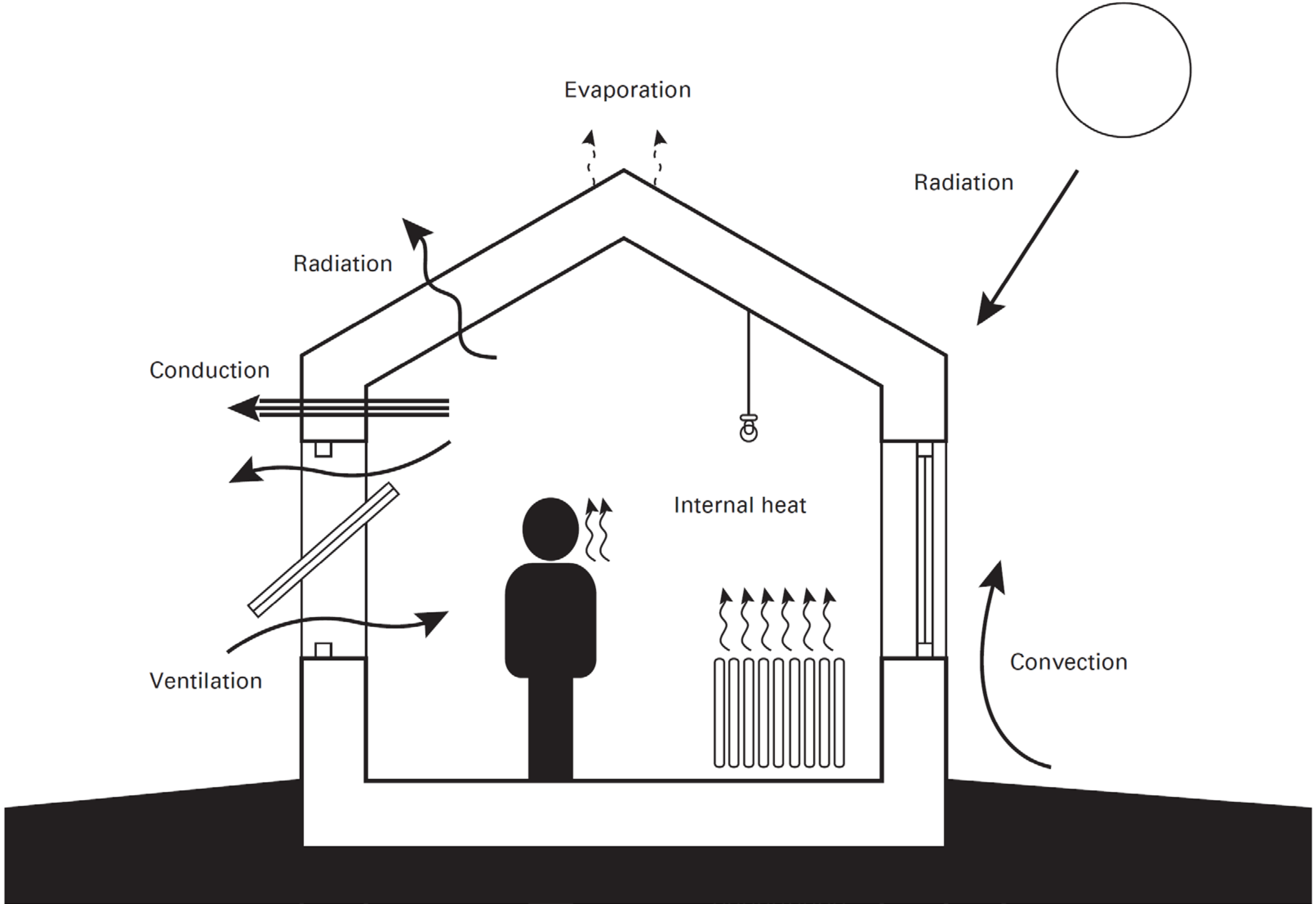
Why are EU building standards not met?

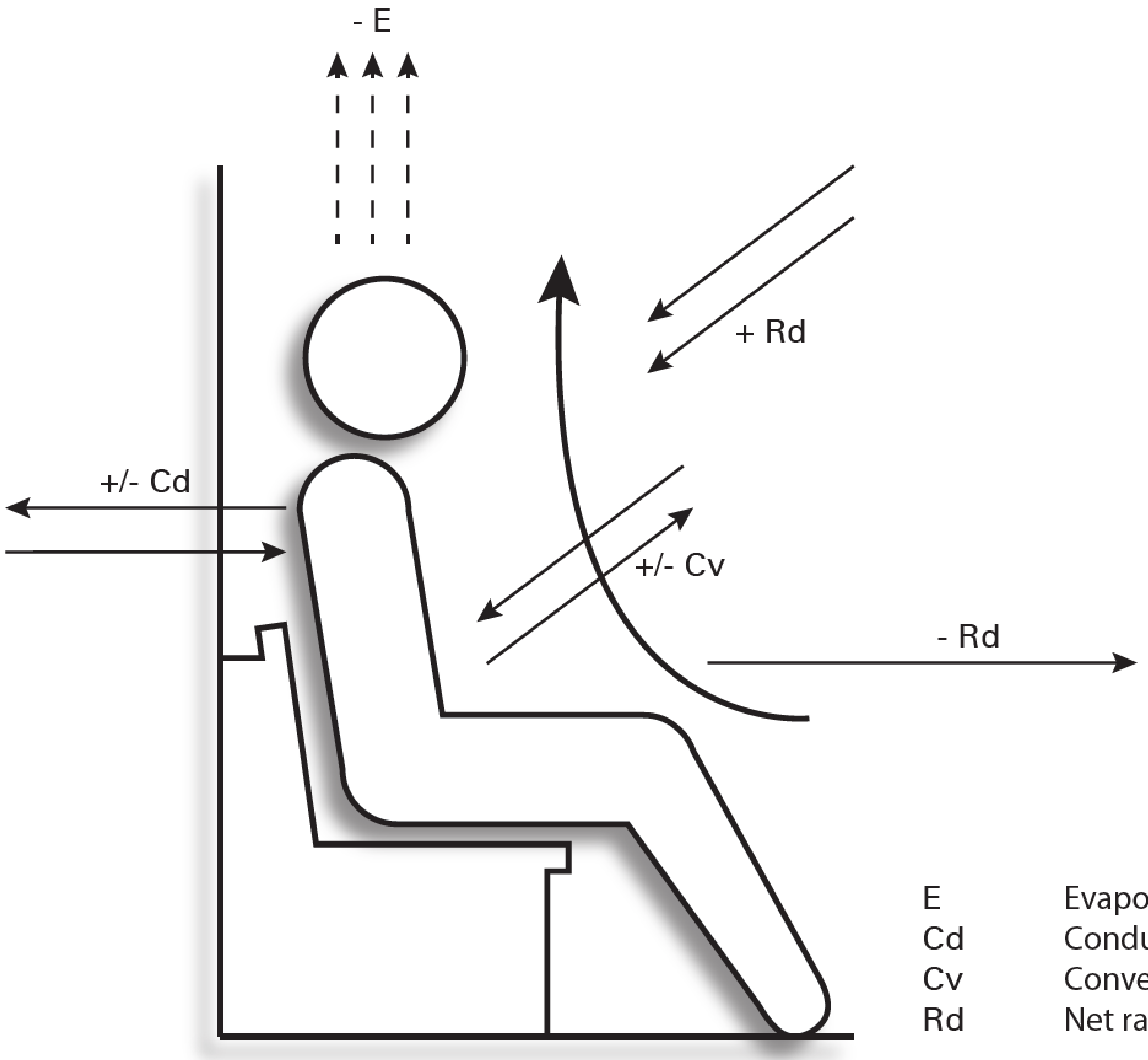
- No regulatory requirement to prove the performance of a building in use
- Extensive political lobbying against changes in standards to do this

RESULT?

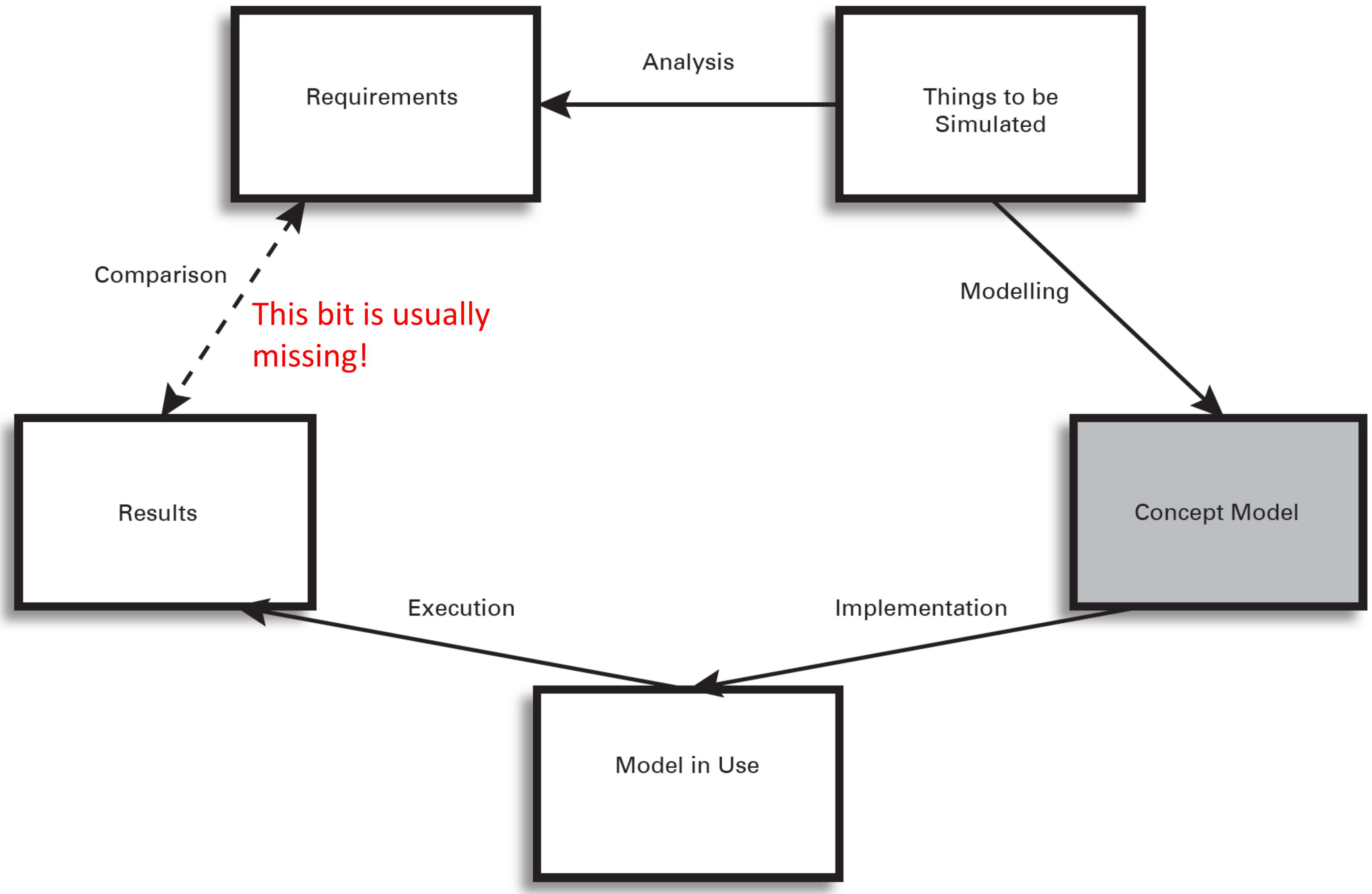
- In the UK, new buildings routinely use x2 or x3 energy predicted
- Other countries may be better or worse – but the problem is there.

MODELLING IN THEORY / PERFORMANCE IN REALITY


Evaporation
Radiation
Radiation
Conduction
Internal heat
Ventilation
Convection



E	Evaporation
Cd	Conduction
Cv	Convention (including respiration)
Rd	Net radiation exchange


Requirements
Analysis
Things to be Simulated
Comparison
This bit is usually missing!
Modelling
Results
Concept Model
Execution
Implementation
Model in Use

The dream design and simulation

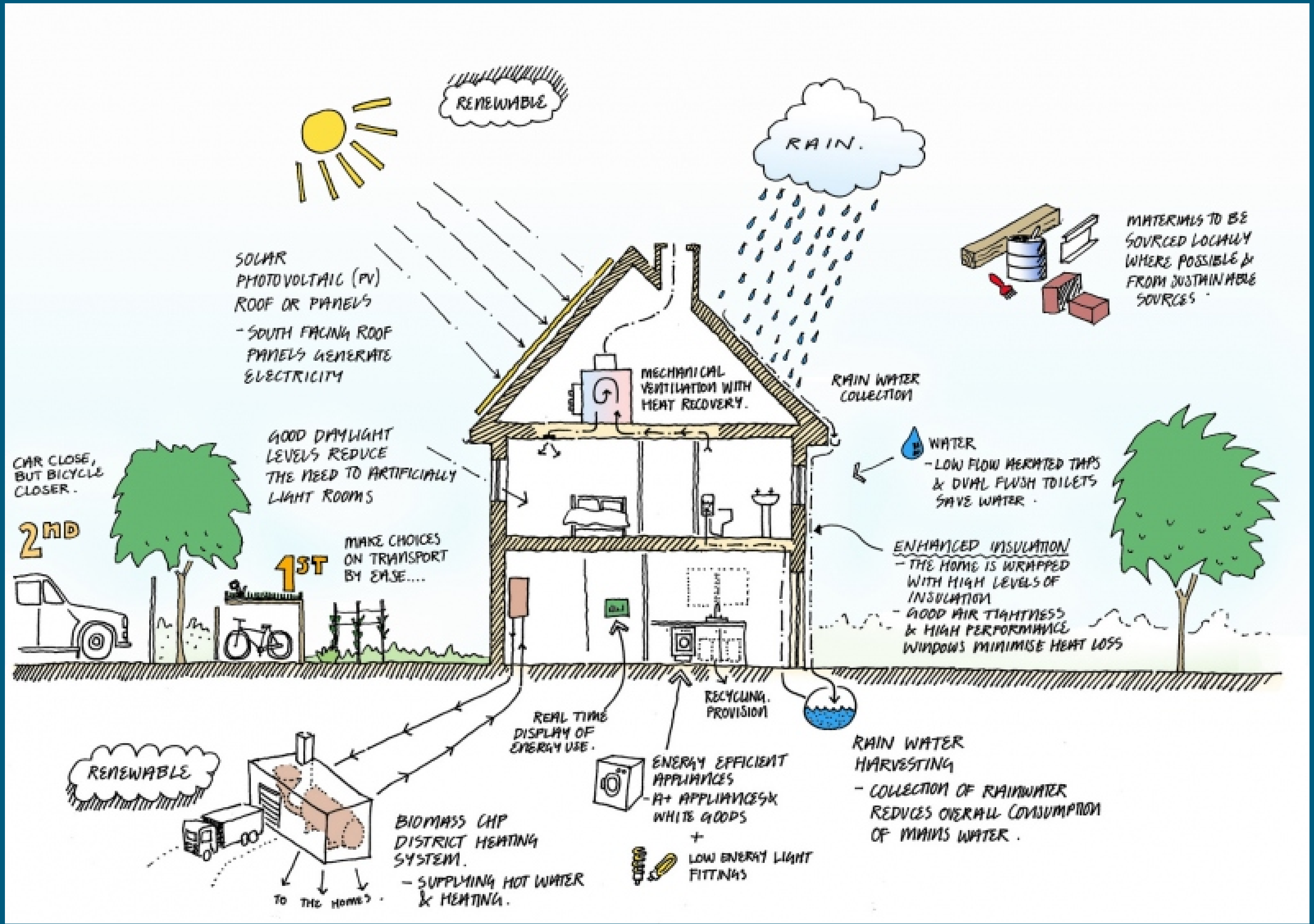
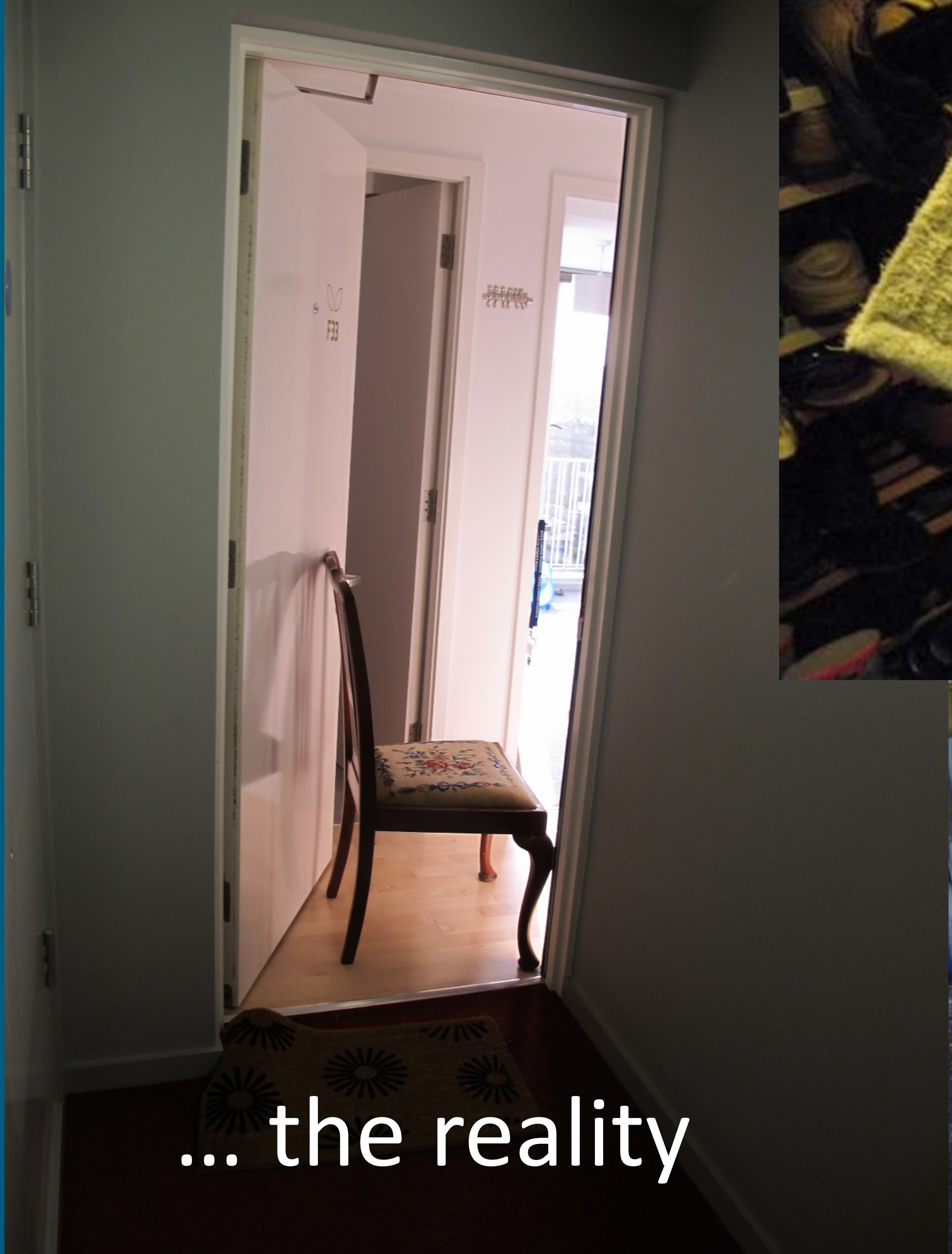


Image: Farrell's Architects



… the reality

Our homes are under-performing – why?

FEEDBACK FOR IMPROVEMENT

Key questions for evaluating buildings in use

1. Is the building physically performing as expected?

2. Are the inhabitants happy in it?

3. Are there any problems that need solving just now?

4. How can we improve our buildings for the future?

Key parameters for building performance

1. Design intentions compared to reality – any specification/construction changes? why?

2. 'Hard' data – physical comfort factors, pollution levels, fabric performance, energy use, water use.

3. 'Soft' data – perceived human needs and capacities, comfort, control, learning, satisfaction.

4. Compare all data to revise design of future buildings- and future-proofing for climate change.

…these need building in from the feasibility stage –not an after thought

‘Light touch’ building performance evaluation

1. Document review - key design, construction and specification documents related to the project intentions

2. Basic energy and water use audit – measure in kWh/m_2/pa and litres/home/pa

3. Thermographic survey –inside and out

4. Simple survey of the occupants – use questionnaire

5. Short tour - with design team, contractor and inhabitants

6. Spot-check - environmental conditions – heat, light, sound, humidity

Thermographic survey…

…in-use evaluation is crucial to validate design and simulations !

Light touch–mobile spot testing equipment

Drill down, don't bean-count...

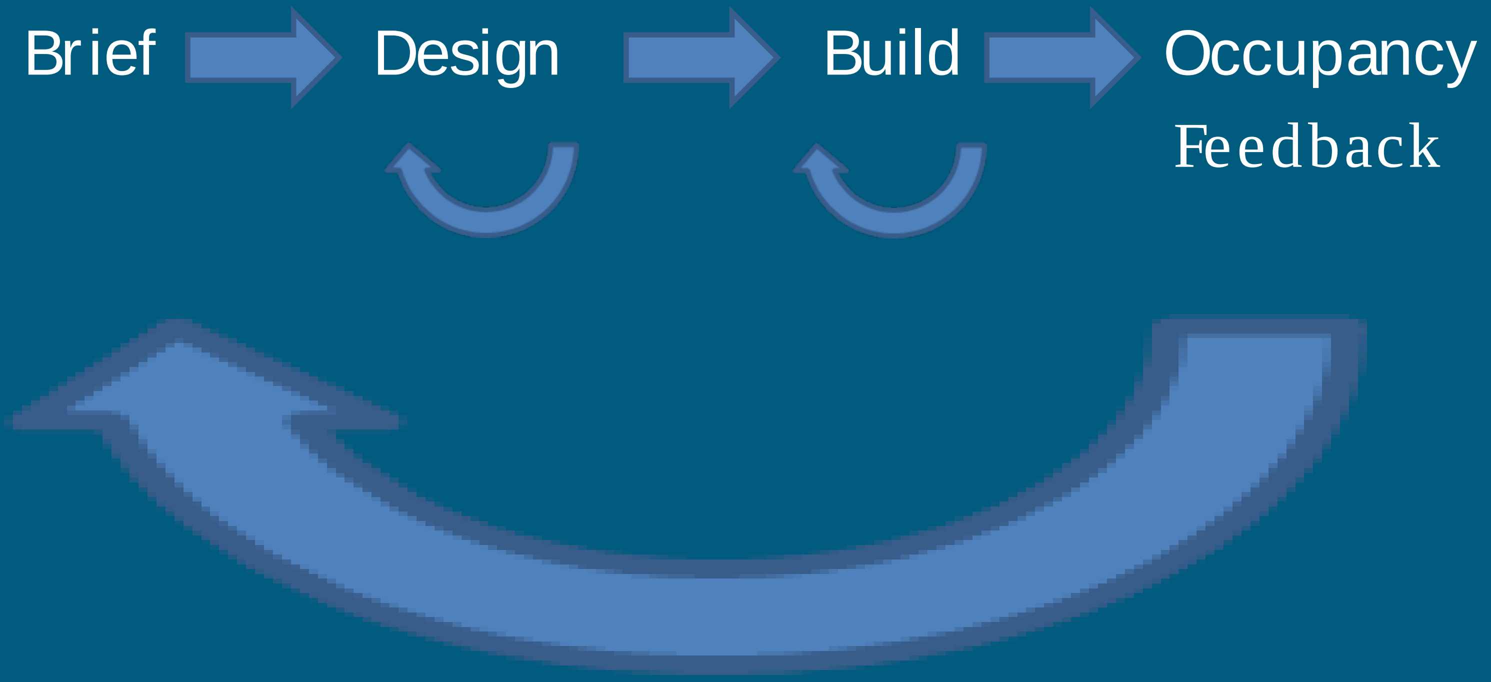
1. Light touch BPE first – cheap, quick and effective. If the building is performing as expected – STOP HERE!

2. Diagnostic BPE next – more intensive POE methods

3. Investigative BPE –for the most stubborn and emergent problems, or for epidemiological data – very intensive, lots of equipment!

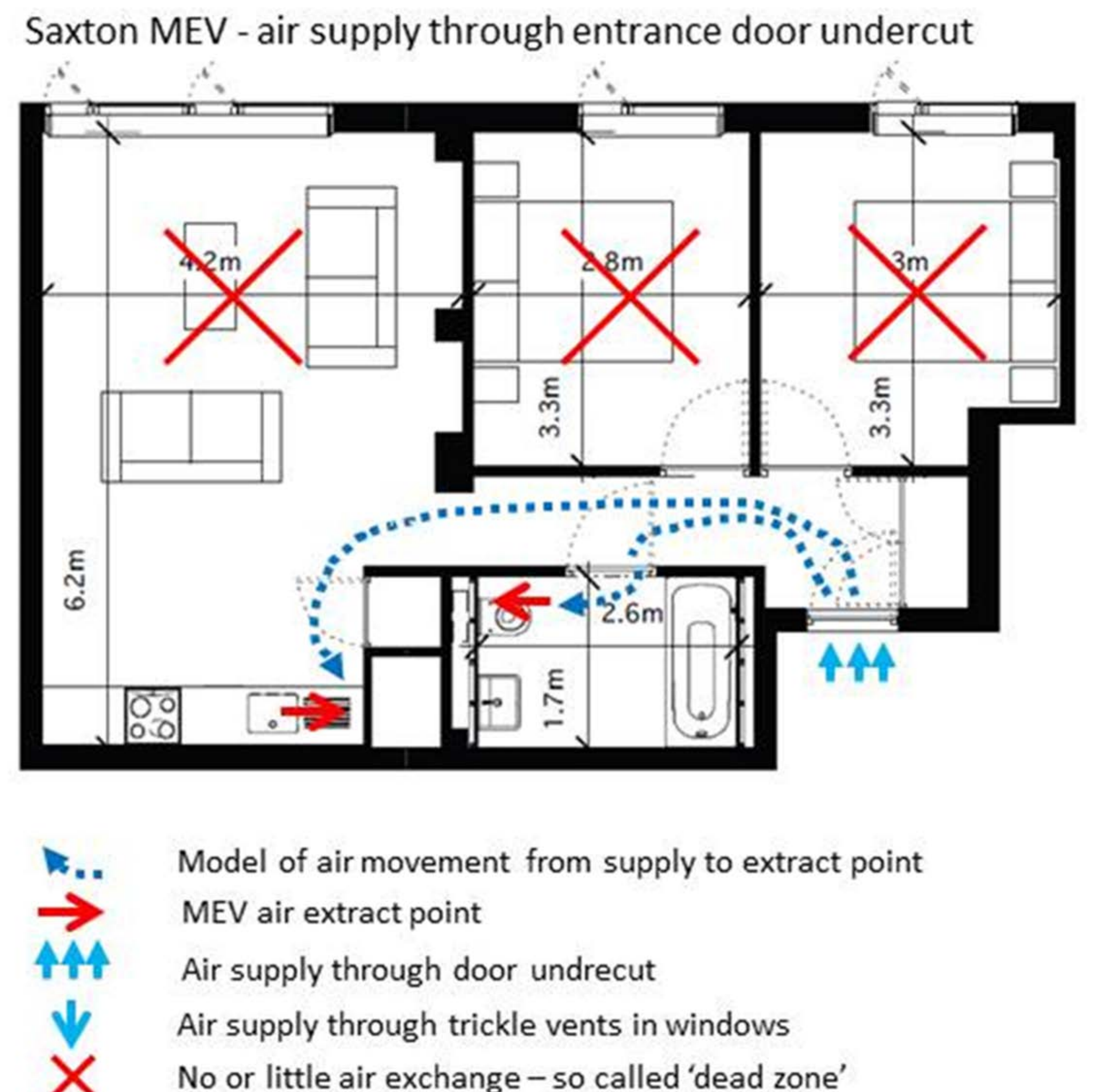
...look for exceptions – don't monitor the routine.

Organisational learning feedback ‘smile’…



Apartments

- Leeds, UK
- Single aspect
- Retrofitted in 2012
- BPE from 2013-14



Initial findings..

Occupants perceptions included:

Overheating

Poor air quality

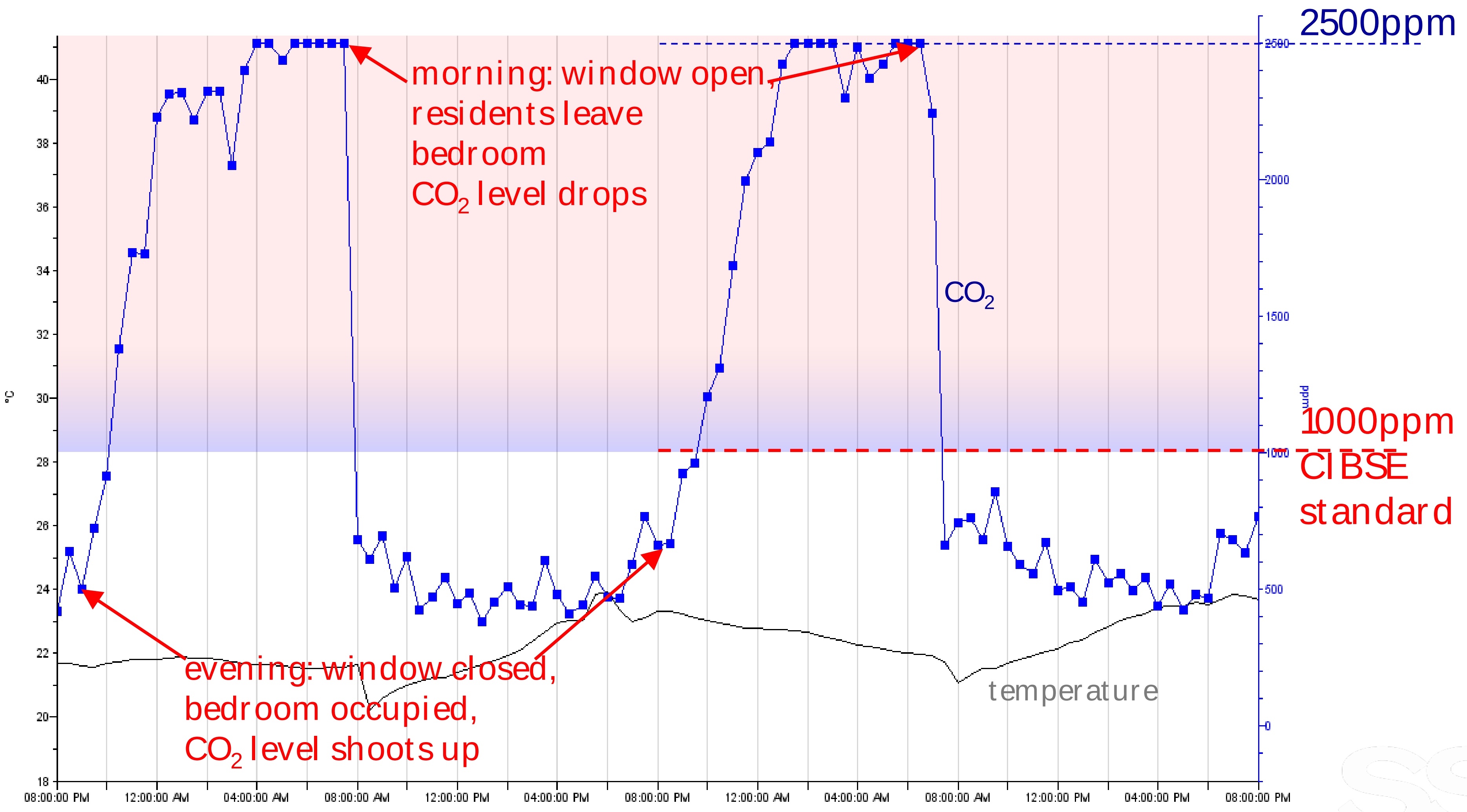
Sleeping poorly

Window openings restricted

Noise problems

Walkthrough revealed reasons…

Poor ventilation is dangerous in our homes – toxic, even… monitoring reveals this



Investigative level

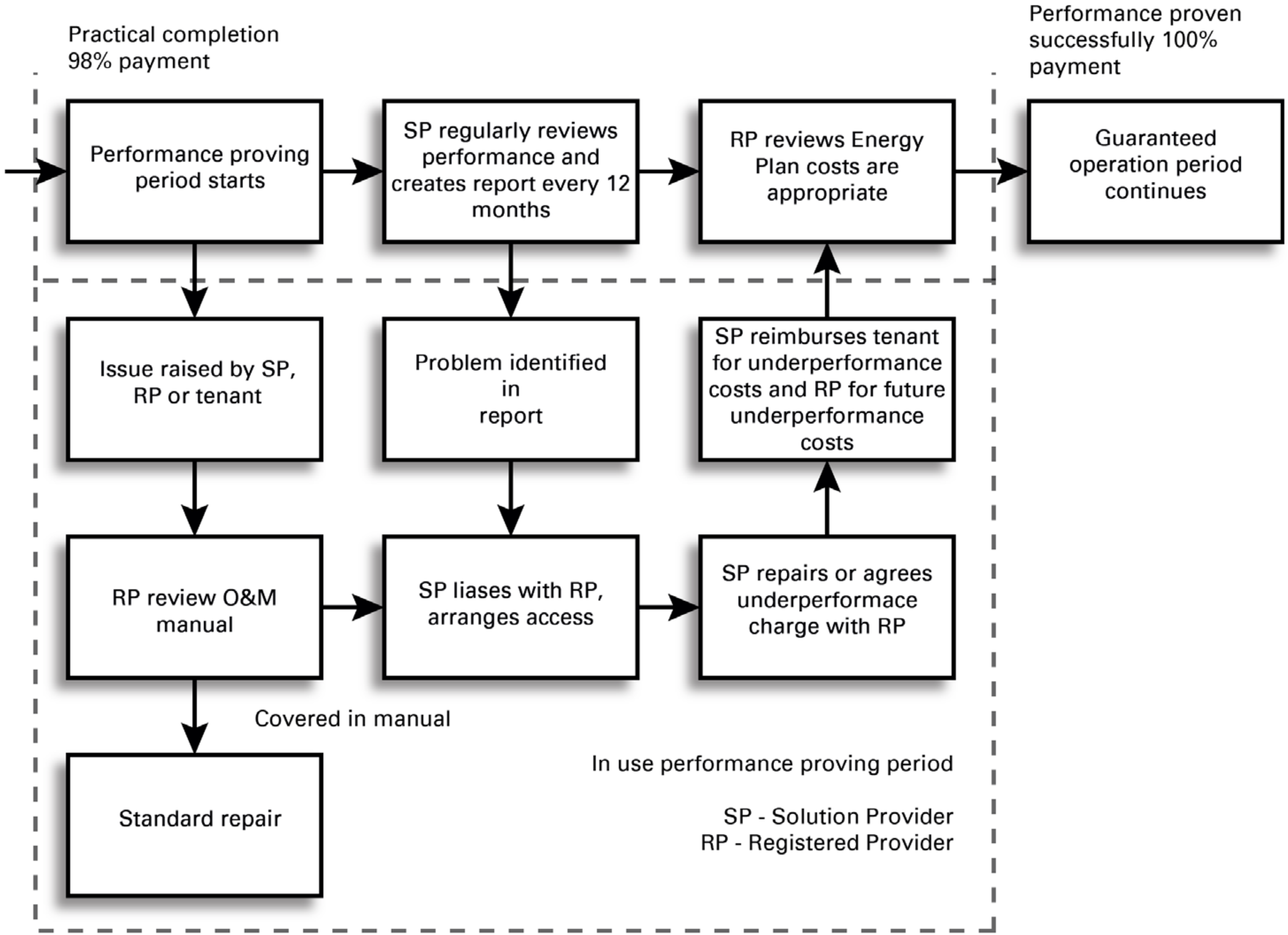
- testing for air flows in the home

Key lessons from the feedback

- Avoid creating single aspect apartments – no natural cross ventilation
- Ensure all windows are properly shaded externally
- Design ventilation with correct air flow paths
- Properly commission all mechanical equipment
- Provide occupants with training, not just manuals

NEW FEEDBACK APPROACHES

Using feedback as a guarantee - Energiesprong


Practical completion 98% payment
Performance proven successfully 100% payment
Performance proving period starts
SP regularly reviews performance and creates report every 12 months
RP reviews Energy Plan costs are appropriate
Guaranteed operation period continues
Issue raised by SP, RP or tenant
Problem identified in report
SP reimburses tenant for underperformance costs and RP for future underperformance costs
RP review O&M manual
SP liases with RP, arranges access
SP repairs or agrees underperformace charge with RP
Covered in manual
Standard repair
In use performance proving period
SP - Solution Provider
RP - Registered Provider

Usability of technology – this is under studied….use video!

Creating new citizen scientists through built in monitoring

Empowering occupants through co-design

1. Greater mutual understanding achieved

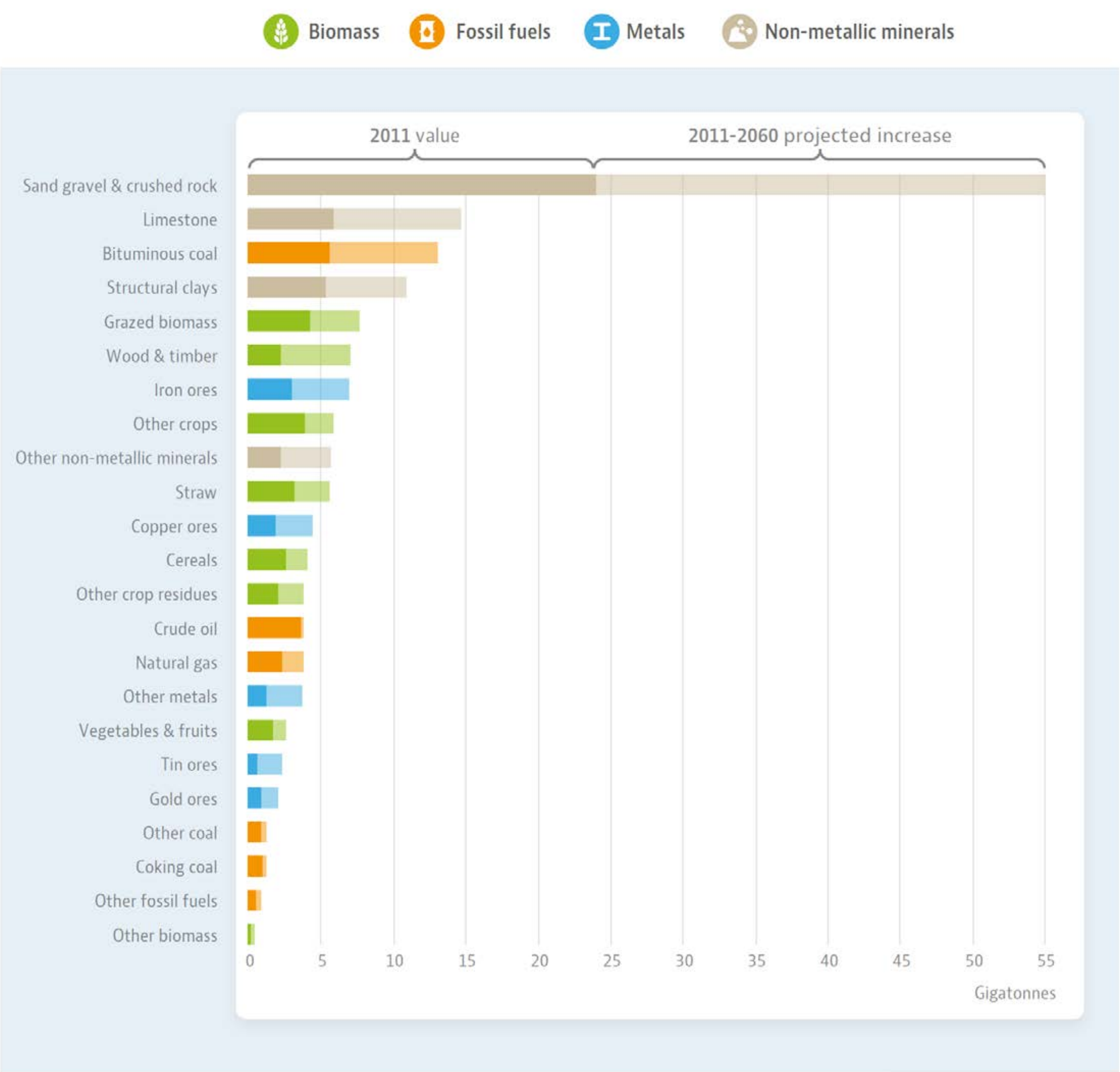
2. Greater buy-in and ownership of design and performance studies

3. Cohousing, Co-ops, Build-to-Rent, social housing

4. New Co-living models available

RESOURCE USE CONTRACTION

Figure 10. **Construction materials dominate total materials use in 2011 and 2060**



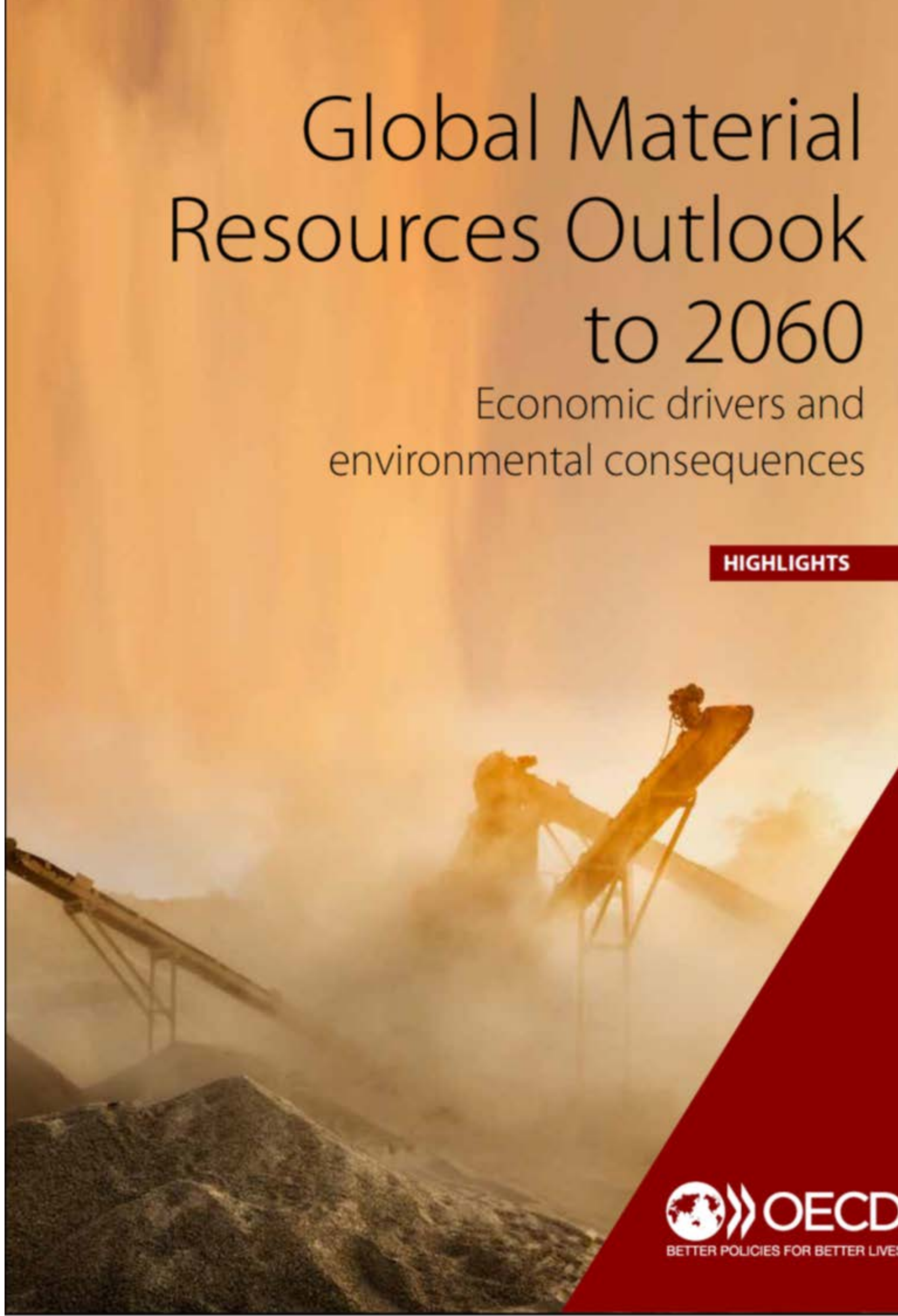
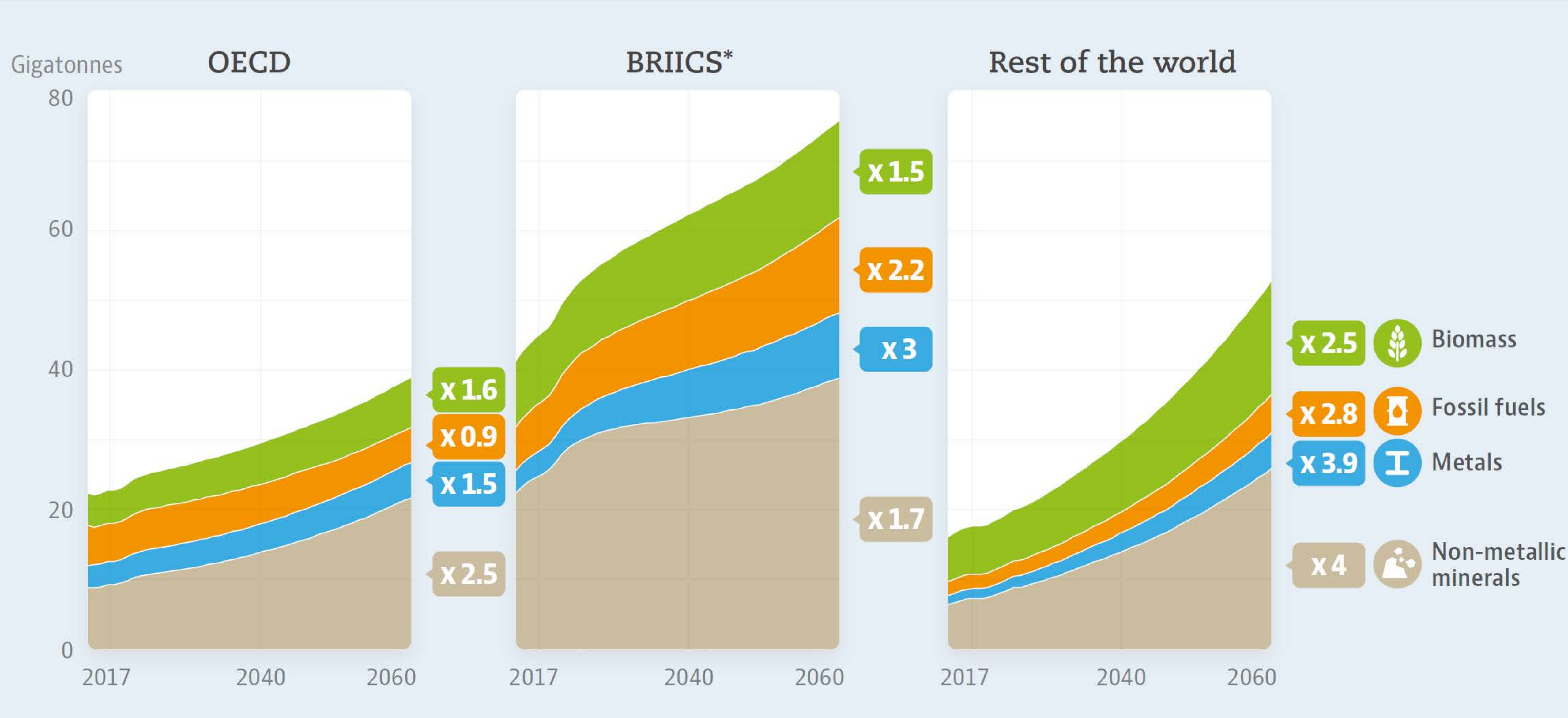
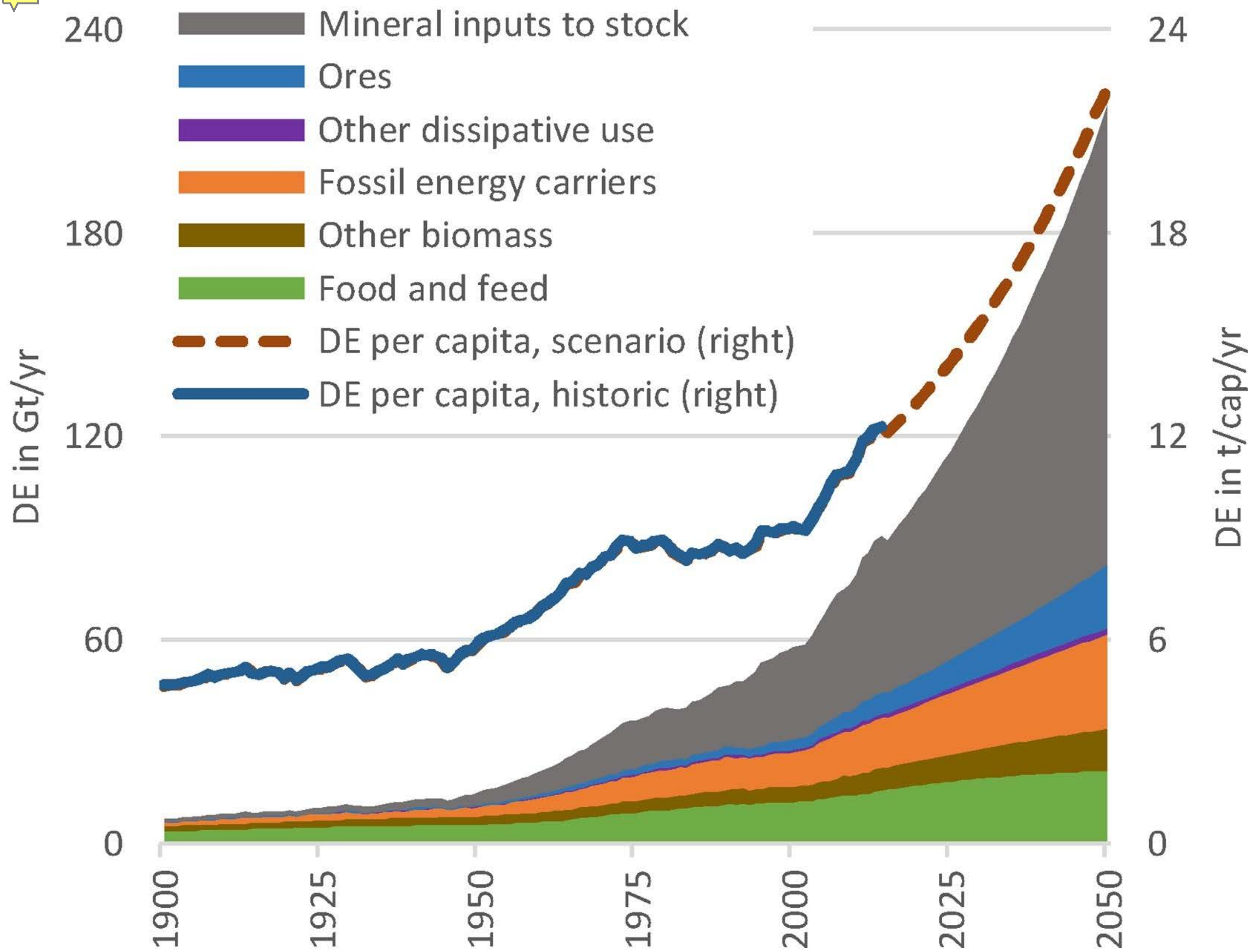


Figure 7. **Materials use rises for all material groups**



*BRIICS: Brazil, Russia, India, Indonesia, China, South Africa



Global Material Extraction 1990 -2050

https://www.sciencedirect.com/science/article/pii/S0959378017313031#fig0025

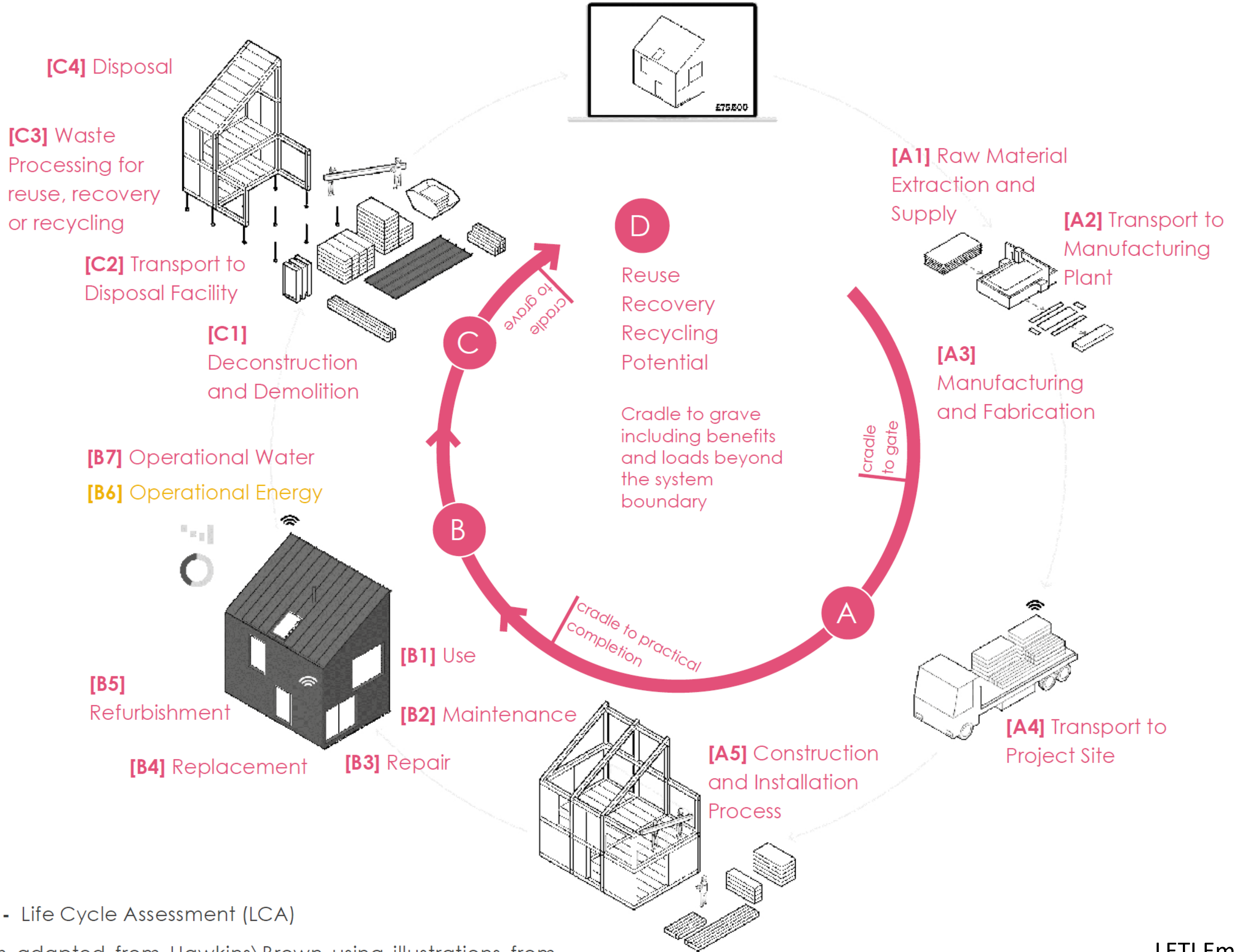
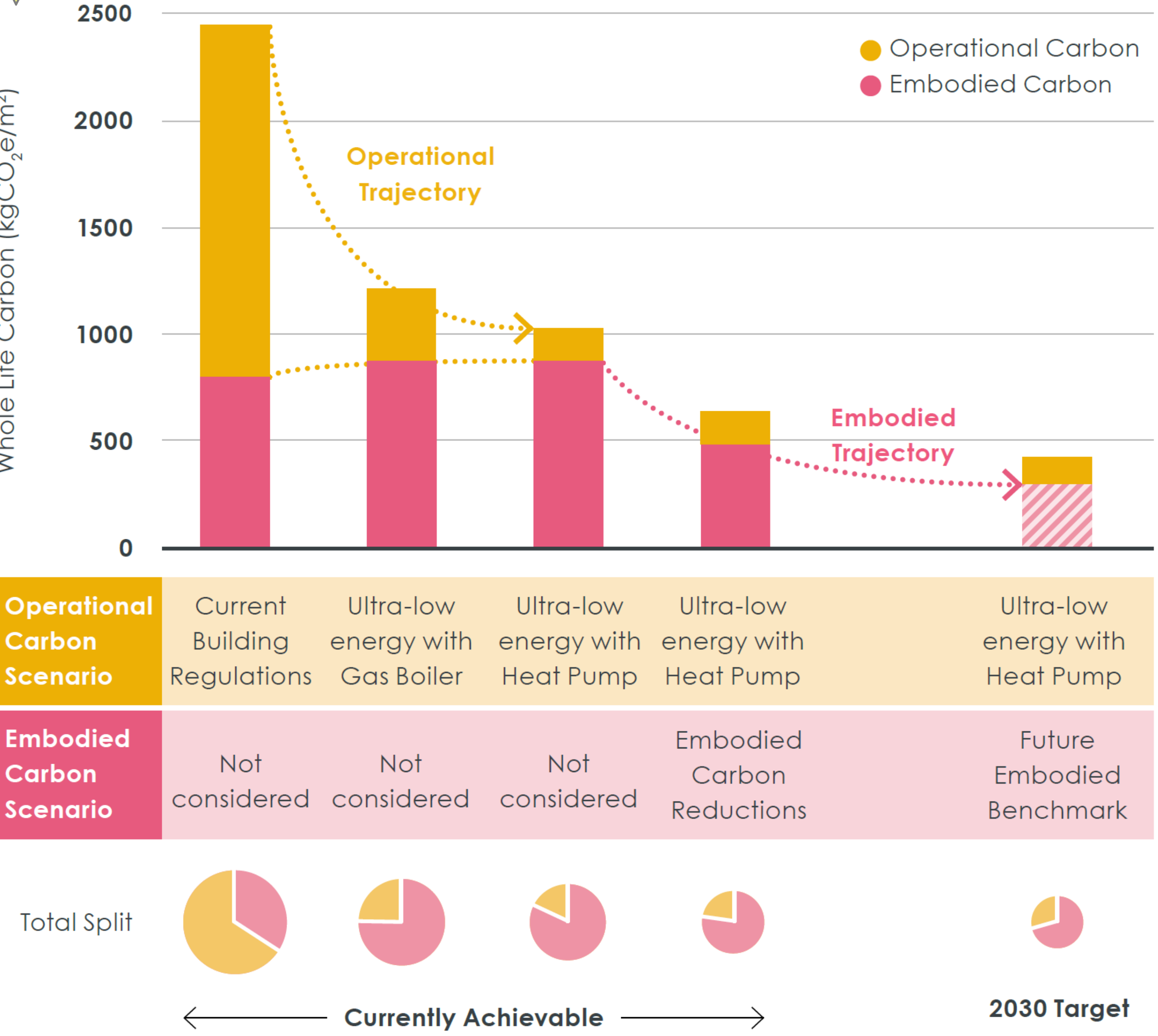


Figure ii - Life Cycle Assessment (LCA)

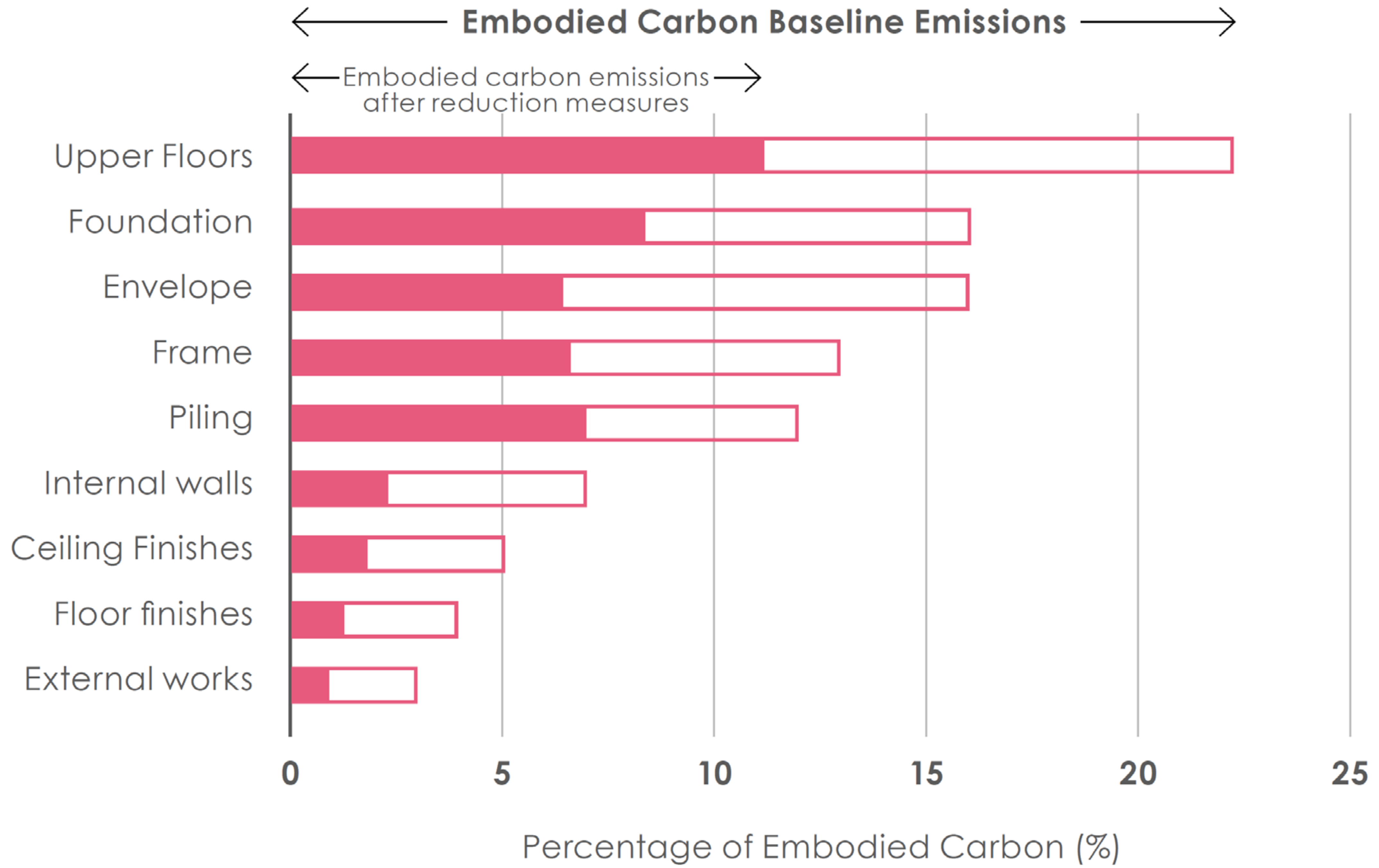
Diagram adapted from Hawkins\Brown using illustrations from



UK carbon emissions trajectory for buildings: Operational v Embodied

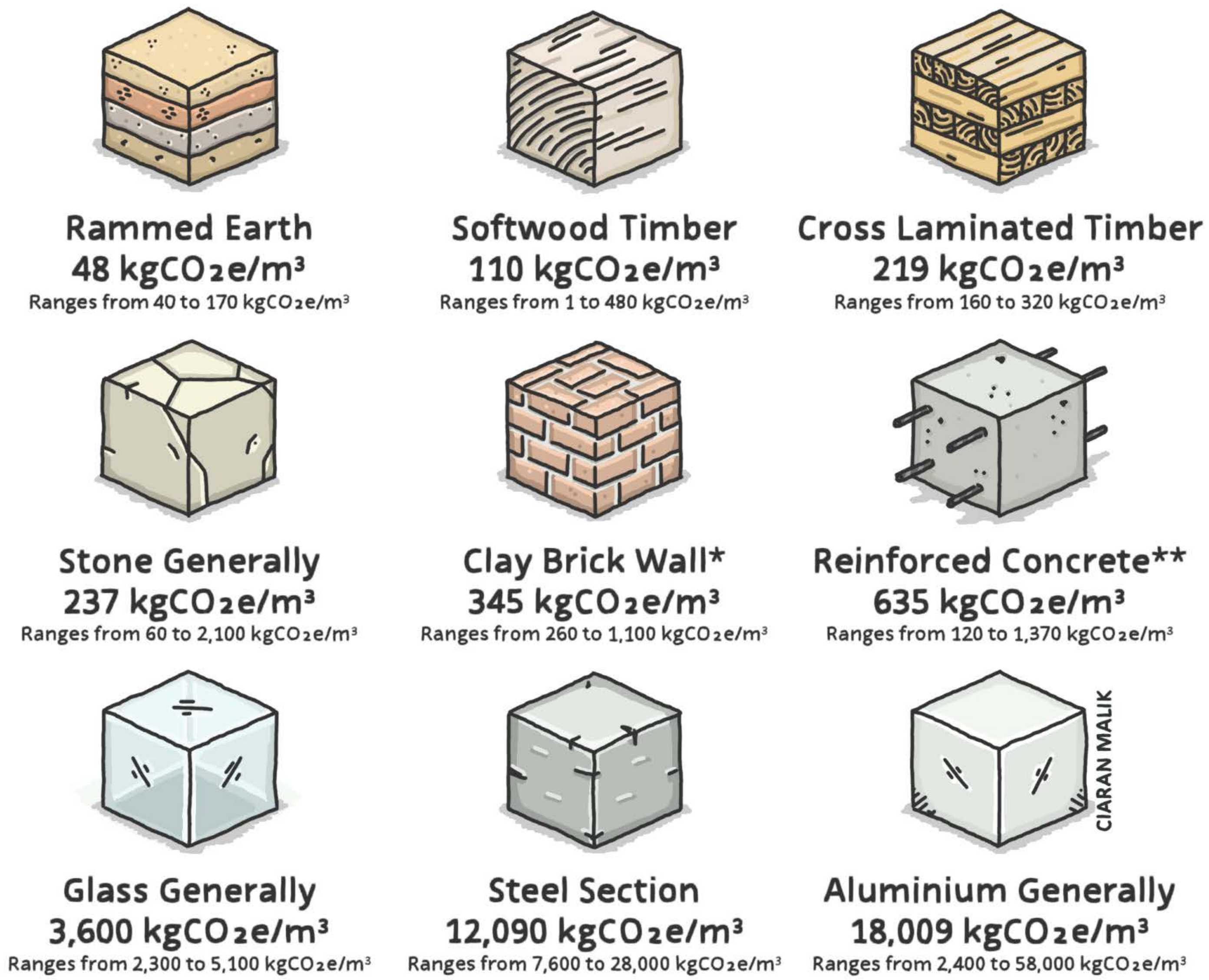
….the embodied carbon is becoming more important

LETI Embodied Carbon Primer



Embodied Carbon Baseline Emissions
Embodied carbon emissions after reduction measures
Upper Floors
Foundation
Envelope
Frame
Piling
Internal walls
Ceiling Finishes
Floor finishes
External works
0
5
10
15
20
25
Percentage of Embodied Carbon (%)

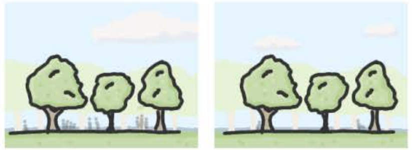
Cradle to Gate Embodied Carbon A1 - A3



Source: http://www.circularecology.com/embodied-energy-and-carbon-footprint-database.html
Using database summary values for product stage, does not include construction, use, end of life or benefits stages.
Ranges are presented to show how values can vary, and require interpretation based on source and analysis method.
*Based on values for brick walls, which use 1,500 bricks for 1m^3 of mortar
**Based on C32/40 concrete with 2% reinforcement, maximum based on 4% reinforcement

Building Life Strategies

Avoid Construction:



Don't Build

Use strategies to avoid construction; locate elsewhere, create alternative routes, use flexible and remote working

Use Existing

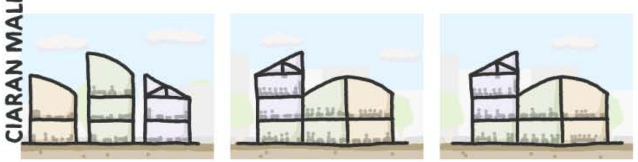
Buy or rent an existing building or several existing buildings next to or around the site

Reuse and Repair:

Repair Existing

Repair and extend existing buildings; restore historic structures, retrofit spaces, convert attics, build extensions

CIARAN MALIK



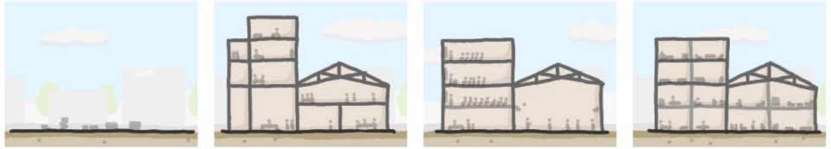
Reuse Existing

Reuse existing building components, elements and materials locally to construct new spaces

Design for Reuse:

Design for Deconstruction

Use mechanical connections, material passports and finishes which can be separated and reused



Long Life, Loose Fit

Guarantee project life for at least 100 years, use spans, ceiling heights and floor capacity which can be adapted for different uses

Before | Short Term | Medium Term | Long Term

Design with a Lighter Touch

Encourage local ecology

Services and structure integrated

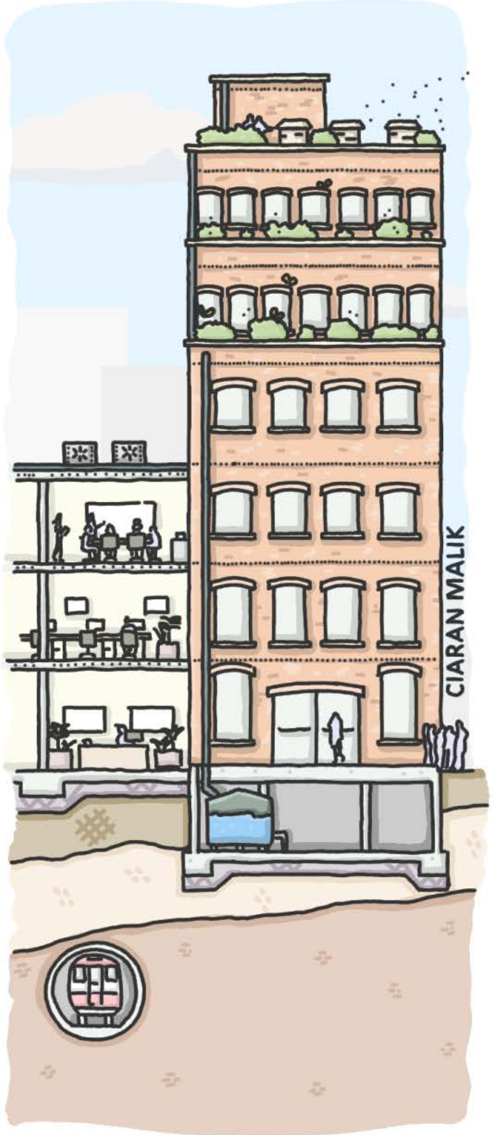
Larger low leaves/ windows to maximise sunlight to all levels

Built from locally available materials

Collect and use rainwater on site

Size balanced with soil conditions

Waste material recycled on site



Bluebell

Hyacinthoides non-scripta

Built Environment

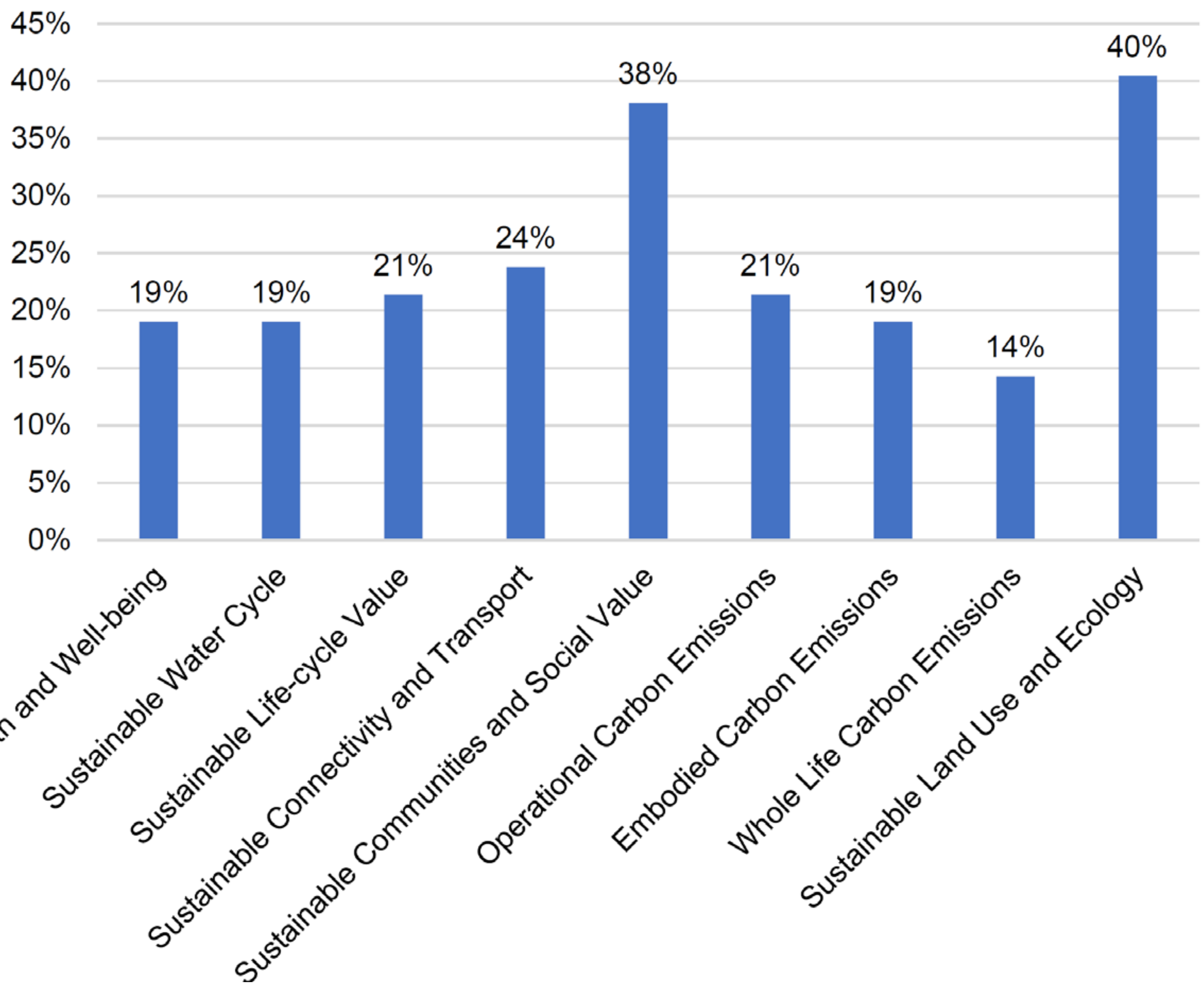
Bond regenerantia consilio

Image: HTA Design LLP


Image: Magda Baborska Narozny

EDUCATION AND TRAINING

UIA survey of national architecture institutions – CPD topics covered in 2020



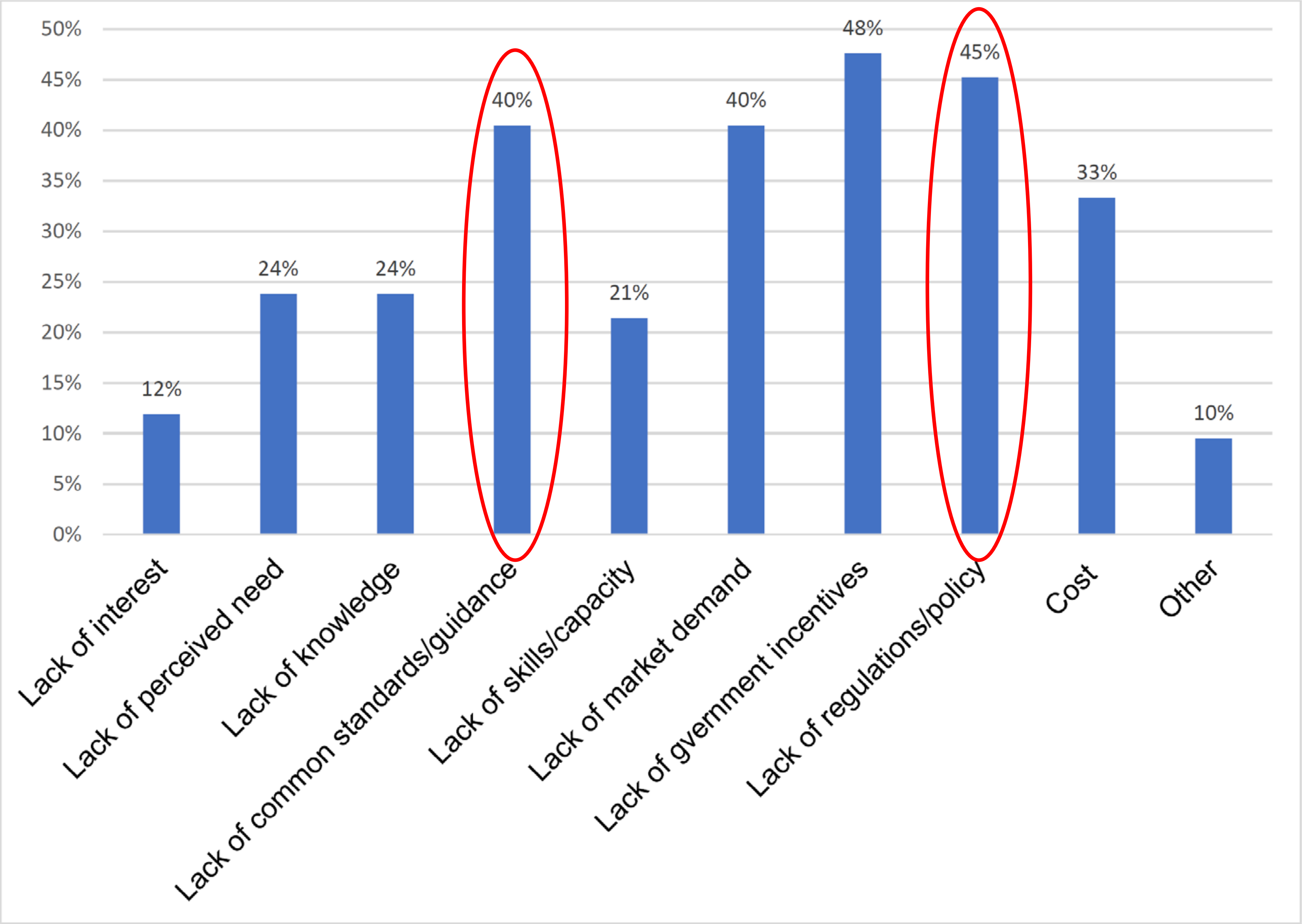


Figure 8, Top 3 barriers/challenges in delivering sustainable development in your country?

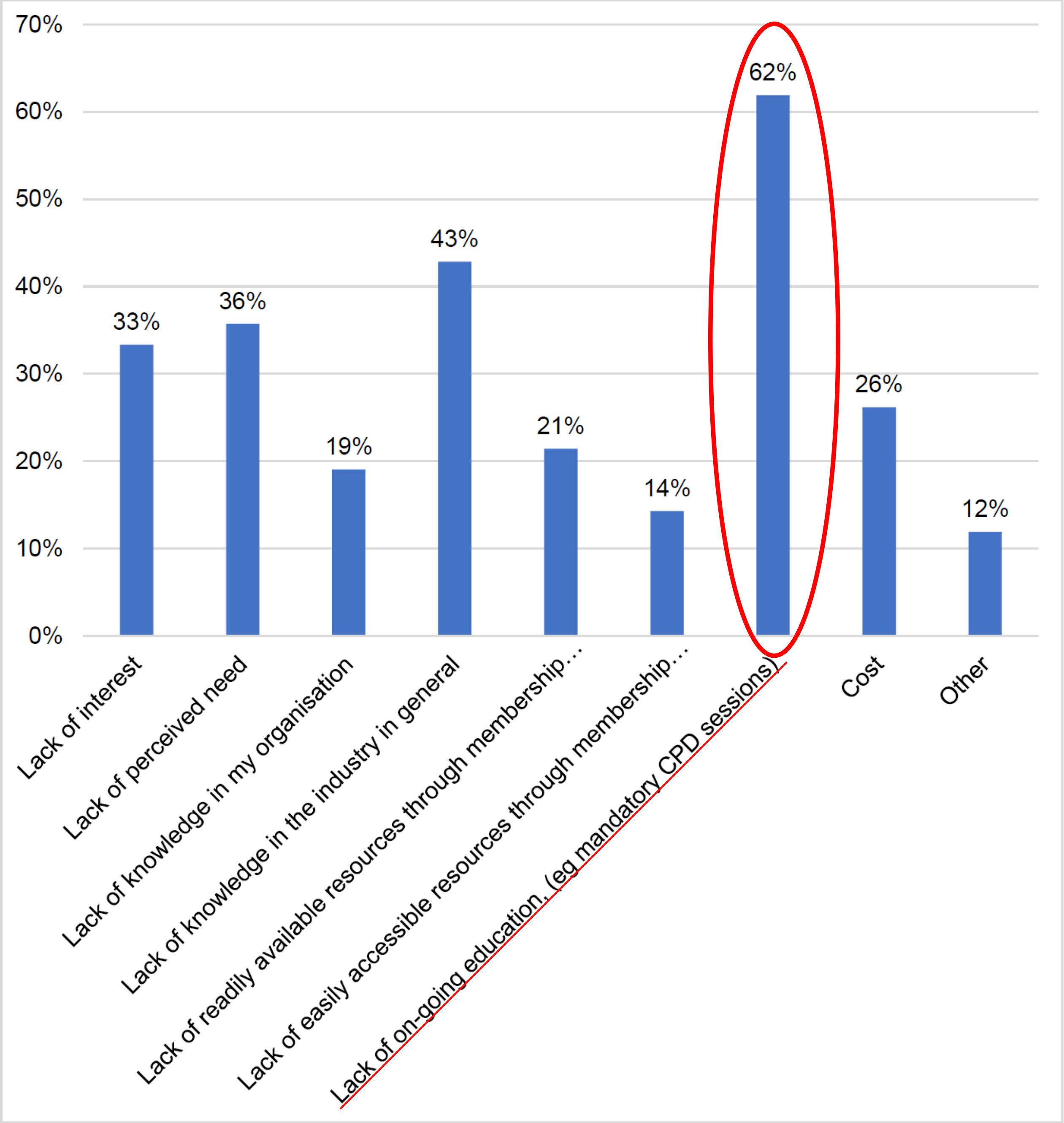


Figure 16, Top 3 barriers/challenges to learning about the UN 2030 SDGs?

What can we do about it?

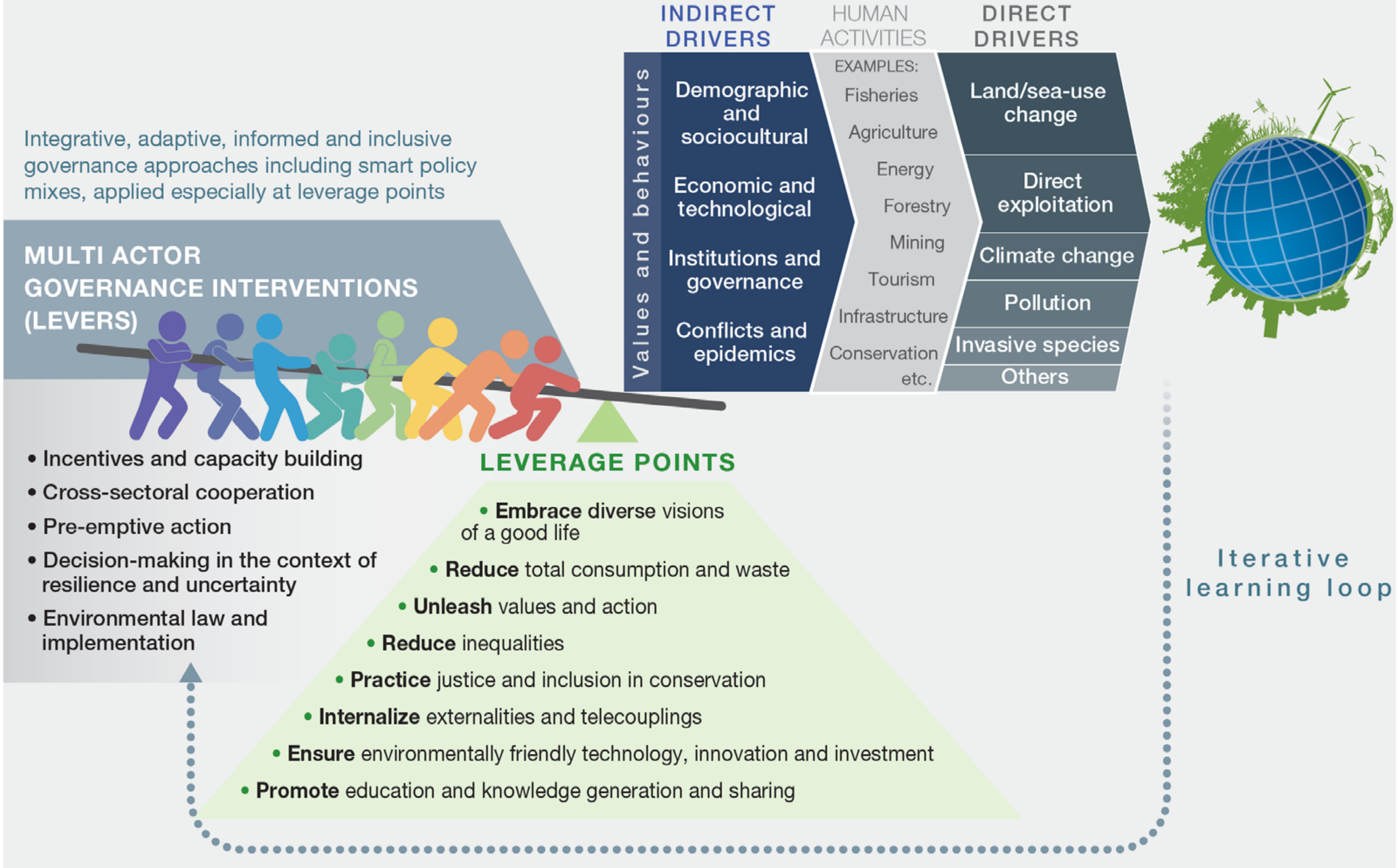
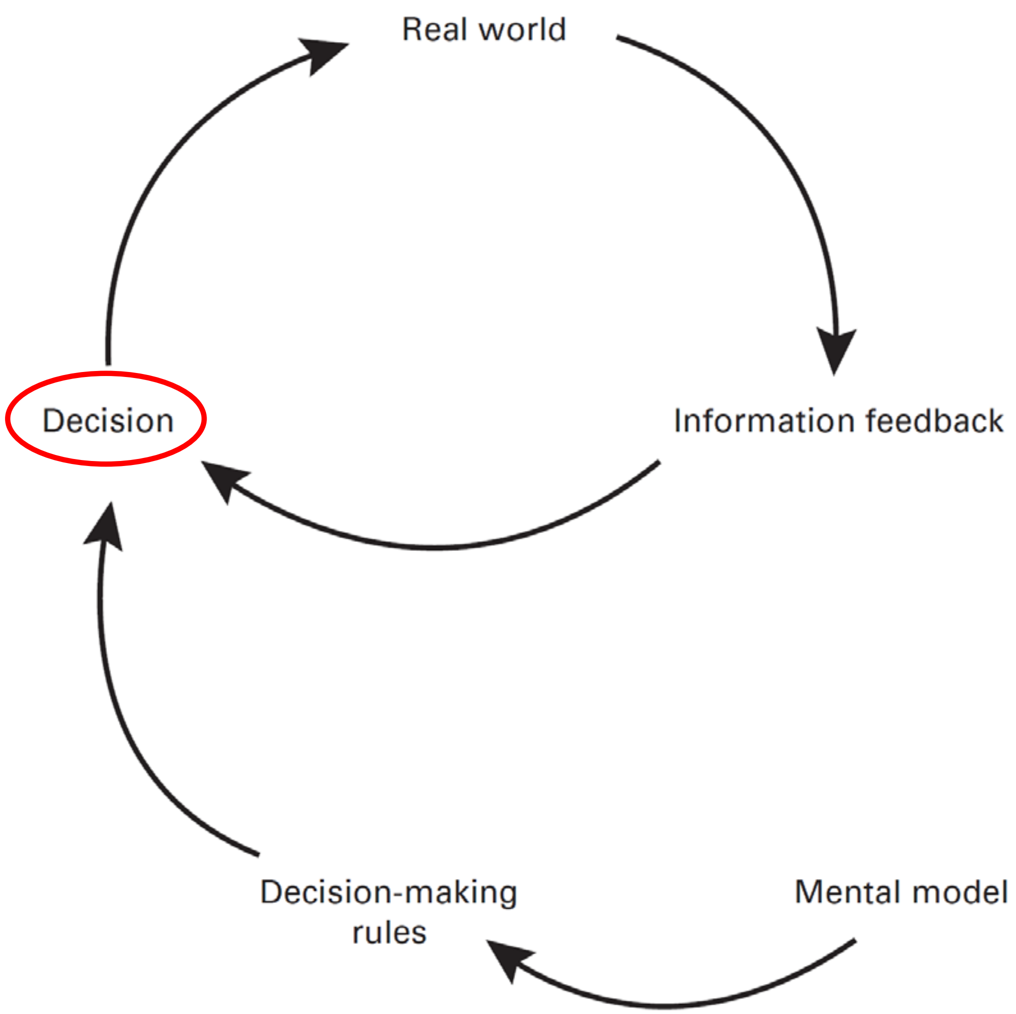
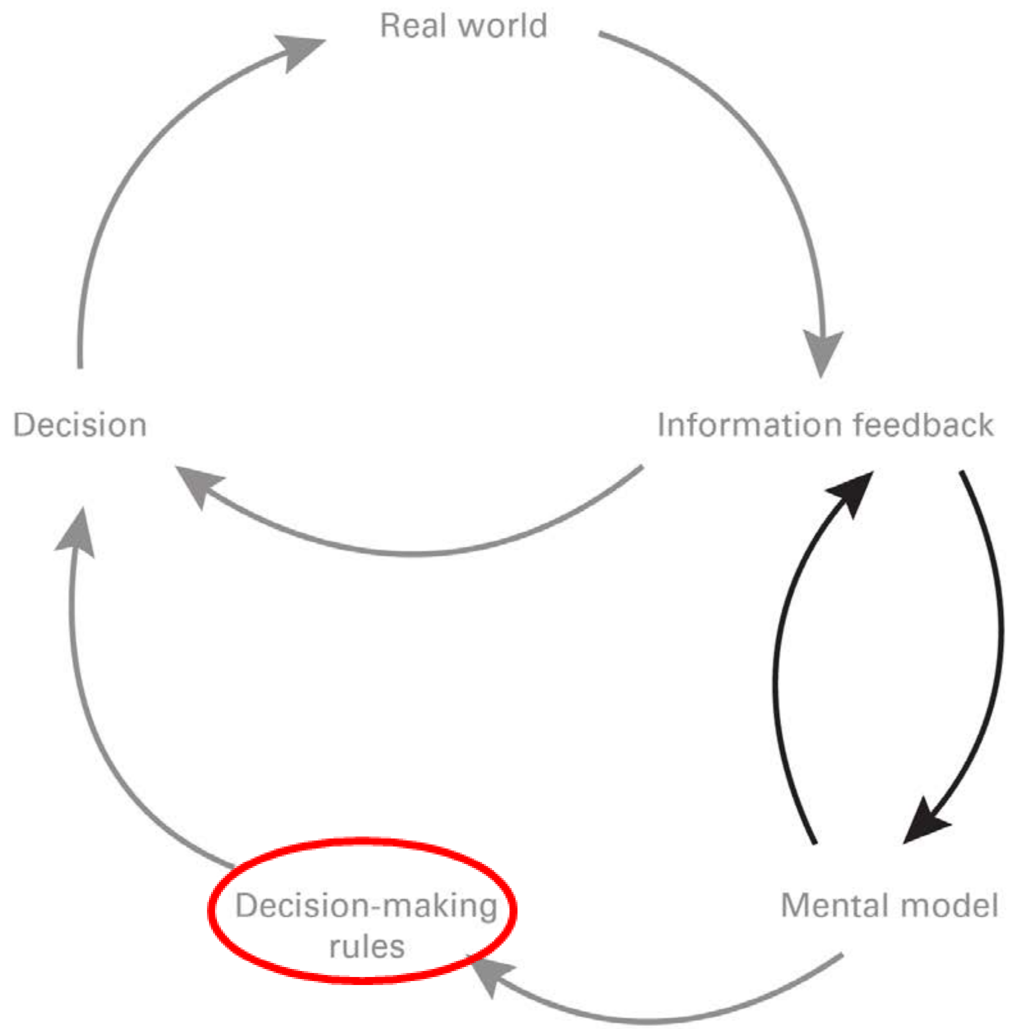


Figure SPM 9 **Transformative change in global sustainability pathways.**

IPBES Global Report, 2021





Changing our mindset

IT’S YOUR MOVE NOW

Eat much less meat – or avoid it

Travel less

Consume and waste less

Conclusion: It’s now or never…

We have all the technology we need already to deliver good building performance

We do not have the mind set to go back and really check how well our buildings are performing – or us!

There is no time left to talk about ‘the future’

If we do not radically change our personal lives and our work right now, it will be too late – the carbon is locked in

Lets be part of the change now

The University Of Sheffield.

Thank you.

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