

## Equipping graduates for the emergency

Will Arnold  
Head of Climate Action  
18 Nov 2021



# What's changed?

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# Your graduates' priorities

## 'No point in anything else': Gen Z members flock to climate careers

Colleges offer support as young people aim to devote their lives to battling the crisis



▲ Hundreds of protesters march to the White House calling for climate action, including a Civilian Climate Corps. Photograph: Allison Bailey/Rex/Shutterstock

**C**alifornia is facing a drought so devastating, some publications call it “biblical”. Colorado now has “fire years” instead of “fire seasons”. Miami, which sees more dramatic hurricanes each year, is contemplating building a huge seawall in one of the city’s most scenic tourist districts to protect it from storm surges.

## 'We are last generation that can stop climate change' – UN summit

Big cuts in carbon emissions and a rise in protection from extreme weather urgently needed



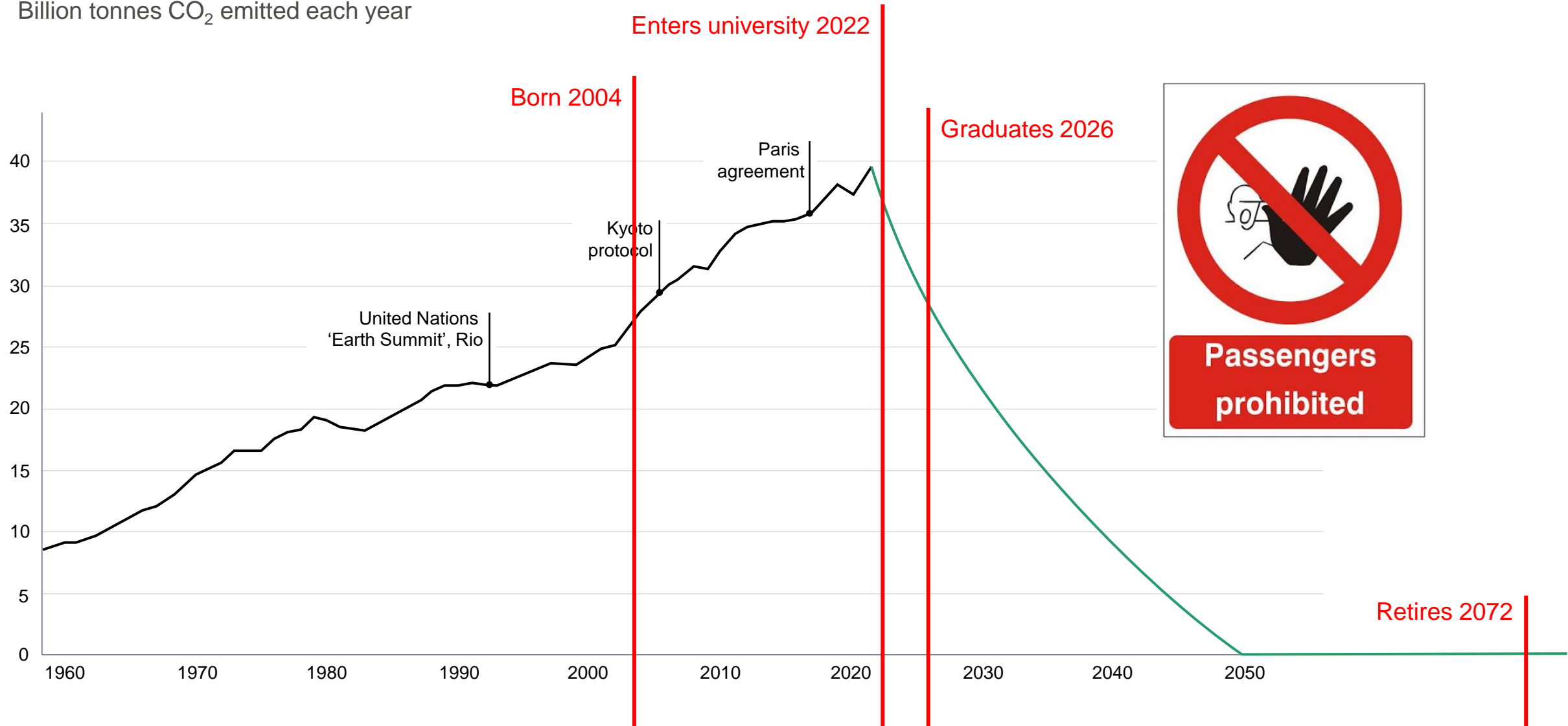
▲ Scientists recommend that warming is limited to 1.5C. Photograph: Fabrice Coffrini/AFP/Getty Images

The UN climate change summit begins on Monday with a warning that today’s generation is the last that can prevent catastrophic global warming, as well as the first to be suffering its impacts.



# Your graduates' lifespans

Billion tonnes CO<sub>2</sub> emitted each year



# Your graduates' next steps

- + Climate
- + Carbon
- + Reuse
- + Materials
- + Sharing
- + Ethical
- + Inclusivity
- + Equality
- + Diversity
- + Global responsibility

## RIBA Climate Literacy Knowledge Schedule

The built environment has an urgent role to play in responding to the Climate Challenge calls on members and industry to make their design by 2030. The subject areas set out in this Knowledge Schedule in Climate Literacy, developed with support from a Cross Sector Group of Architects to design buildings that deliver sustainable outcomes.

### Global and built environment climate fundamentals

- Climate fundamentals
- Financial risks and net zero economy
- Environmental impacts of the built environment
- Sustainable urbanism, architecture and engineering
- Built environment policy, legislation, regulations, commitments, benchmarks and construction industry guidance

### RIBA Sustainable Outcomes and common threads

- RIBA Sustainable Outcomes Guide: outcomes based briefing and design, Plan for Use, Soft Landings and post occupancy evaluation
- Retrofit, adaptation and reuse
- Planning for climate extremes, disaster risk, resilience, redundancy and adaptation
- Life cycle costing, investment and procurement
- Research and innovation

As part of the Education and Professional Development Framework, the RIBA has set out in Knowledge Schedules, in order for them to be competent to practice as

## The Institution of Structural Engineers

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E membership@istructe.org  
www.istructe.org

## Chartered Membership Examination

Monday 6 January 2020

### Structural Engineering Design and Practice

09.30 – 13.00 and 13.30 – 17.00 (Discussion between individuals is not permitted during lunch period). A period of fifteen minutes is provided for reading the question paper immediately before the commencement of the examination. Candidates are not permitted to write in answer sheets, or on drawing paper or to use a calculator during this time. Candidates must satisfy the Examiners in ONE question.

### Important

The written answer to the question selected and any A3 drawings must bear the candidate's number and the question number at the bottom of the page. Only the answer sheets supplied by the Institution may be used. The candidate's name should not appear anywhere in the script.

### Notes to Candidates

1. TO PASS THE EXAMINATION, CANDIDATES MUST SATISFY THE EXAMINERS IN BOTH PARTS OF THE QUESTION ATTEMPTED.
2. Candidates should note that Figures are produced to illustrate the question and are not necessarily drawn to scale. Figured dimensions should be followed.
3. A fair proportion of marks will be awarded for the demonstration of an understanding of fundamental engineering concepts, as distinct from calculation of member forces and sizes. NOTE: In the calculation part of all questions, establishing "form and size" is taken to mean compliance with all relevant design criteria, i.e. bending, shear, deflection, etc.
4. In all questions 50 marks are allocated to Section 1 and 50 marks to Section 2.

5. The Examiners are looking for sound structural designs. It should also be remembered that aesthetics, economy and function are important in any competent engineering scheme.
6. Any assumptions made and the design data and criteria adopted must be stated.
7. Clear drawings and sketches are required. They do not have to be to a defined scale, but should be in proportion.
8. Candidates will not be allowed to include any previously prepared calculations, notes, sketches, diagrams, computer output or other similar material in their answer sheets or A3 drawings. Any previously prepared information submitted by candidates will be ignored by the examiners.
9. Candidates may not bring into the examination room any electronic devices capable of wireless communication, optical photography or scanning.  
  
The following devices are not permitted: mobile phones, laptops, notebooks or portable computers and similar devices, iPads, tablets and similar devices, e-readers (e.g. Kindle) and similar devices, cameras, optical scanners and similar devices.  
  
Any candidates arriving at the examination room with such devices will be asked to switch them off and place them in a sealed bag kept by the Invigilator for the duration of the exam, which includes the lunch period.
10. This paper is set in SI Units.

Now read "Reminder" on page 3.

## Carbon Zero: the professional institutions' climate action plan



The Institution of  
of Structural  
Engineers

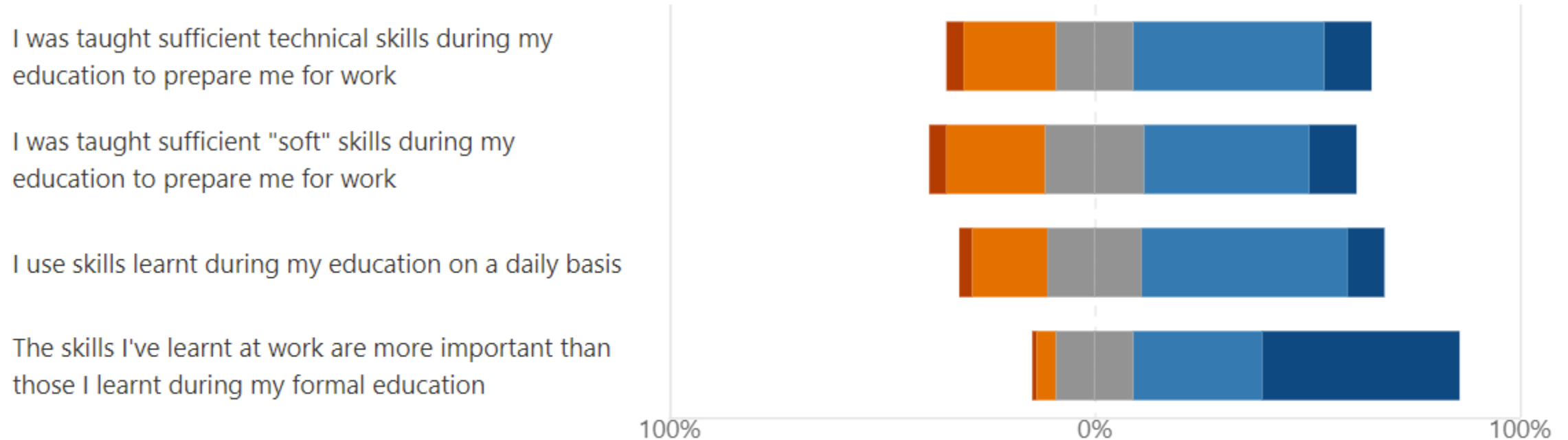
Initial Professional Development  
Chartered Member

## Your graduates' feedback

### 12. Education: How well do you agree with these statements?

[More Details](#)

Strongly disagree Disagree Neutral Agree Strongly agree



# Your graduates' feedback

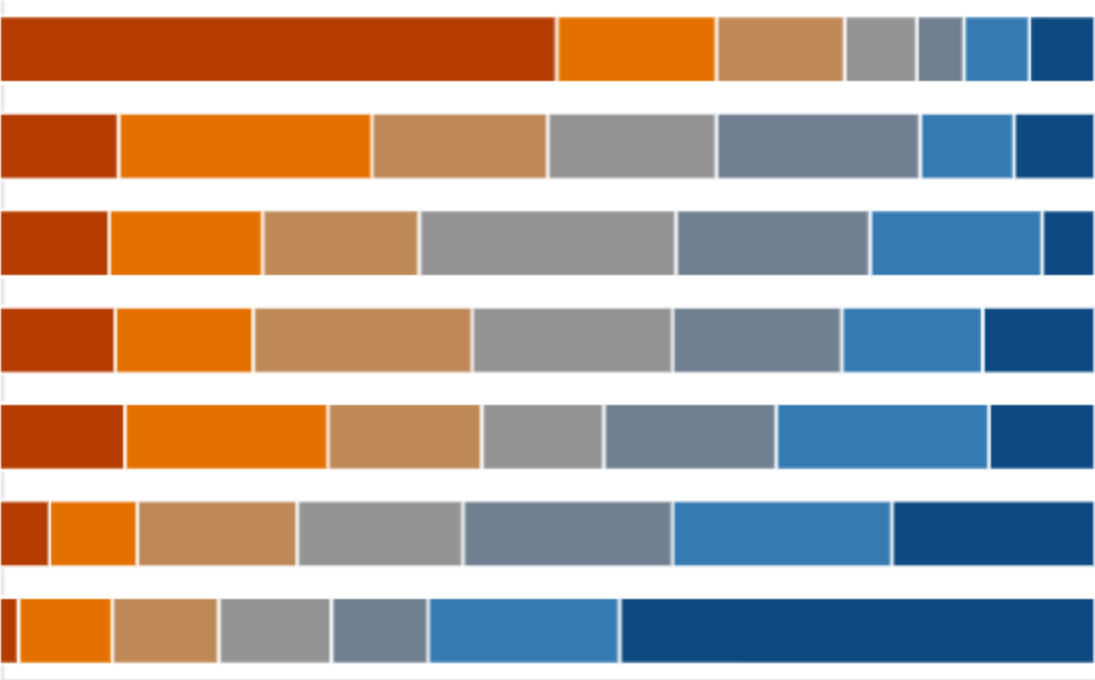
19. Put the following topics in the order in which you would like to see your institution to prioritise them

[More Details](#)

**Rank Options**

- 1 Climate and biodiversity emer...
- 2 Inclusion and diversity
- 3 Mental wellbeing
- 4 Health and safety
- 5 Modern construction methods
- 6 Digital tools
- 7 Flexible working practices for f...

First choice Last choice



# What are they up against?

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sustainable architecture



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Collections SafeSearch

- concept
- green
- residential
- diagram
- house
- tropical
- section
- future
- modern
- interior



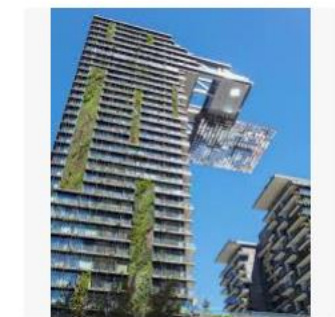
Sustainable architecture - Wikipedia  
en.wikipedia.org



1m<sup>2</sup> office = 1000 kgCO<sub>2</sub>e  
10m<sup>2</sup> forest = -1000 kgCO<sub>2</sub>e<sub>(50yr)</sub>



architecture ...  
architecturaldigest.com



Sustainable Architecture ...  
architecturaldigest.com



Sustainable Architecture in the 21st ...  
globuswarwick.com



An Introduction to Sustainable Architecture  
azobuild.com



Industry 4.0 could revolutionize ...  
sustainability-times.com



Sustainable Architecture. Living ...  
medium.com



Sustainable Architecture ...  
egyptianstreets.com



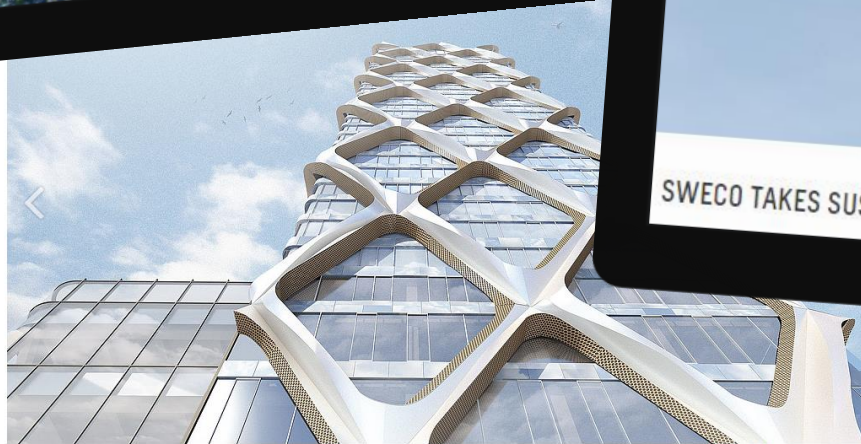
Sustainable architecture: green future ...  
engelvoelkers.com





## #WorldEnvironmentDay: 9 Leading Green Buildings In The World

© June 04, 2019 | Surbhi Gupta



1 of 2

Developing the World's Tallest Net Zero Timber Building with Sidewalk Labs

SWECO TAKES SUSTAINABILITY TO NEW HEIGHTS WITH WORLD'S TALLEST TIMBER BUILDING

BLOG  
Now is the Time to...  
COVID-19 could force us to  
improve construction's...

BLOG  
Doubling Down on Our...  
With hundreds of millions of  
square feet of buildings...

OFFICE  
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1055 West Georgia Street,  
Suite 2100  
Vancouver British Columbia  
BC V6E 3P3  
Phone: 604-334-6371

OFFICE  
Toronto  
150 King Street West, Suite

## WE ARE NET CARBON NEGATIVE

As you'd expect from the UK's No 1 producer of engineered wood panels,  
we are good at saying things that sell lots of wood panels.



We lock in 1.1 million tonnes of CO<sub>2</sub>e every year



74% of our primary energy use is from renewable sources



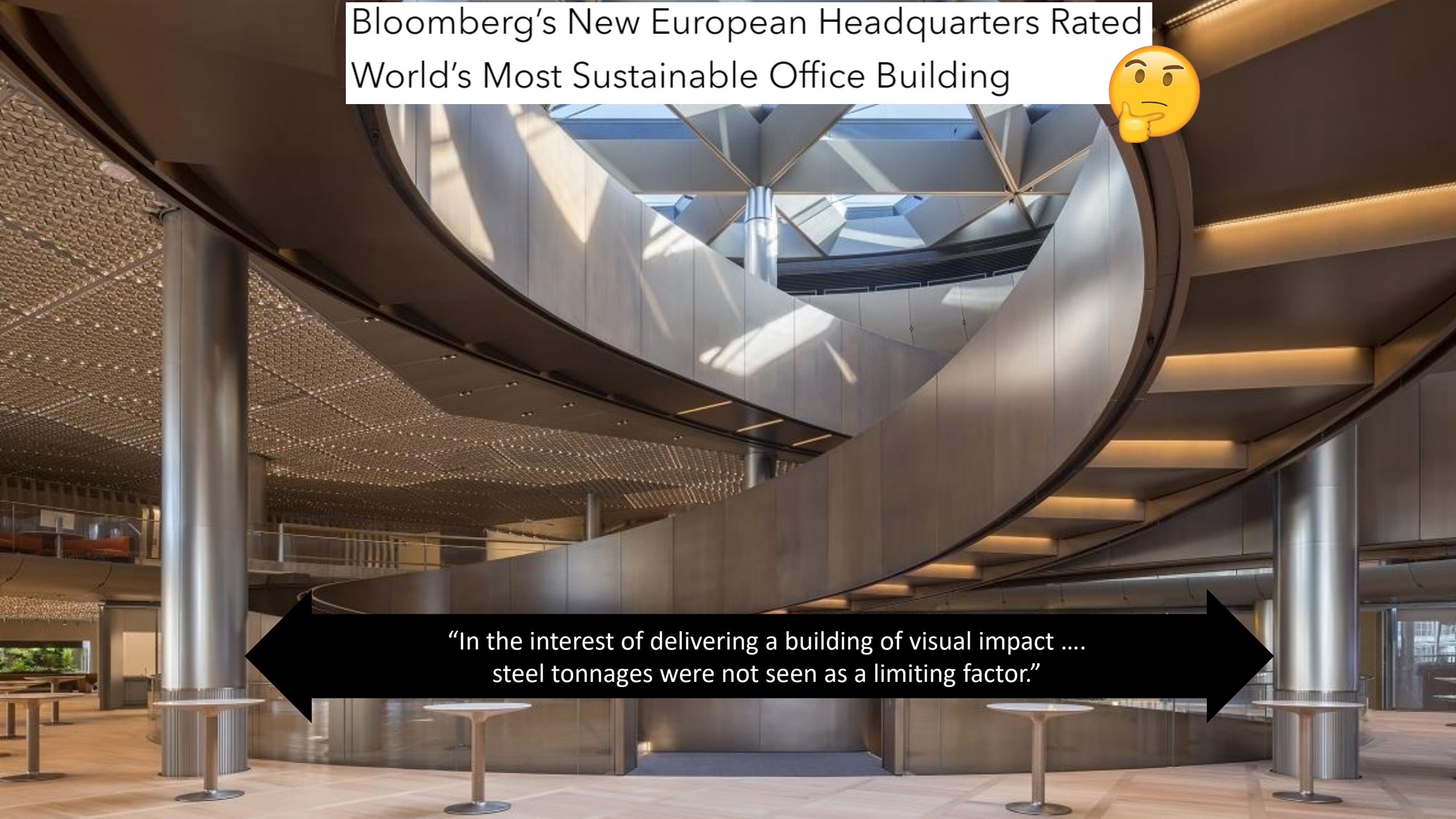
For every 1m<sup>3</sup> of OSB we make, 828kg of CO<sub>2</sub>e is sequestered



99.5% of all raw material is used during production



# Bloomberg's New European Headquarters Rated World's Most Sustainable Office Building



“In the interest of delivering a building of visual impact ....  
steel tonnages were not seen as a limiting factor.”



**3D-printed concrete**



**mass timber**



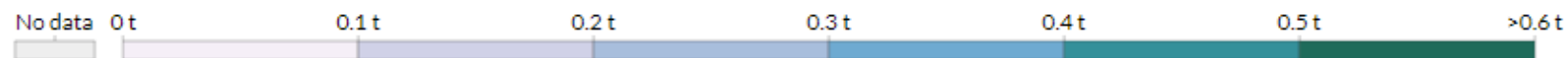
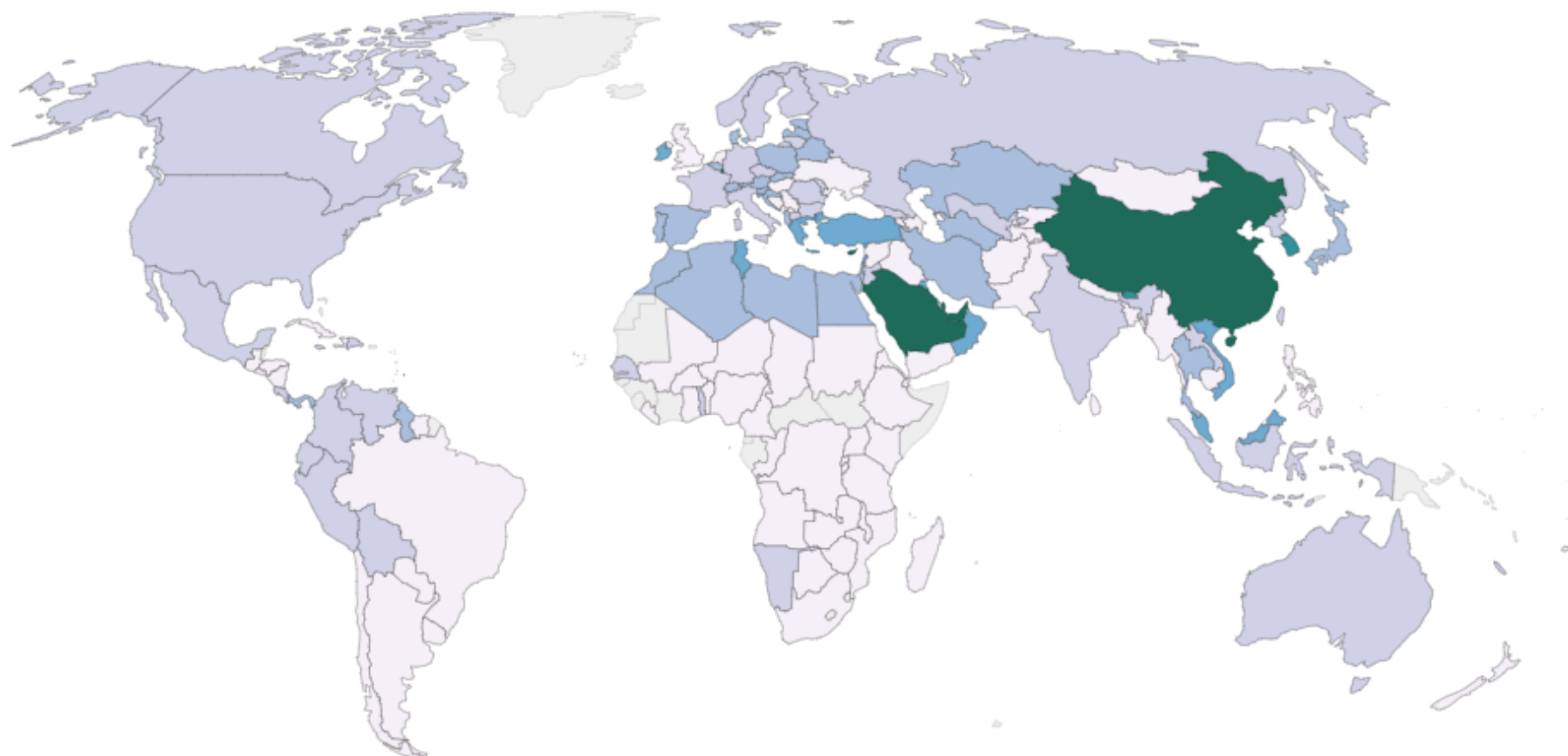
**Actually lower carbon?**



## Per capita CO<sub>2</sub> emissions from cement, 2019

Our World  
in Data

World



Source: Our World in Data based on the Global Carbon Project

[OurWorldInData.org/co2-and-other-greenhouse-gas-emissions](https://OurWorldInData.org/co2-and-other-greenhouse-gas-emissions) • CC BY



## Their impact matters



London to New York  
One-way, economy Class

1 tonne CO<sub>2</sub>e

Approximate, 0.85T including radioactive forcing - from <https://www.carbonfootprint.com/calculator.aspx>



An aerial photograph of the CIBC Square skyscraper in Toronto, Canada. The building is a prominent feature with its distinctive glass facade and diamond-shaped structural elements. It is surrounded by other high-rise buildings in the downtown core. In the background, the city extends to the waterfront, with a body of water visible on the left. The sky is clear and blue.

← 500,000  
tonnes CO<sub>2</sub>e

CIBC Square  
(estimate based on 2.5msqft office space @ 2tCO<sub>2</sub>e/m<sup>2</sup>)





Better design

**10,000** tonnes CO<sub>2</sub>e

## Their impact matters



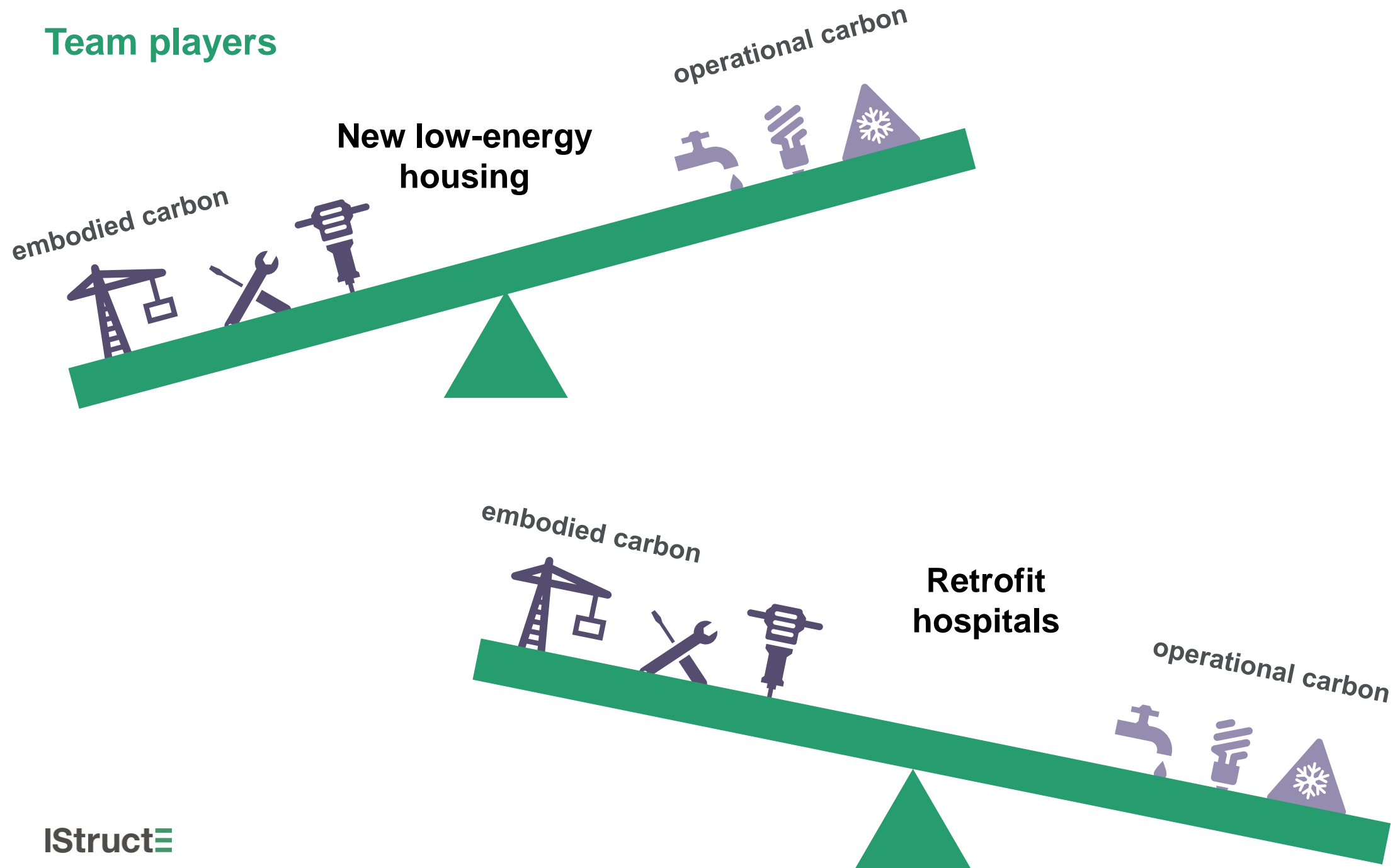
**1** tonne CO<sub>2</sub>e



**10,000** tonnes CO<sub>2</sub>e

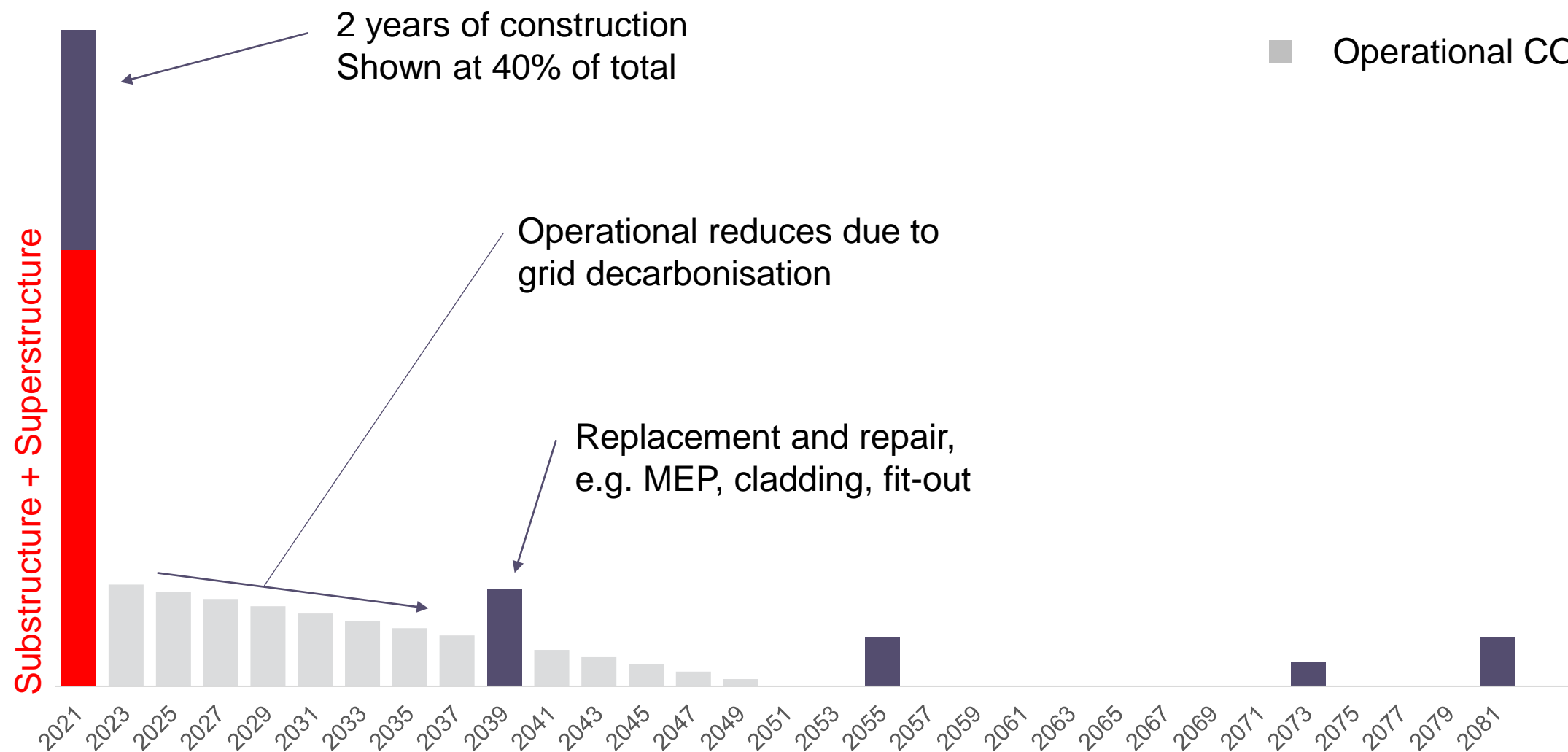


## Team players



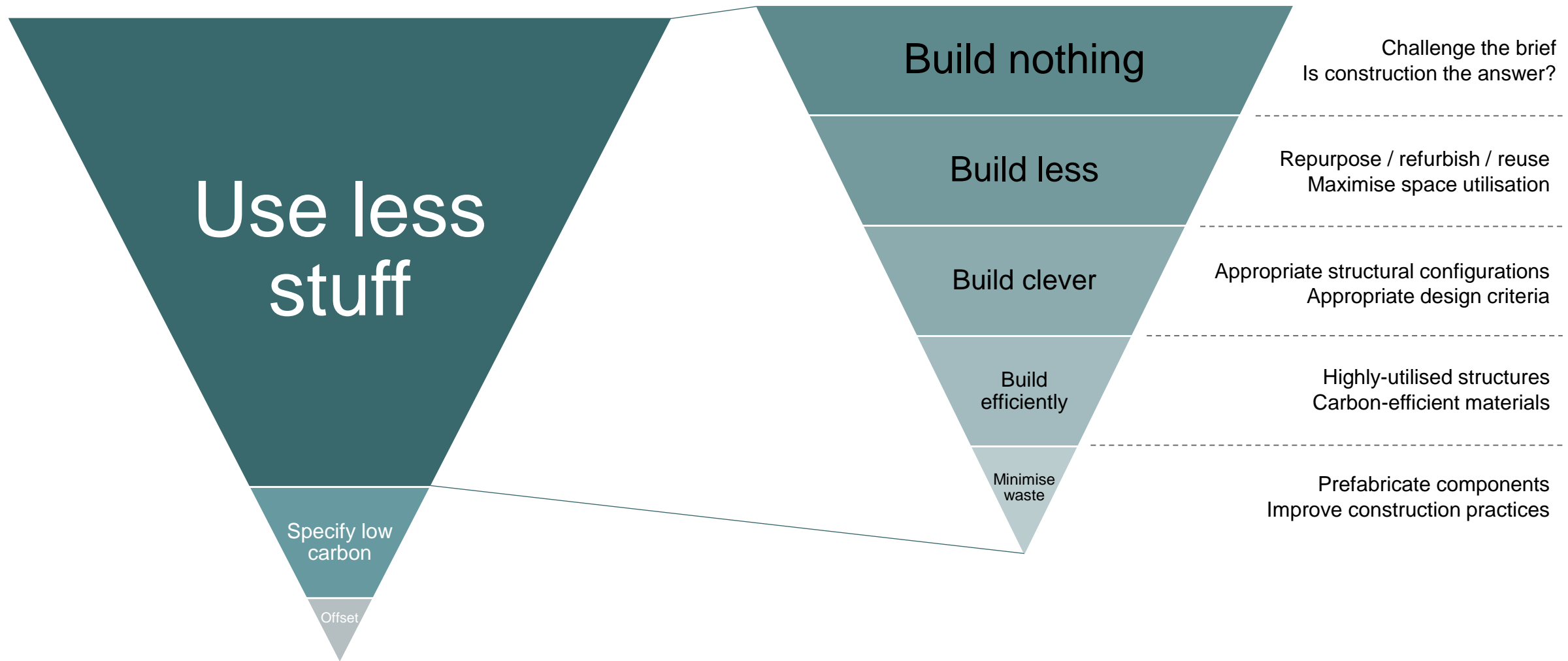
# It's about time

- Embodied CO<sub>2</sub>e
- Operational CO<sub>2</sub>e



# Equipping them

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## Challenge the brief



Will demolition become a thing of the past?

JAMES NORMAN

<https://www.istructe.org/IStructE/media/Public/TSE-Archive/2020/Nothing-is-better-than-something.pdf>



## Repurpose and reuse



Grosvenor Material Reuse hub

<https://www.grosvenor.com/our-businesses/grosvenor-britain-ireland/environmental-leadership/accelerating-material-re-use>

## Appropriate structural configurations





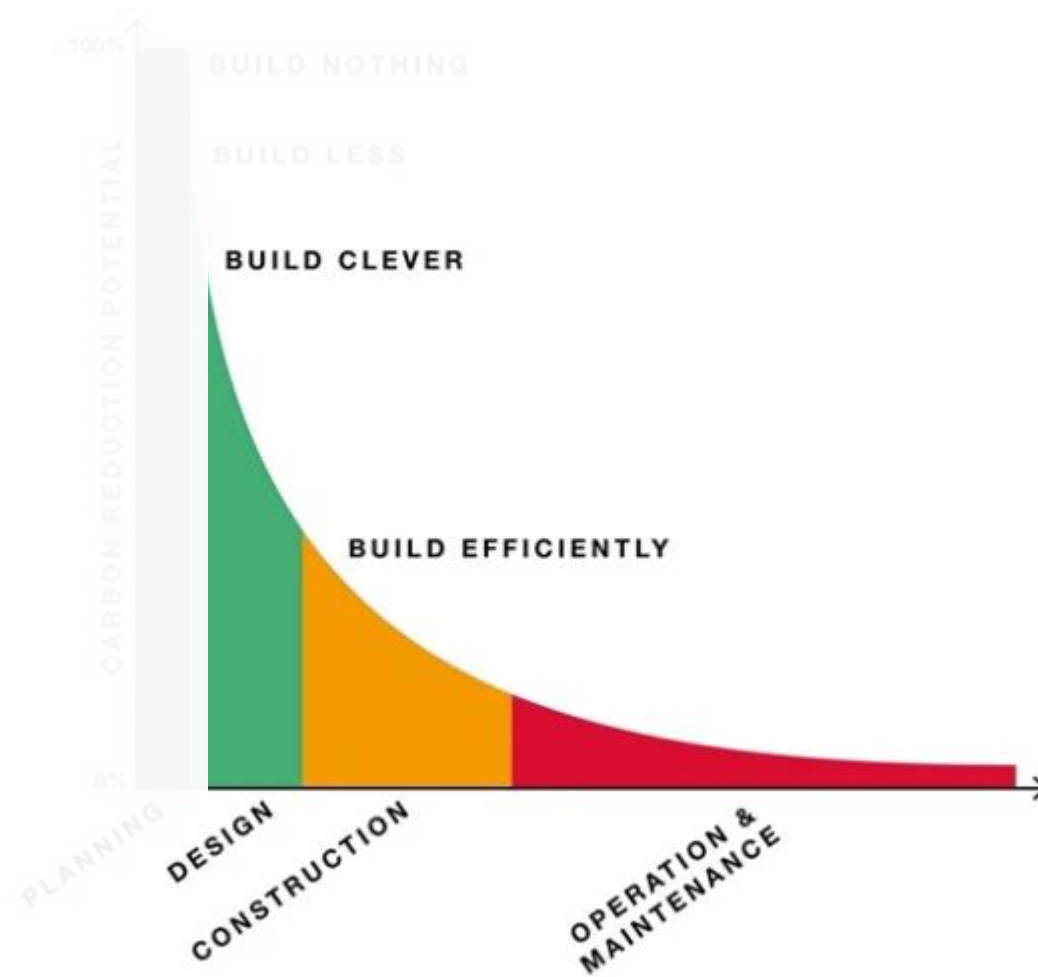
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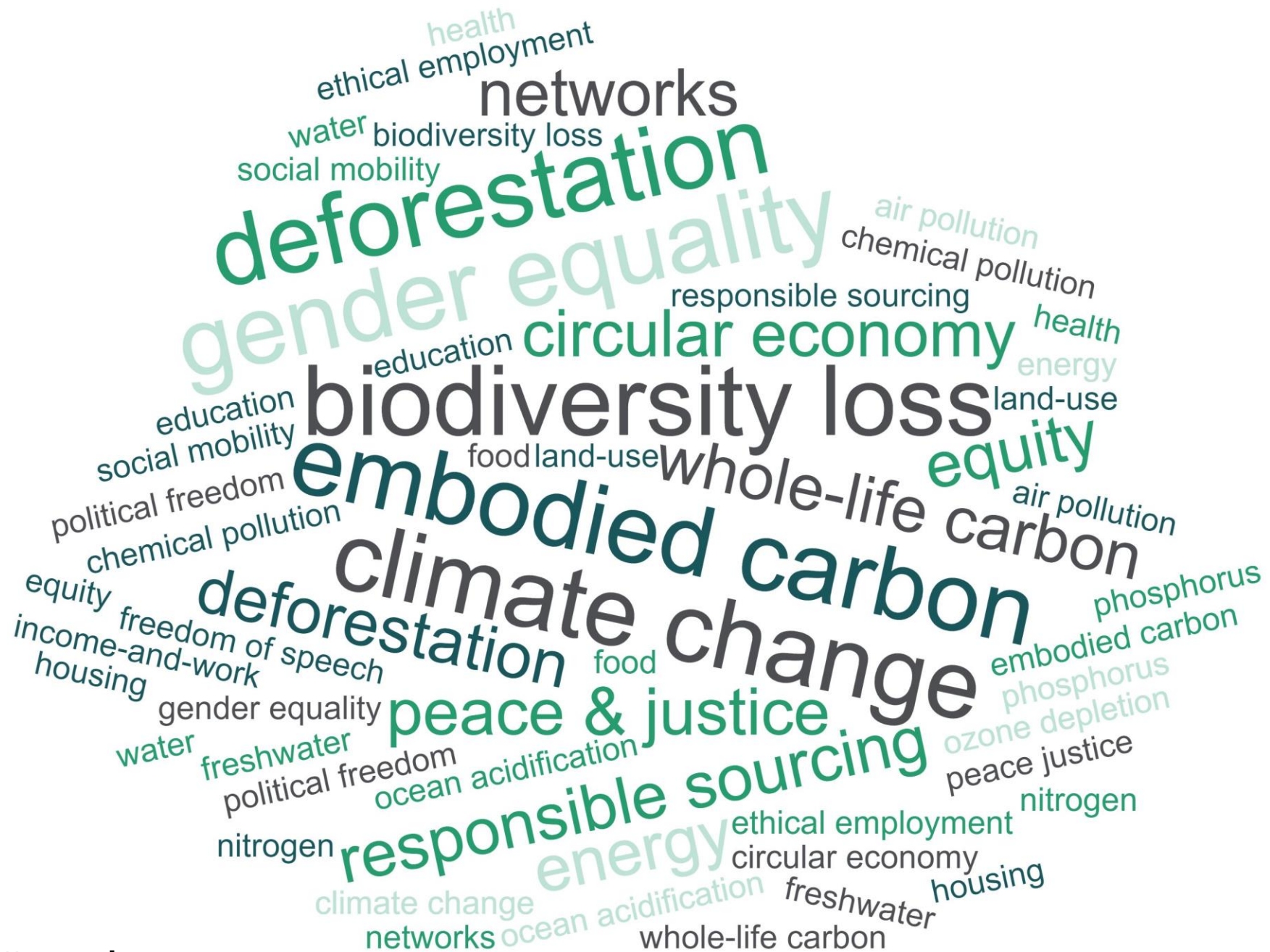
UNIVERSITY OF  
CAMBRIDGE

$5.60 \text{ kN/m}^2$   
29 people over  $3.75 \text{ m}^2$

Even after all the wrong decisions have been made,  
there are still plenty of decisions left to make



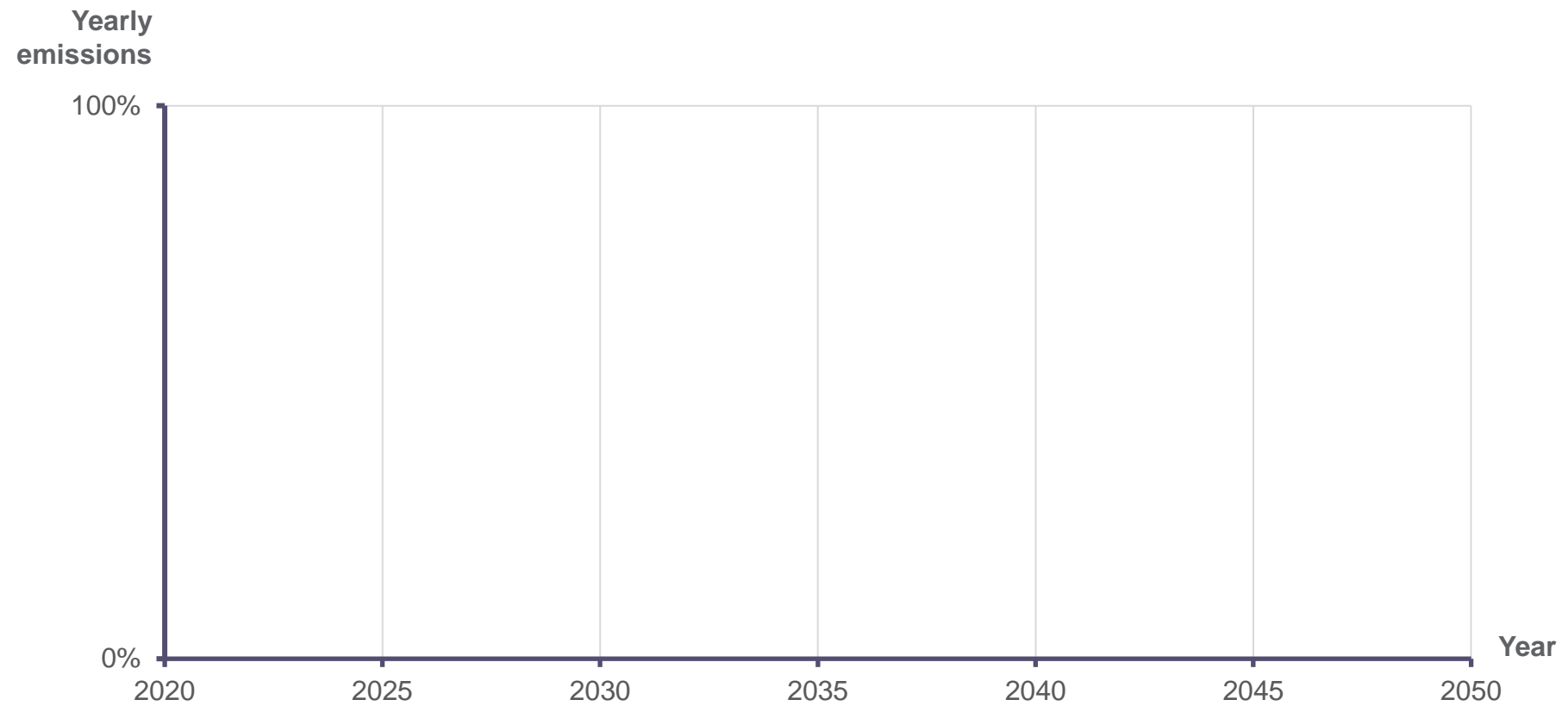


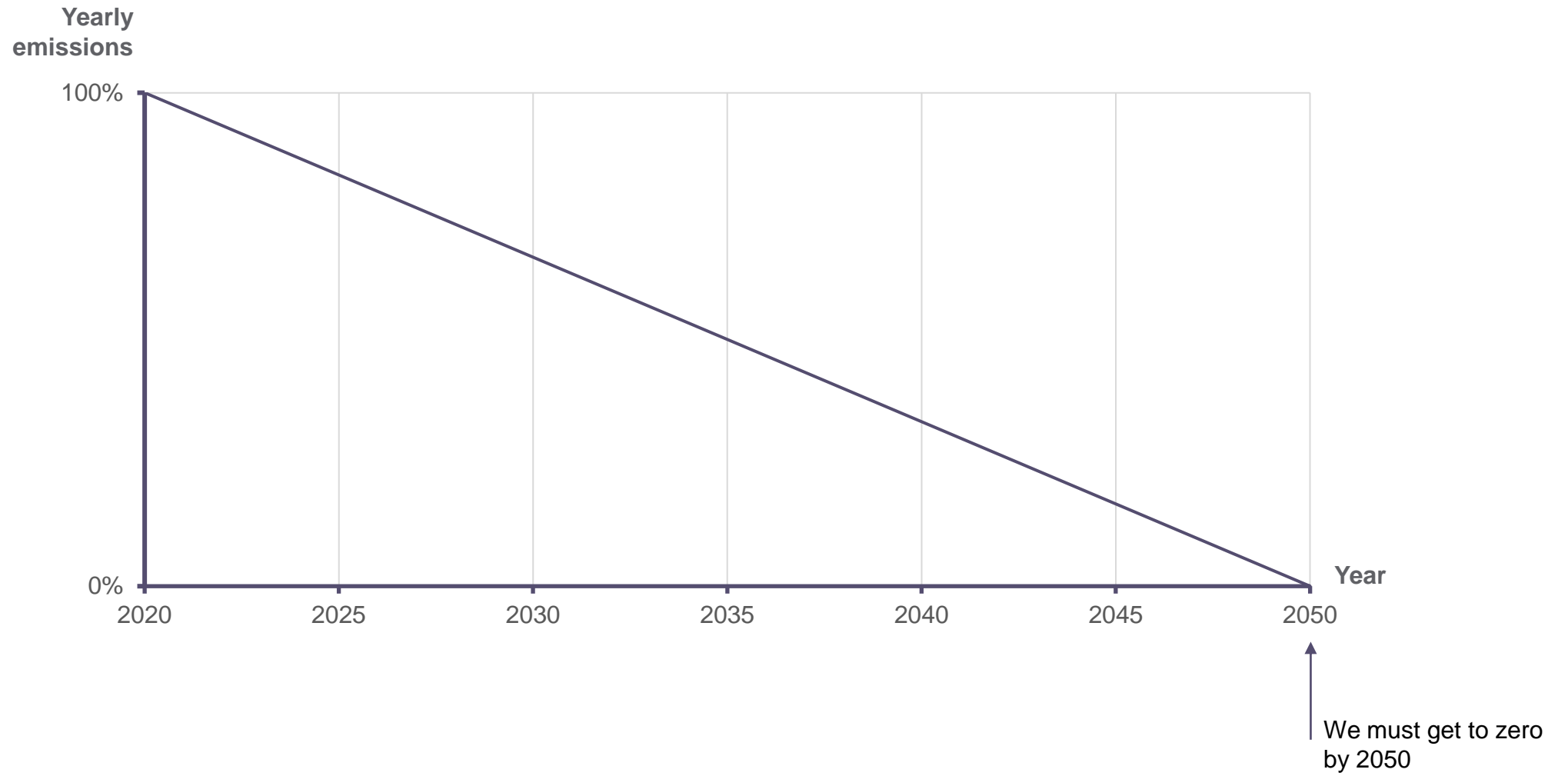


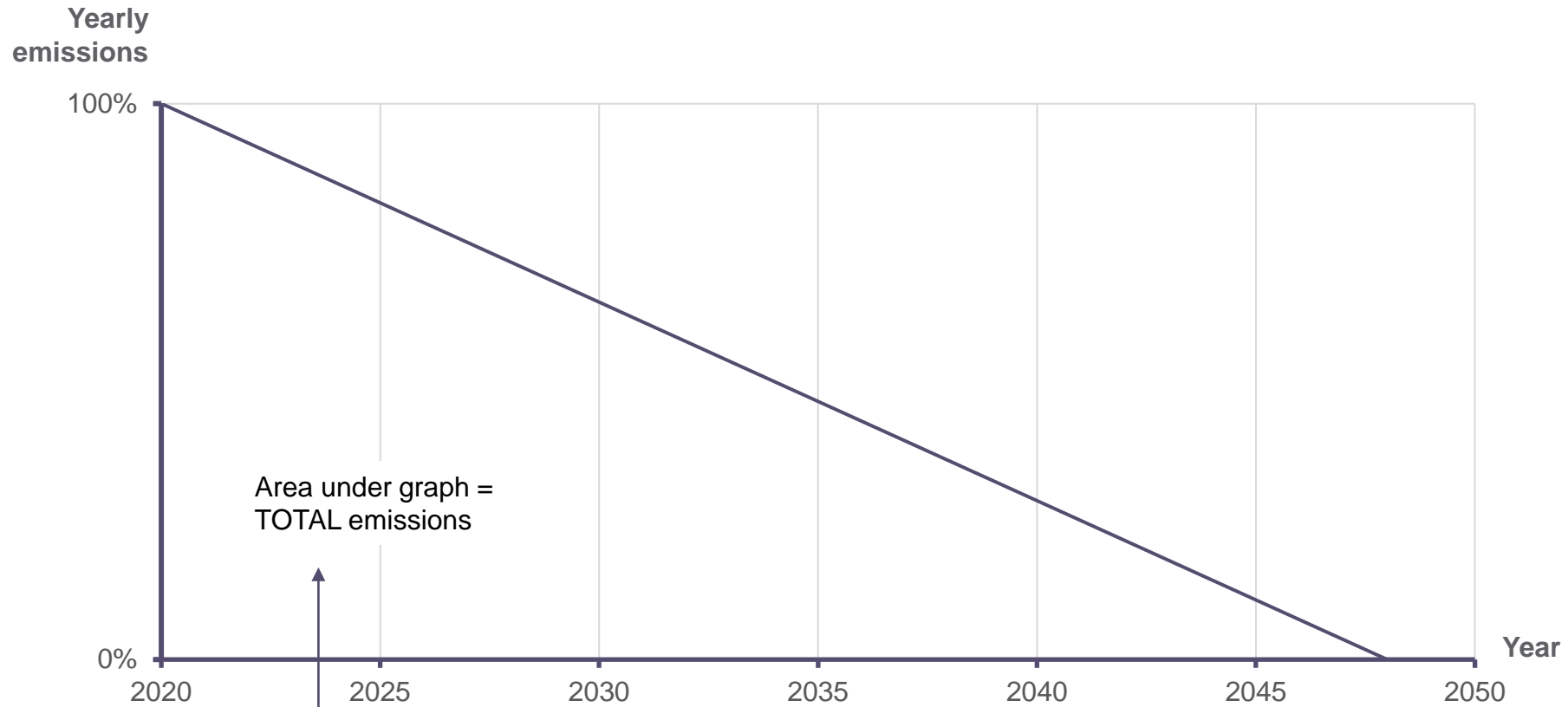


# Research

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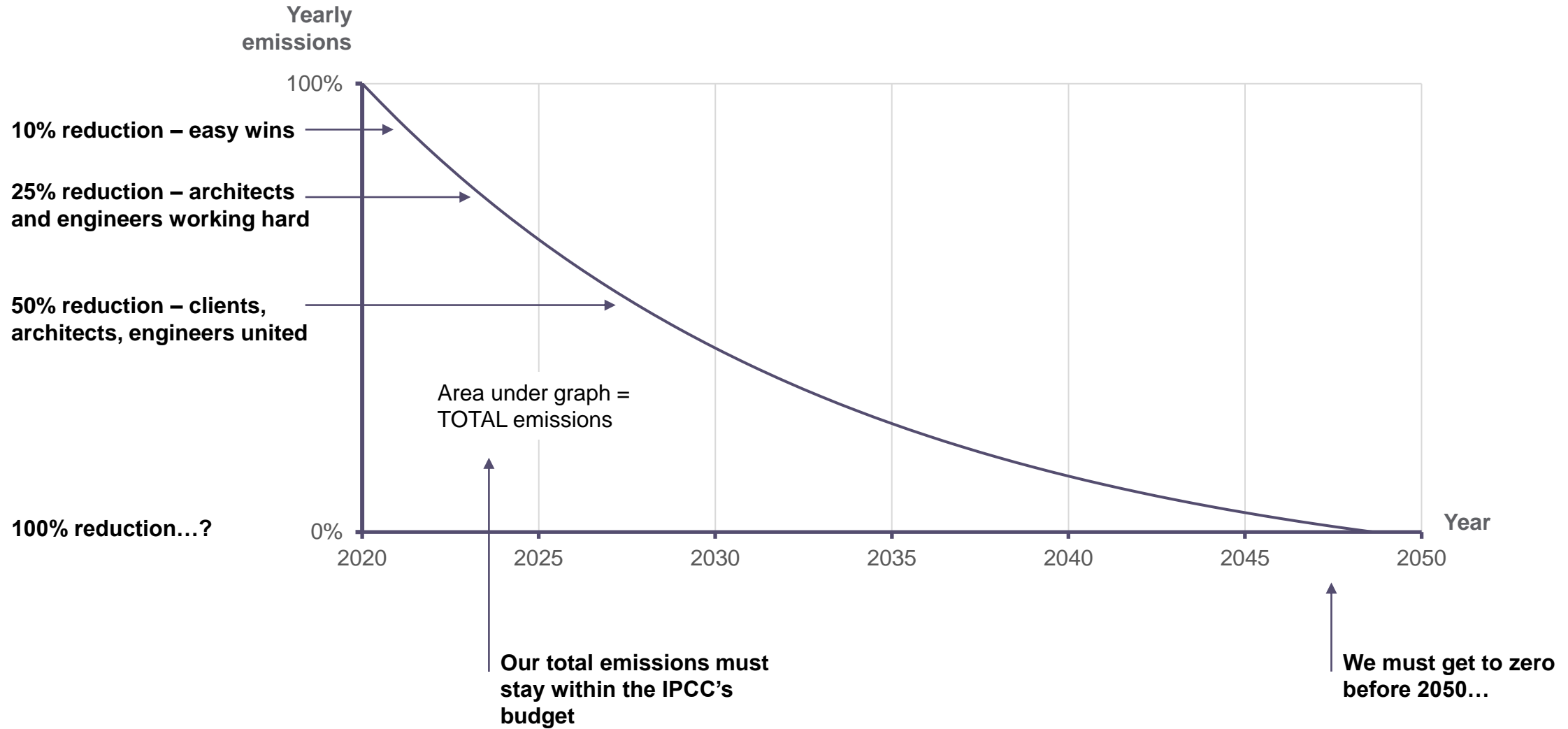


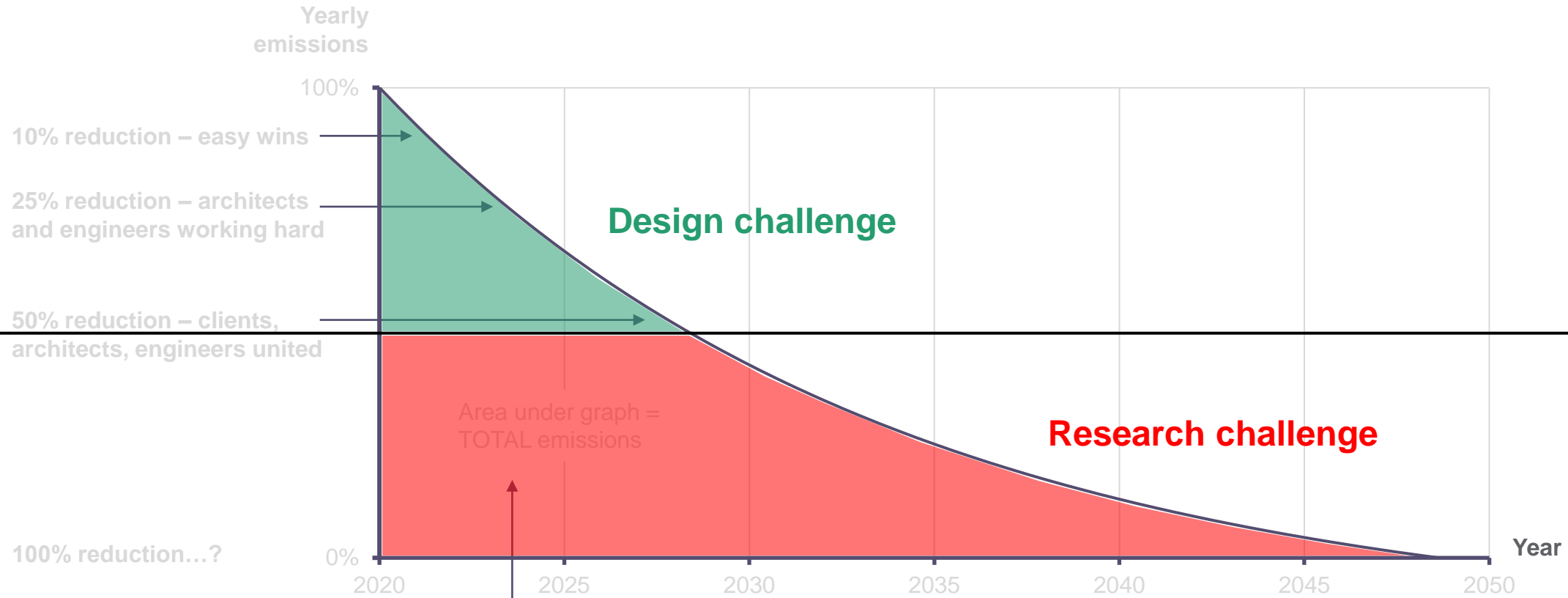


Area under graph =  
TOTAL emissions

**Our total emissions must  
stay within the IPCC's  
budget**

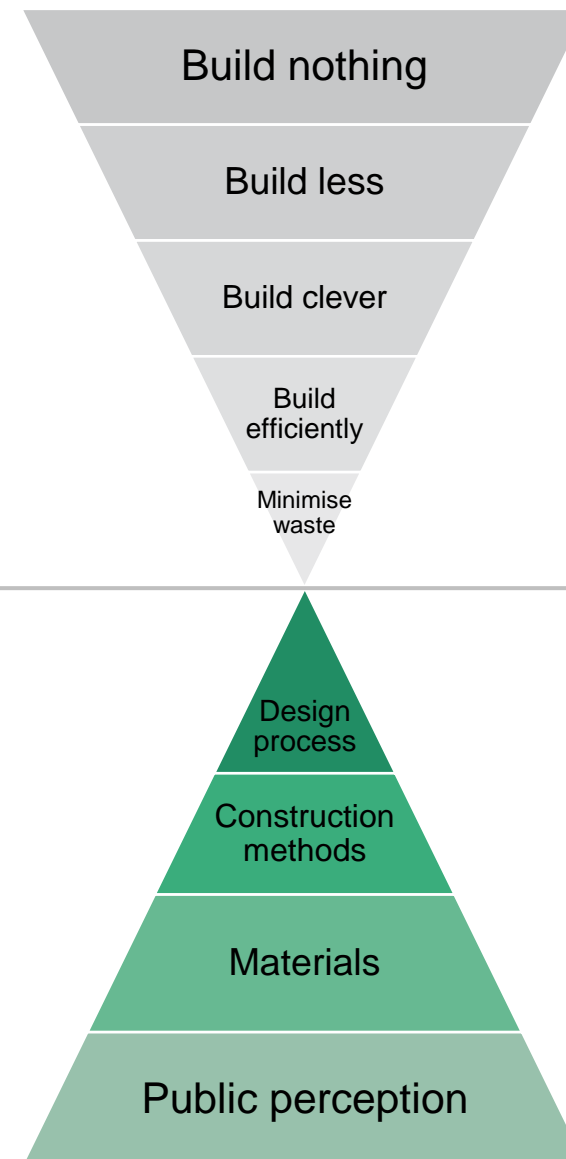
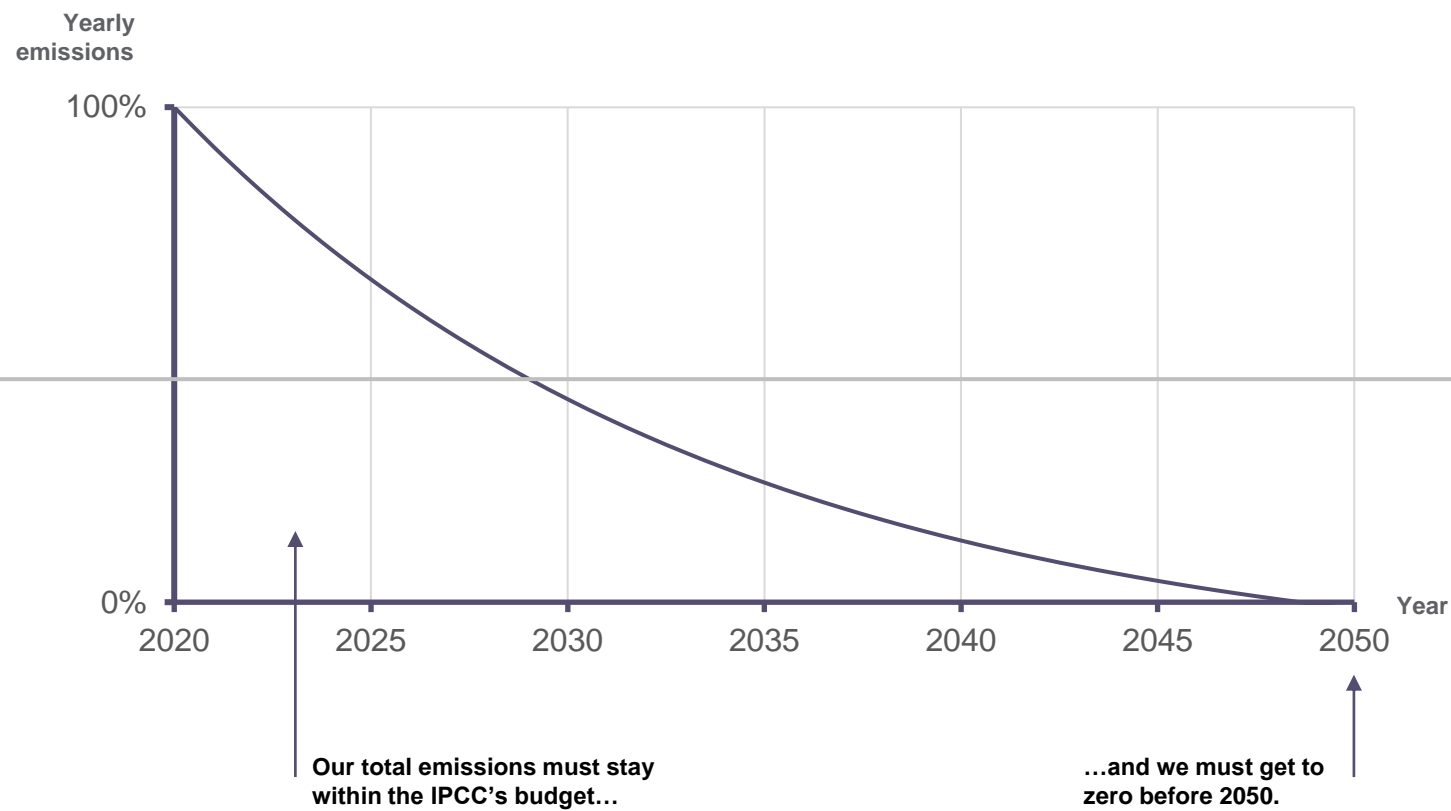
**We must get to zero  
before 2050...**



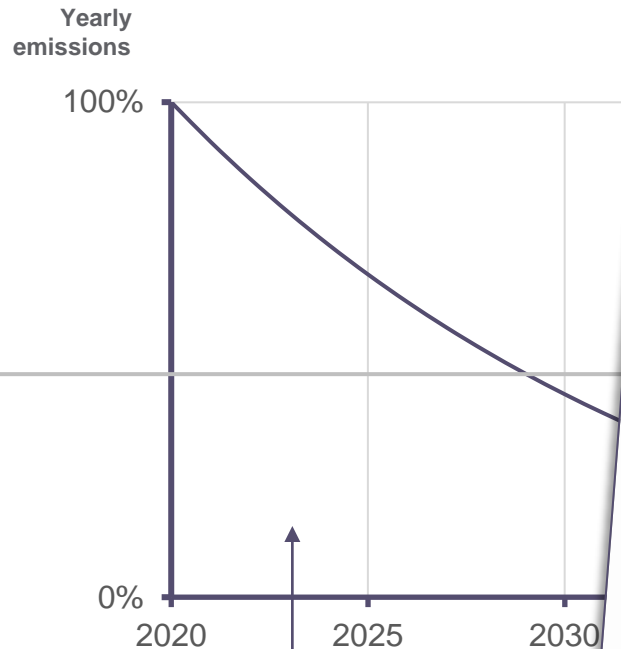


Our total emissions must stay within the IPCC's budget

We must get to zero before 2050...







Our total emissions must  
within the IPCC's budget

Climate emergency ■ Innovating for zero carbon

**co<sub>2</sub> 2.Low carbon**

## Structural engineering innovation for a zero-carbon world: an R&D agenda to match the carbon budget

Pete Winslow, Mike Sefton and Will Arnold set out a vision for a net-zero structural engineering sector and the R&D that we as a profession need to tackle to get there.

**Introduction**  
The IPCC Special Report on Global Warming of 1.5°C shows the importance to our planet and society of limiting further global temperature increases and of the emissions reductions required to achieve this. Reaching net zero by 2050 is the headline target, but it is also critical to reduce carbon dioxide (CO<sub>2</sub>) emissions by 45% by 2030 compared with 2010 levels, and to keep total greenhouse gas emissions below the global 440GtCO<sub>2</sub>e 'budget' (for the period 2021–60, derived from IPCC data). As discussed by Arnold et al<sup>1</sup>, this means we need to make significant annual emissions reductions of around 10% per year, year on year, starting now.

This article considers these reductions within construction split into 'now and next' (Figure 1). The 'now' harnesses a cultural shift in design using existing technology to reduce emissions in the immediate years ahead. In the past year, the Institution of Structural Engineers has published significant amounts of guidance to support this. However, at some point we will reach the limit of emissions reductions through this approach. At which time the 'next' phase will need to be ready to provide further reduction opportunities.

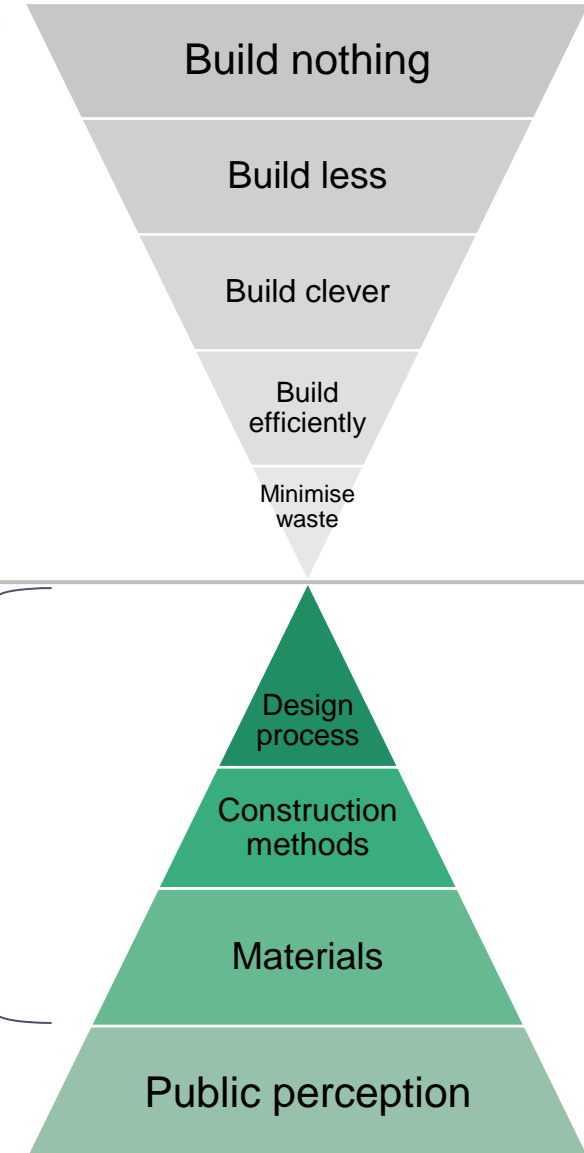
The 'next' phase relies on technology which currently requires either new fundamental research or, more realistically within the timeframe required, the scaling-up of existing technology and the development and implementation of emerging technology. It is imperative to boost this research, development and innovation work now in order that, as the gains of the 'now' phase lose pace, we have new approaches to continue making carbon reductions year on year over the coming decades.

This article sets out a research, development and innovation agenda, aiming to promote, inform and steer the collective effort – of both practising engineers and researchers – to rapidly and coherently transition to a zero-carbon world. No single initiative identified is a 'silver bullet' and simply waiting for new technologies is not a viable pathway to keep warming within 1.5°C. While this portfolio of needed technologies and approaches is in development, we still need to take as much action as possible on today's projects, to enable optimal outcomes within current parameters.

Although the primary focus of this article is greenhouse gas emissions reductions, the importance of biodiversity cannot be overstated. This has been reinforced by the recent publication of *The Economics of Biodiversity: The Dasgupta Review*<sup>2</sup>, which promotes nature-based solutions to enhance biodiversity and is also a key part of the UK Structural Engineers Declare Climate & Biodiversity Emergency movement. Low-carbon construction has little meaning without the biodiversity needed to sustain life, fertile crops, etc., and so a key tenet flowing through all R&D – from industrial ecology of timber to novel structural manufacturing processes – will be the need to consider and improve biodiversity, a critical topic for many future articles.

**Challenges of today**  
The agenda set out in this article reflects the orders of magnitude of emissions that the structure contributes at each stage of an asset's lifecycle.

**FIGURE 1: Carbon reductions 'now and next'**



# Something's got to give

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# Priorities

Moment redistribution  
Computational flow dynamics  
Soil mechanics  
Hydraulics  
Finite element analysis  
Second order differential equations  
CAD

Understanding structural behaviour  
Learning 'on the job'  
Being OK with being wrong  
Critical evaluation  
Collaboration  
Designing for people  
Non-verbal communication

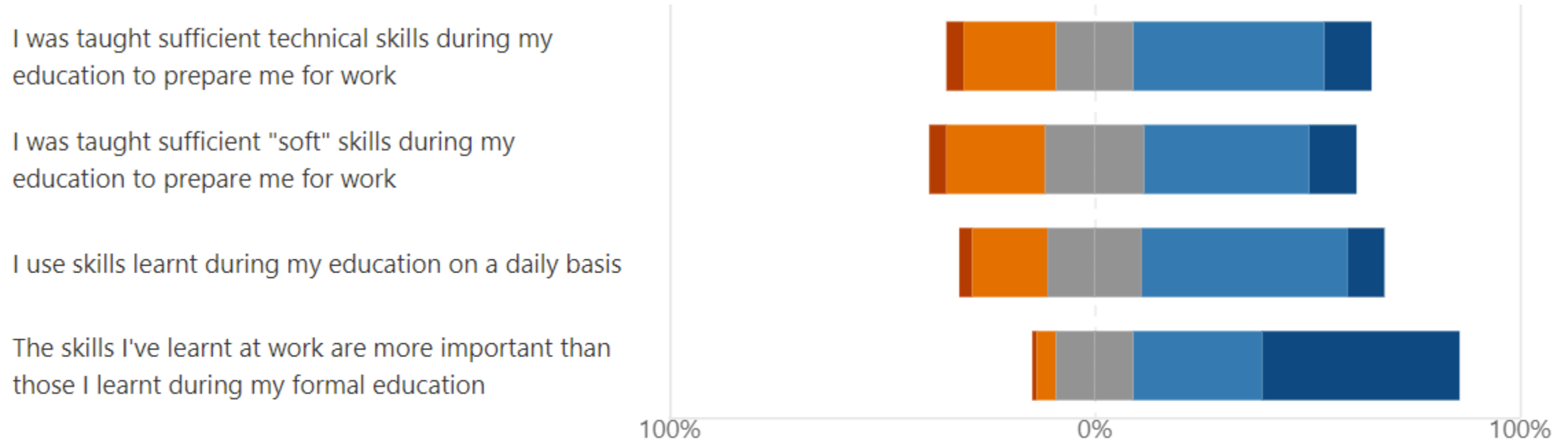


## Your graduates' feedback

### 12. Education: How well do you agree with these statements?

[More Details](#)

Strongly disagree Disagree Neutral Agree Strongly agree



# Thank you

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[will.arnold@istructe.org](mailto:will.arnold@istructe.org)