The building paradox

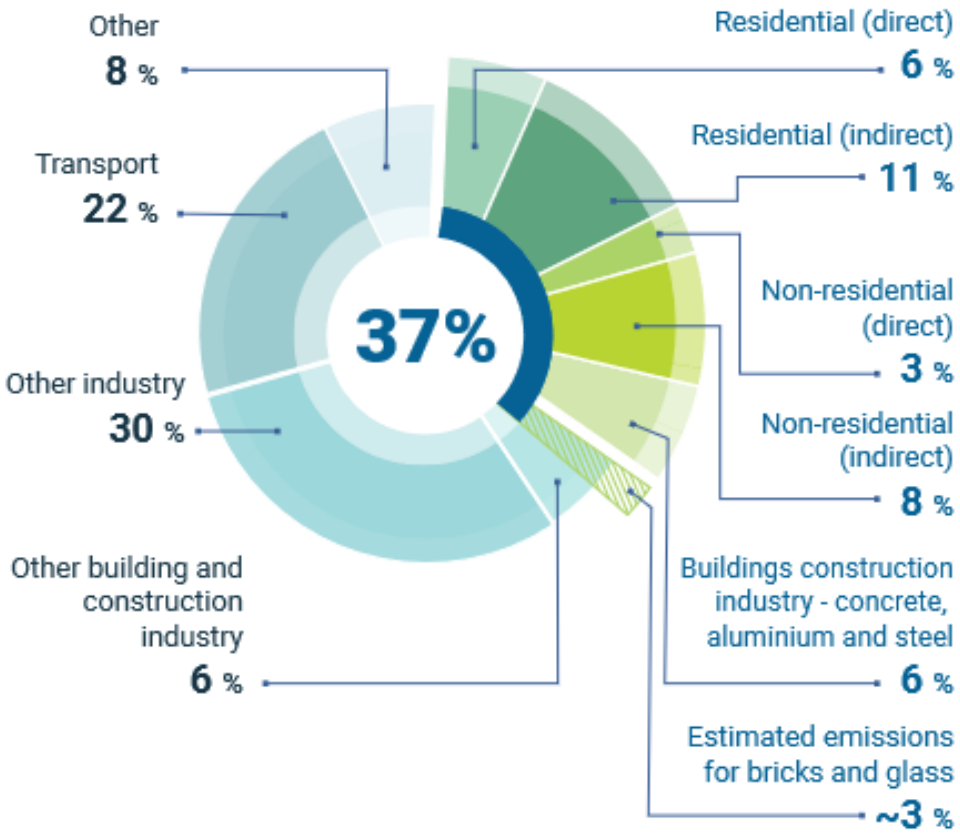
Philip Oldfield
UNSW Built Environment, Sydney

Photo by Jonny Miller


To build: a necessary societal good

To build: an environmental bad?

Buildings are responsible for **37%** of global CO2 emissions



The cement industry is estimated to contribute **8%** of all global anthropogenic CO2 emissions

Source: UNEP (2022). *2022 Global Status Report for Buildings and Construction*

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To build: an environmental bad?

Source: Elhacham *et al.* (2020). Global human-made mass exceeds all living biomass, *Nature*, 588, pp. 442–444

Visualizing the Scale of Anthropogenic Mass

Anthropogenic mass, or **human-made mass,** refers to the materials embedded within inanimate solid objects that are made by humans.

In 2020, the amount of anthropogenic mass exceeded the weight of all global living biomass.

As humans continue to dominate Earth, questions surrounding our material output are increasing. We break down the composition of all human-made materials and the rate of their production.

1120 Gt

Global Biomass

The dry weight of all life on Earth is comprised of plants, animals, bacteria, fungi, protists, archaea, and viruses, too.

This study converted carbon weight of all life on Earth to dry weight by a factor of 2.25

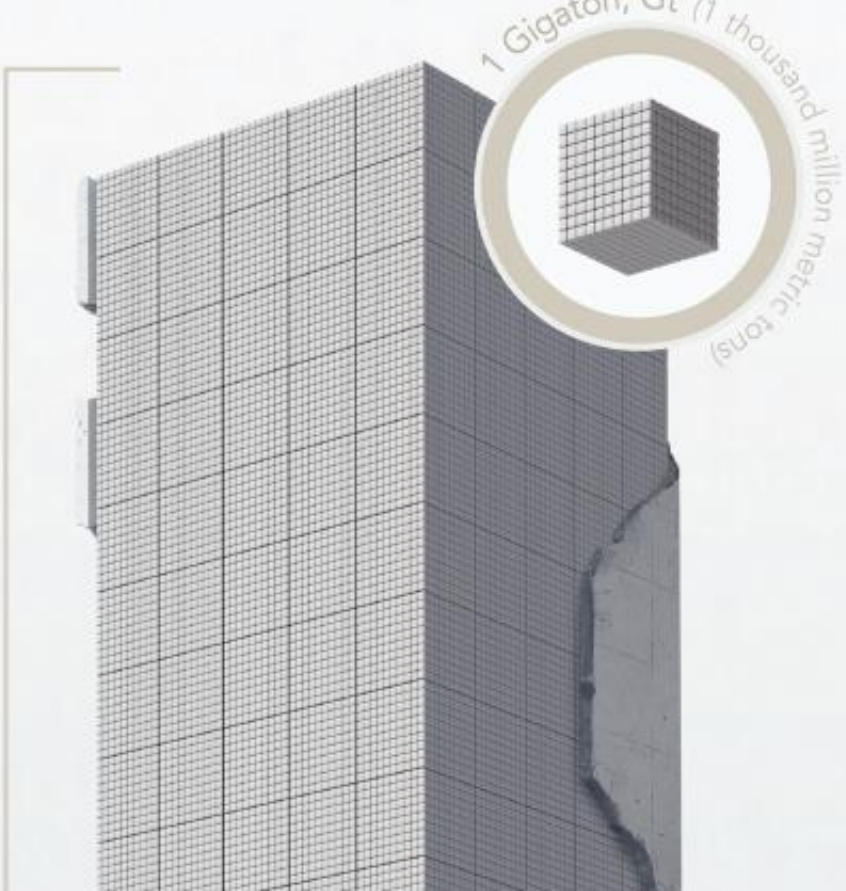
All humans make up ~0.01% of global living biomass.

Humans

1154 Gt

Anthropogenic Mass

Here is everything the human population has created since **1900** to **2020**.



The Impact of Building

Demands are *“equivalent to building the current floor area of Japan every single year from now until 2060”*

x 36

By 2060

Source: Ness (2020). Growth in Floor Area: The Blind Spot to Cutting Carbon. *Emerald Open Research*

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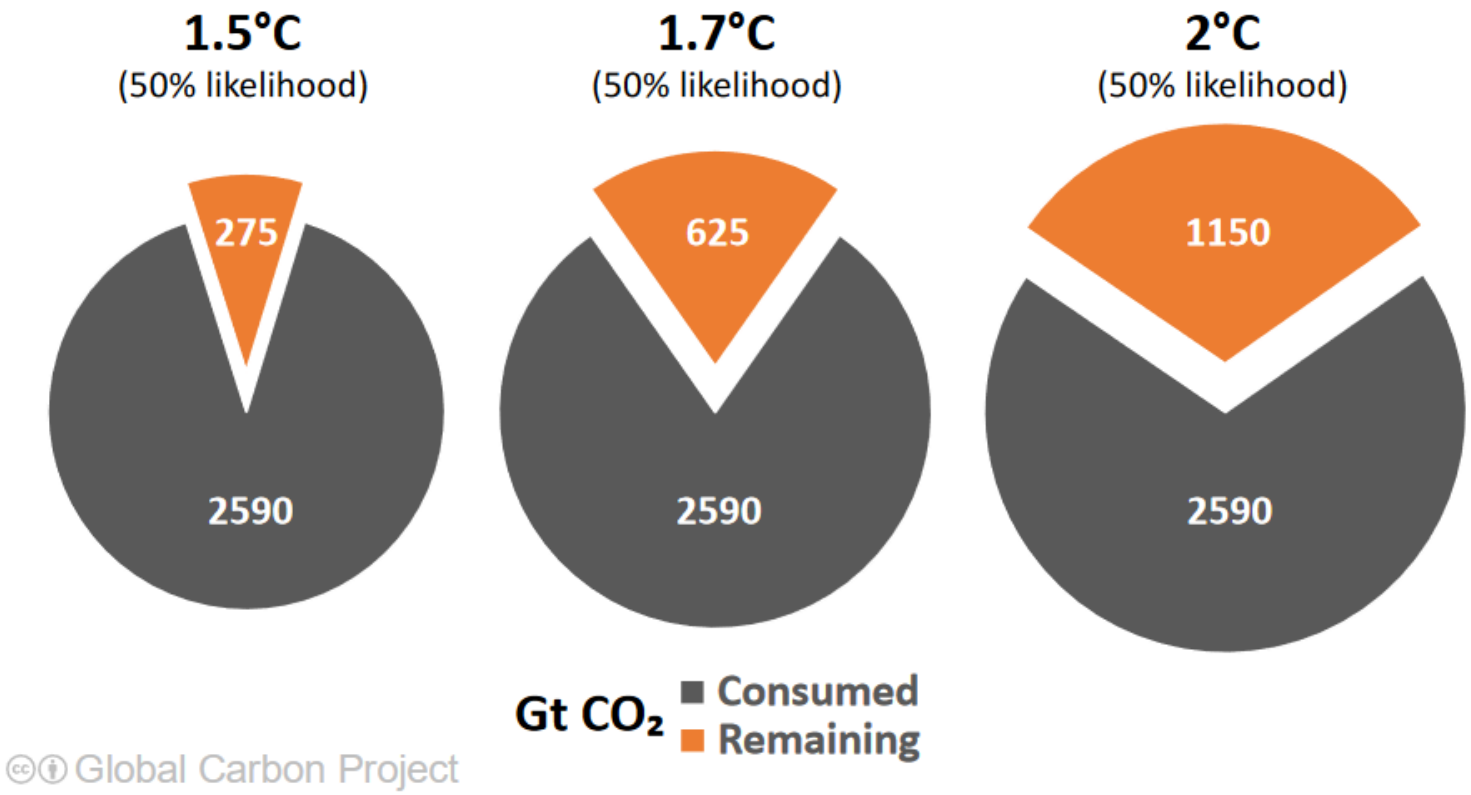
The Impact of Building



The world needs to build 2 billion new homes in the next 75 years

2 billion new homes

X

140 tonnes CO_2e
(the embodied carbon of a typical Australian detached house)

=

280 Gt CO_2e

that is 102% of our total carbon budget before a light is even switched on

Sources: Global Carbon Project, WGBC and data for a typical Australian home taken from Schmidt et al. (2020).

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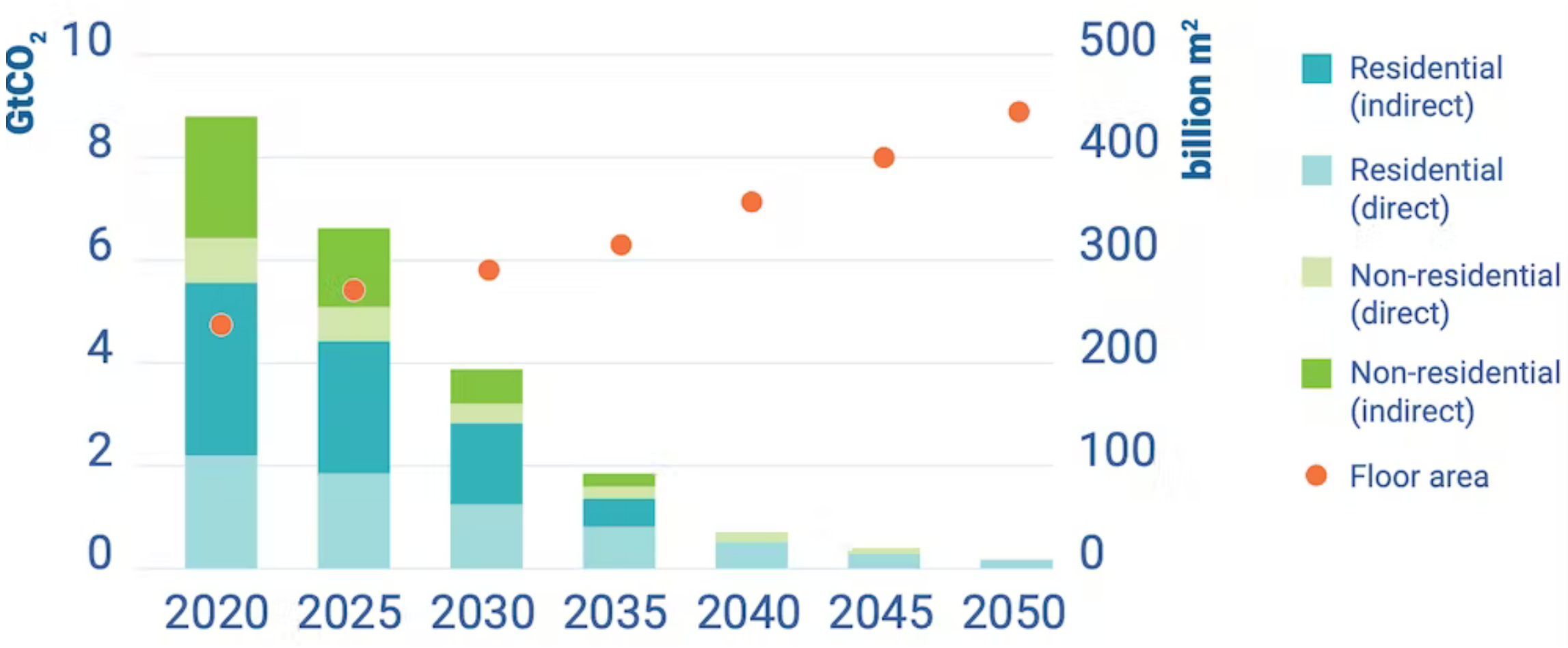
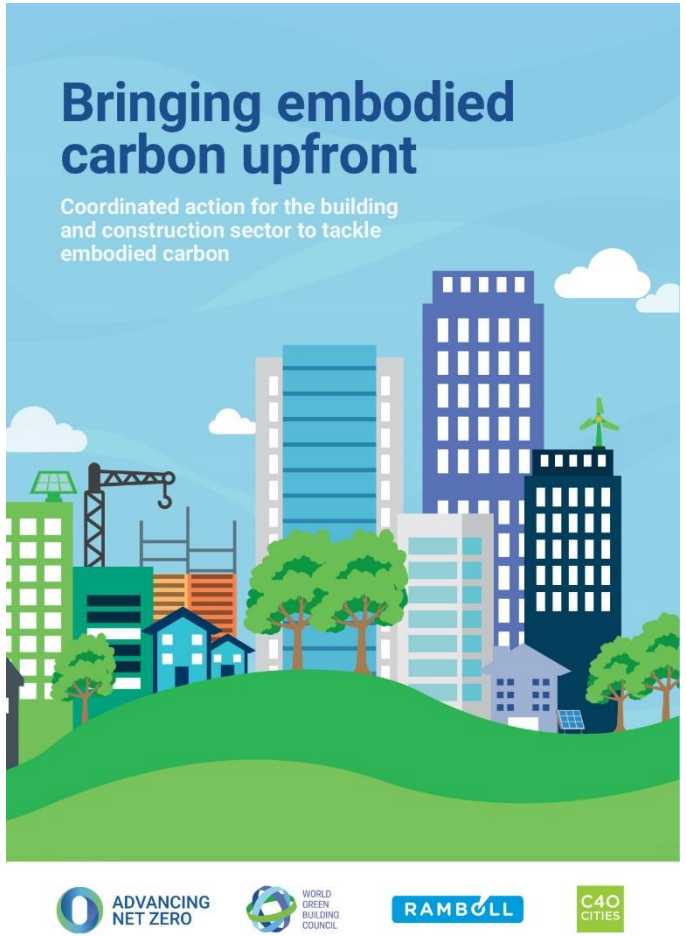
The ‘Building Paradox’



Source: UNEP (2022). *2022 Global Status Report for Buildings and Construction*

Targets, frameworks, definitions…



2030 Targets

- All new buildings, must be net zero operational carbon
- All new buildings, infrastructure and renovations will have at least 40% less embodied carbon

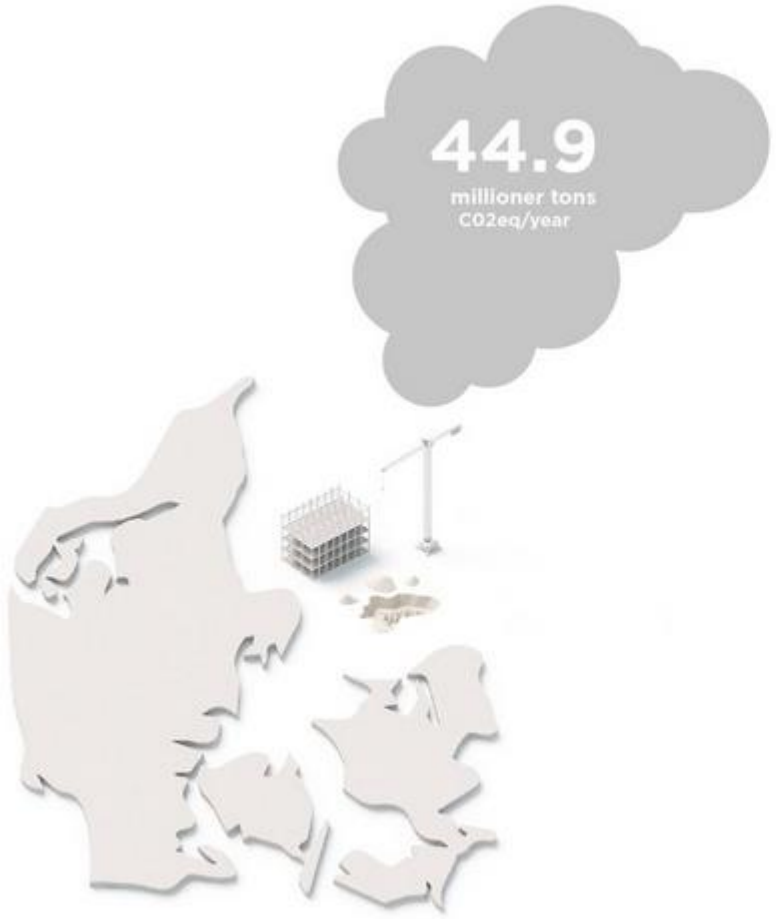
2050 Targets

- All new and existing buildings must be net zero operational carbon
- All new buildings, infrastructure and renovations will have net zero embodied carbon

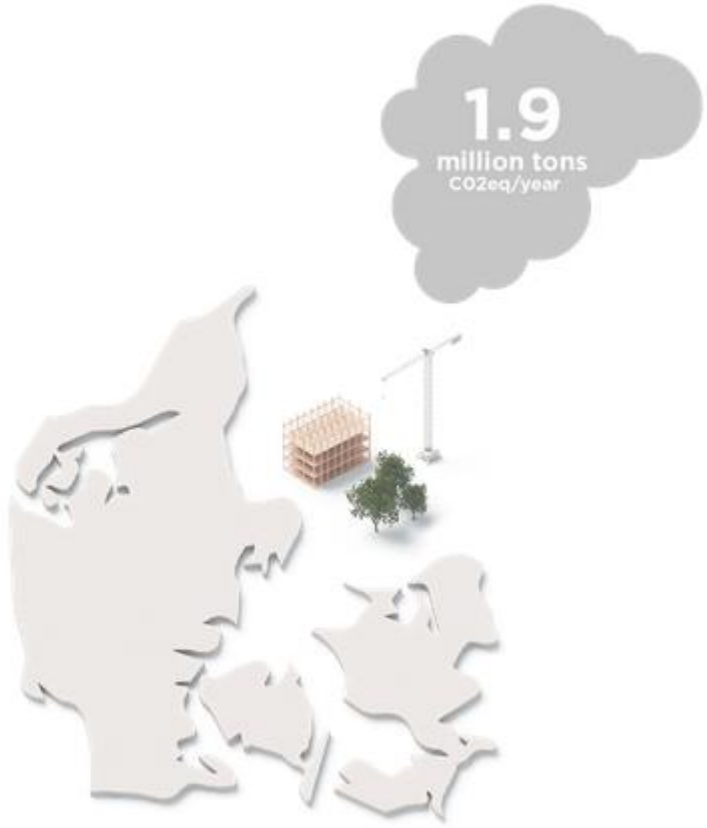
Source: https://worldgbc.org/advancing-net-zero/whole-life-carbon-vision/

Targets, frameworks, definitions…

Reduction Roadmap, Denmark



What current emissions are



What the earth can ‘safely’ handle

Source: https://reductionroadmap.dk/

Targets, frameworks, definitions…

Reduction Roadmap, Denmark

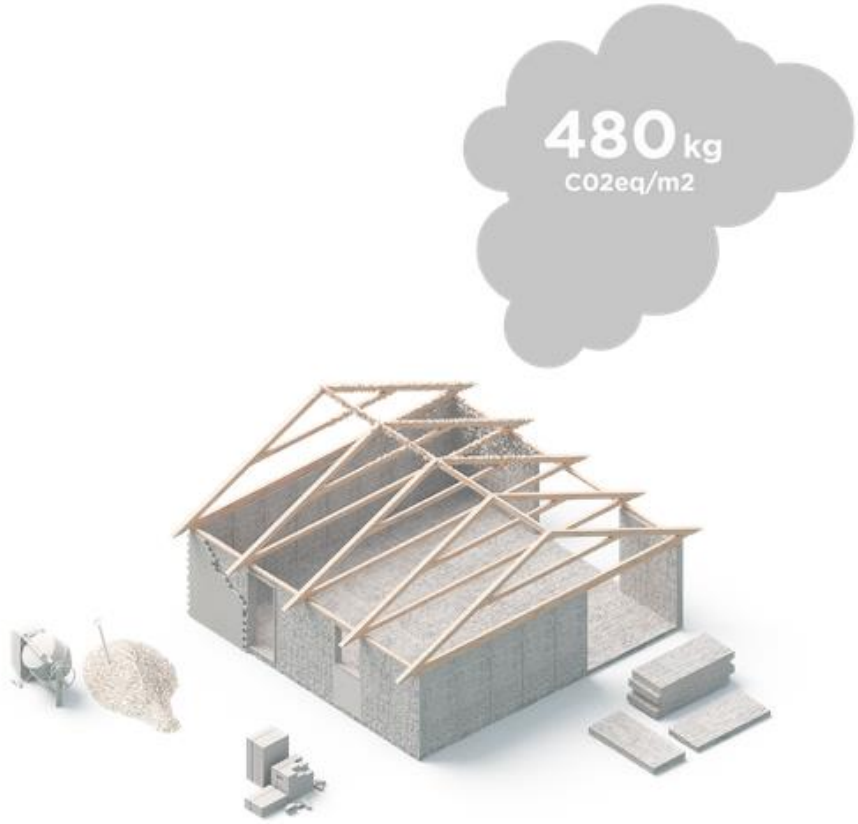
What current emissions are

What the earth can ‘safely’ handle

Source: https://reductionroadmap.dk/

Targets, frameworks, definitions…

Reduction Roadmap, Denmark



What current emissions are

What the earth can ‘safely’ handle

Source: https://reductionroadmap.dk/

A shift towards ‘sufficiency’

“Sufficiency is about long-term actions driven by non-technological solutions, which consume less energy in absolute terms. Efficiency, in contrast is about continuous short-term marginal technological improvements.” [IPCC]

1. Can we build *nothing*… sometimes?

Census snapshot: One million homes left empty across Australia

By **Eryk Bagshaw**

Updated July 18, 2017 – 3.30pm, first published July 17, 2017 – 1.32pm

Australia has 200,000 more homes sitting empty than it had a decade ago, new figures show, despite the country grappling with a housing supply shortage that is pushing the cost of a first home beyond many of its residents.

1 million x 140 tonnes of CO2e = 140 million tonnes of CO_2e

Source: https://www.smh.com.au/politics/federal/census-snapshot-one-million-homes-left-empty-across-australia-20170717-gxcpiw.html

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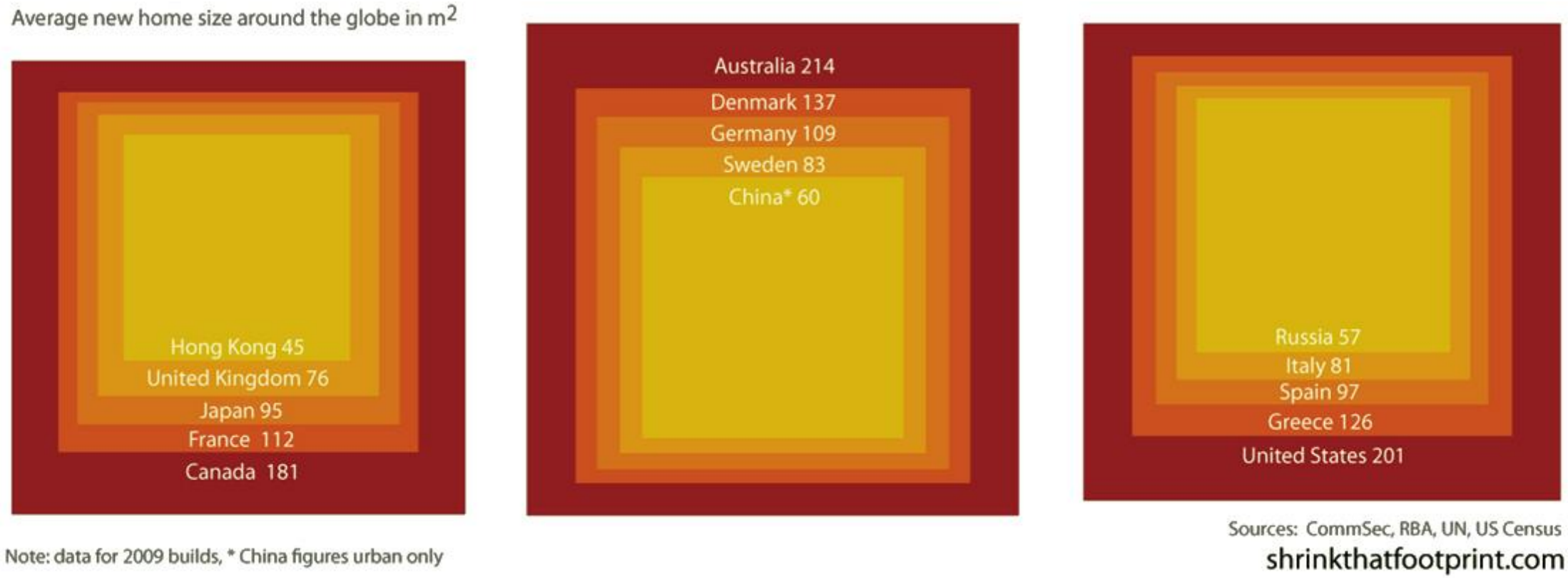
2. Can we build smaller and share more?



Source: http://shrinkthatfootprint.com/how-big-is-a-house

2. Can we build smaller and share more?

Source: https://www.hmfh.com/2019/07/18/schools-as-community-centers/

3. Retrofit First

Quay Quarter Tower, 3XN

Retains 2/3’s of the existing AMP tower built in 1976 and extends the building to the north

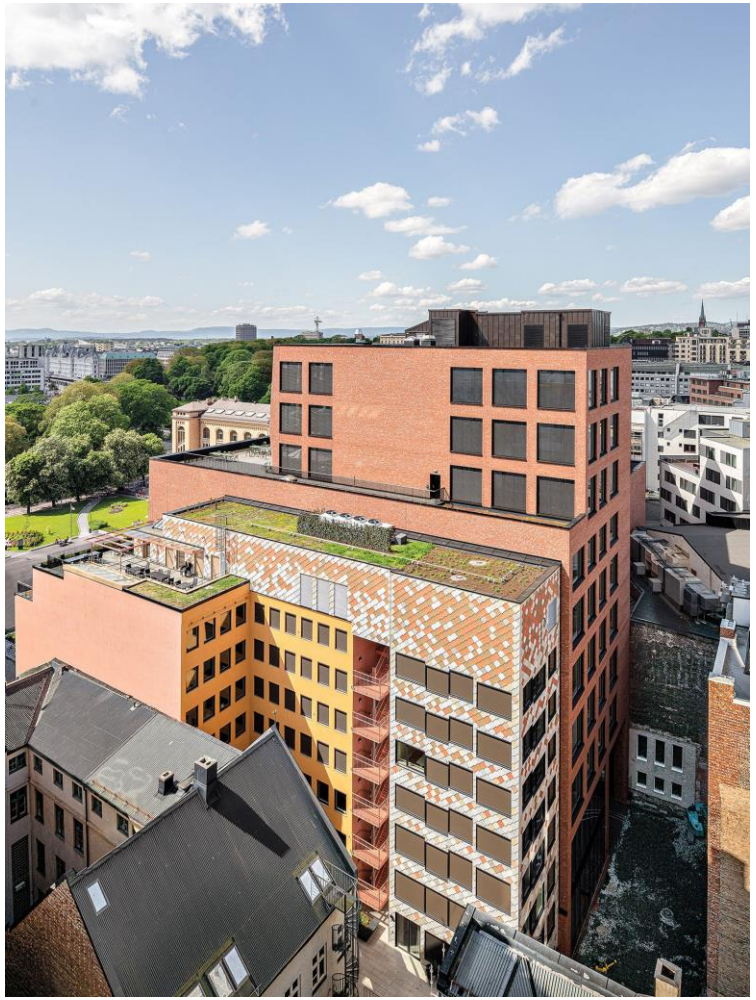
Around the world there are 944 office buildings more than 100m in height that were completed between 1953 and 1983 (53 of which are in Australis)

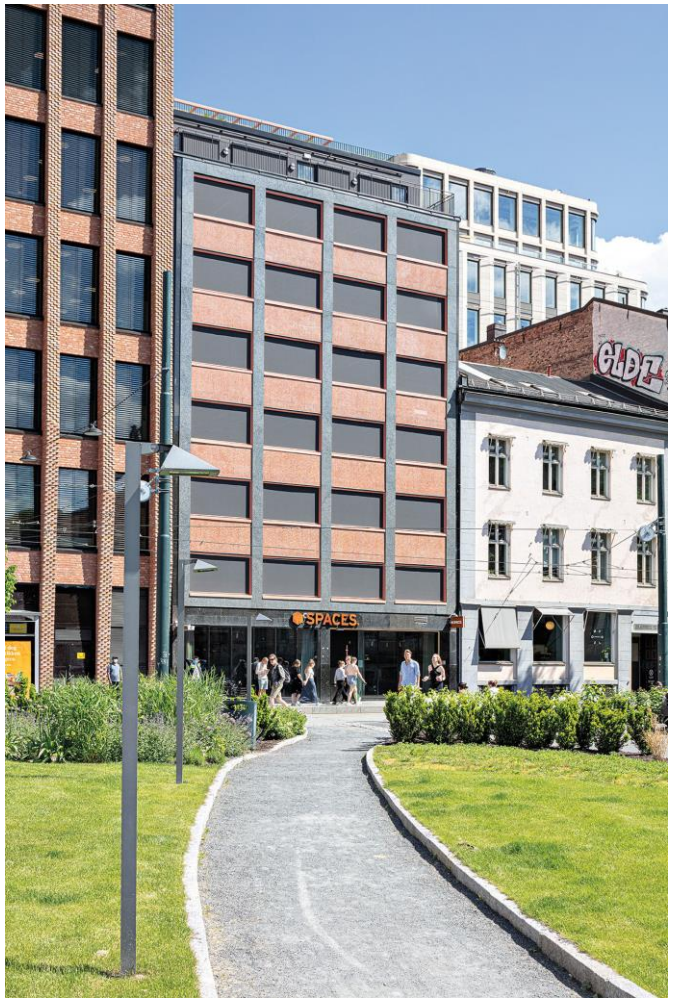
4. Radical upcycling and circular economy

Mad Arkitekter, Kristian Augusts Gate 13, Oslo

70% embodied carbon saving

1. Adaptive reuse of 1958 office
2. 80% reused components – even floor slabs
3. Materials sourced from 25 ‘donor buildings’

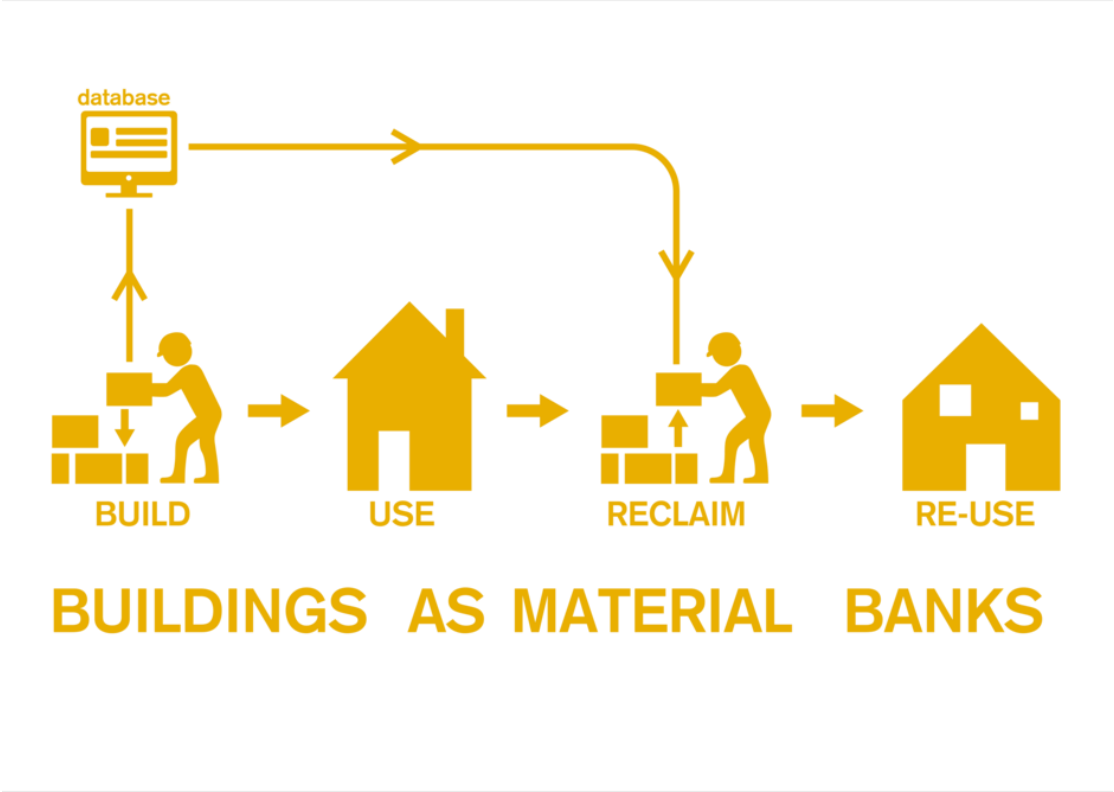




Source: https://metropolismag.com/projects/oslo-workplace-reused-materials-mad-arkitekter/

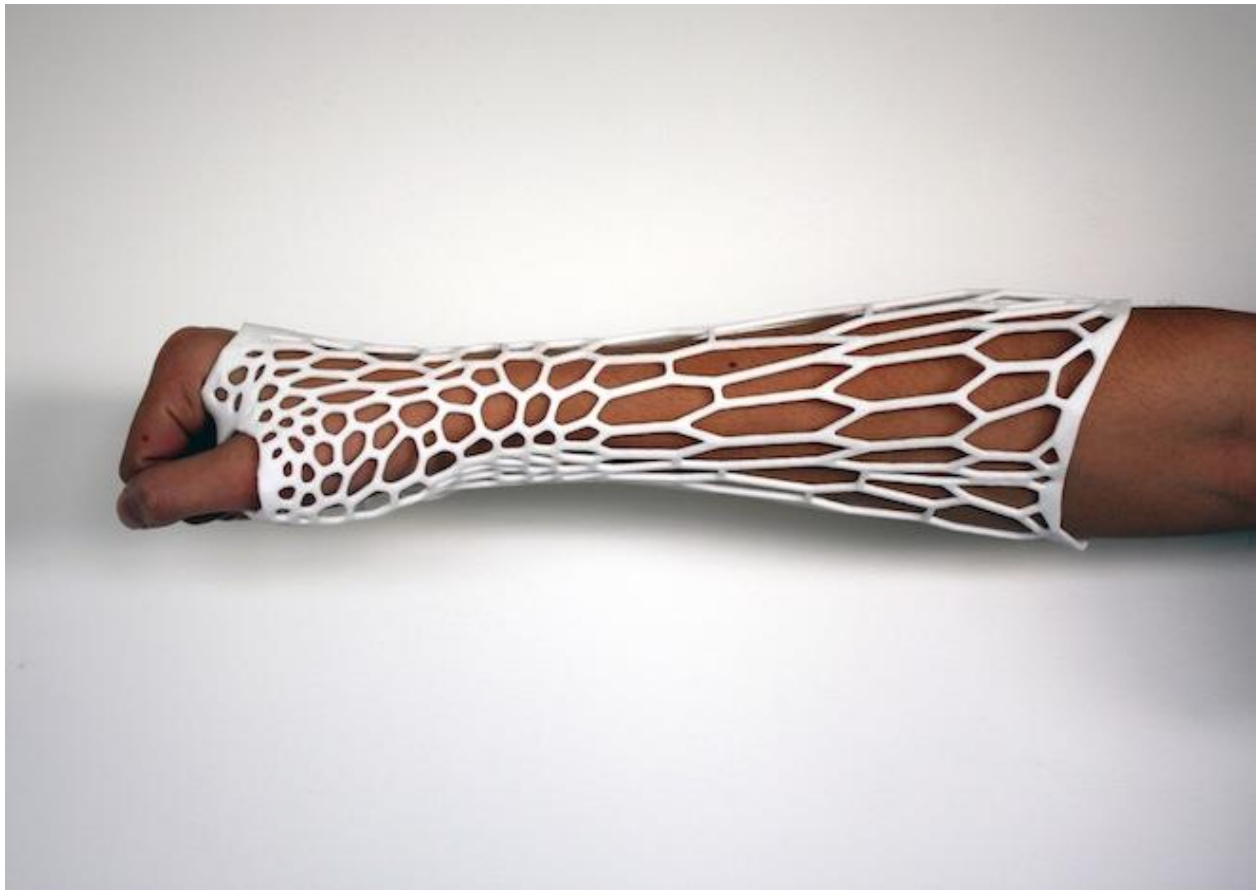
4. Radical upcycling and circular economy

Can we consider buildings as a temporary (long term) resting place for materials?



Source: BBM Sustainable Design

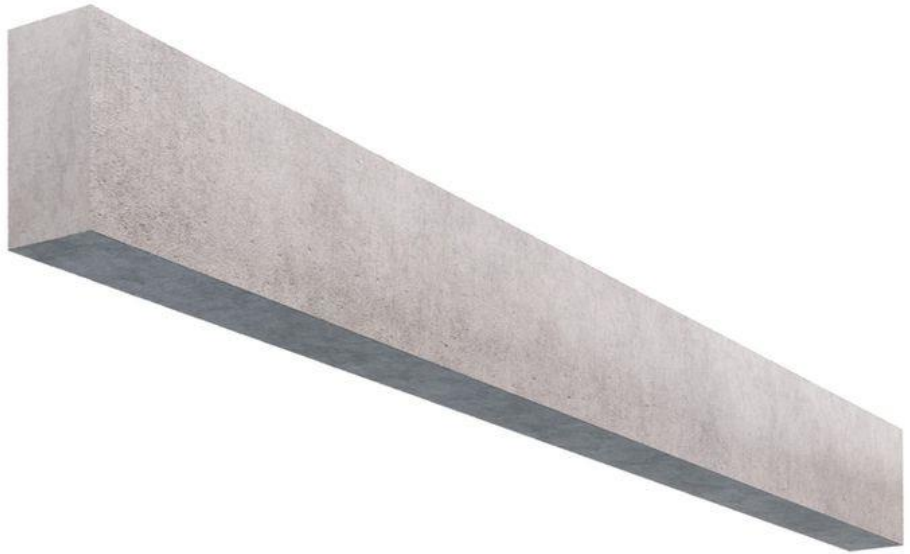
5. Treating all materials as precious



Source: http://www.wired.com/2013/07/is-this-cast-the-future-of-healing-broken-bones/

5. Treating all materials as precious

the mission: minimum construction for maximum development



conventional beam

minimass™ beam

78%

reduction in concrete
vs conventional beam

Source: minimass hybrid beam https://www.minimass.net/

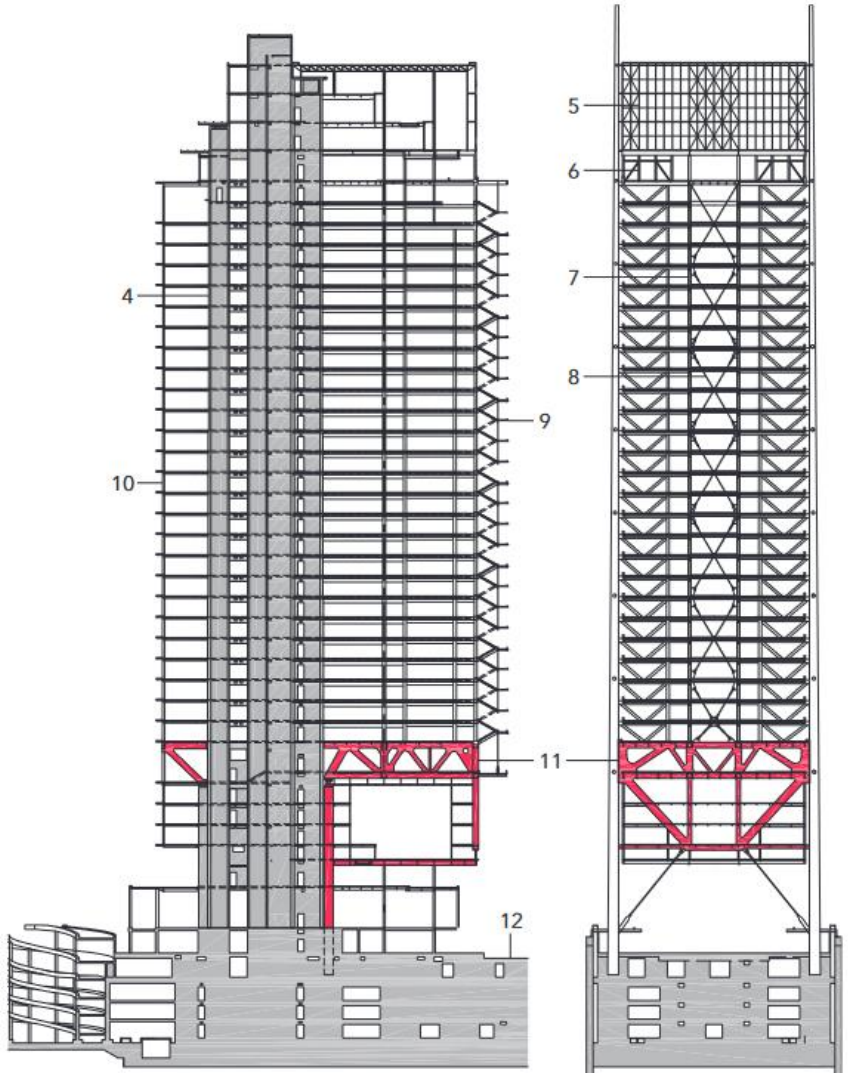
6. Balancing social benefit with environmental impact

Intesa Sanpaolo Tower, Turin

2,350 tonne transfer truss to create an open public auditorium at ground

Embodied carbon of steel = 2.9kgCO_2e/kg (EPiC data)

Total embodied carbon of truss = 6,815 tonnes CO_2e



Source: Images from Detail Magazine

6. Balancing social benefit with environmental impact

The mortality cost of carbon

R. Daniel Bressler

Nature Communications **12**, Article number: 4467 (2021) | Cite this article

Abstract

Many studies project that climate change can cause a significant number of excess deaths. Yet, in integrated assessment models (IAMs) that determine the social cost of carbon (SCC) and prescribe optimal climate policy, human mortality impacts are limited and not updated to the latest scientific understanding. This study extends the DICE-2016 IAM to explicitly include temperature-related mortality impacts by estimating a climate-mortality damage function. We introduce a metric, the mortality cost of carbon (MCC), that estimates the number of deaths caused by the emissions of one additional metric ton of CO2. In the baseline emissions scenario, the 2020 MCC is 2.26×10^{-4} [low to high estimate -1.71×10^{-4} to 6.78×10^{-4}] excess deaths per metric ton of 2020 emissions. This implies that adding 4,434 metric tons of carbon dioxide in 2020—equivalent to the lifetime emissions of 3.5 average Americans—causes one excess death globally in expectation between 2020-2100.

Source: Bressler (2021). The mortality cost of carbon

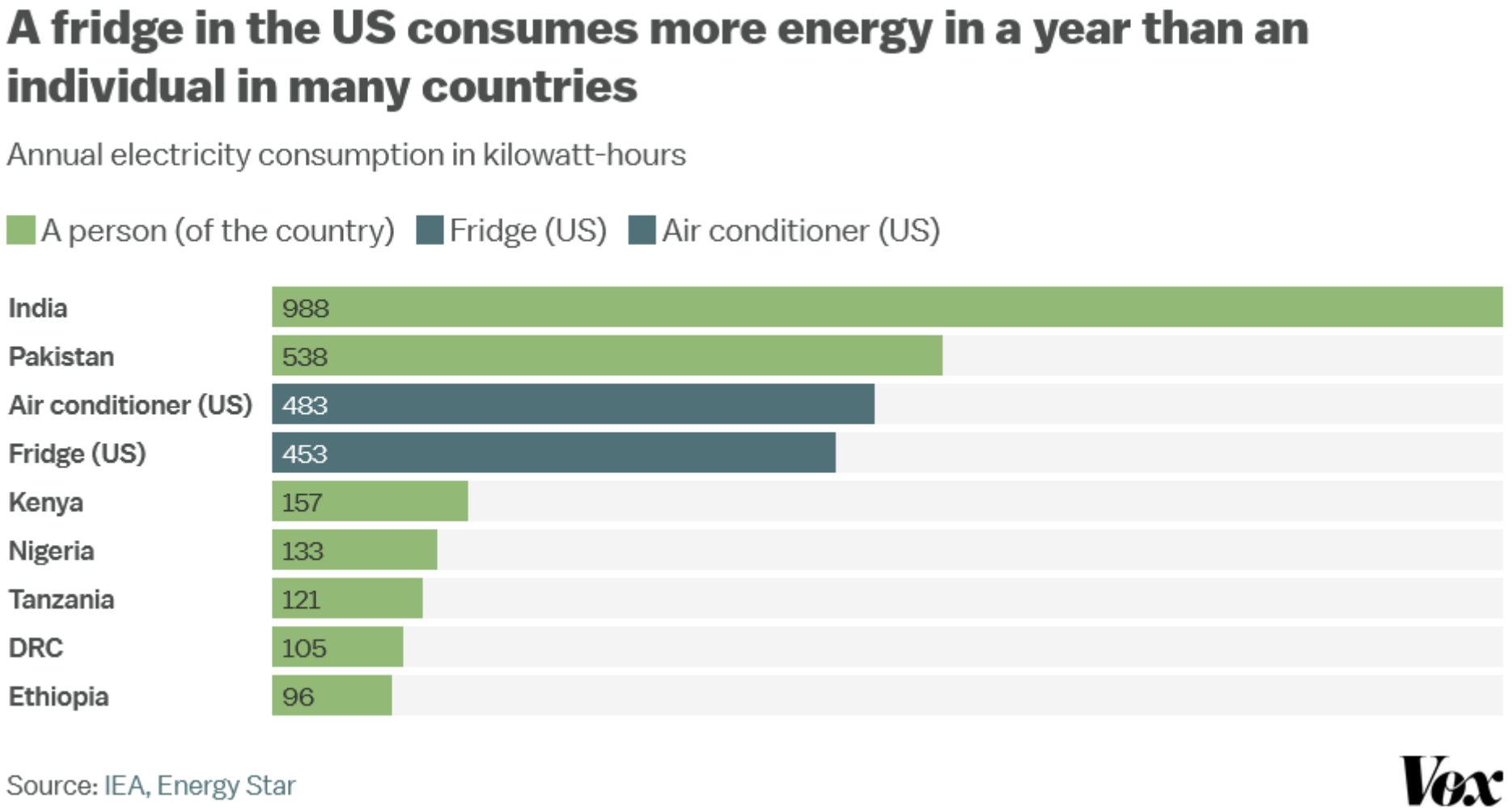
The need for global equality in decarbonisation

“This State cannot go on without proper facilities for the expression of talent and the staging of the highest forms of artistic entertainment which add grace and charm to living and which help to develop and mold a better, more enlightened community,”

NSW Premier, Joseph Cahill, 1954

Source: https://www.sydneyoperahouse.com/our-story/jorn-utzon

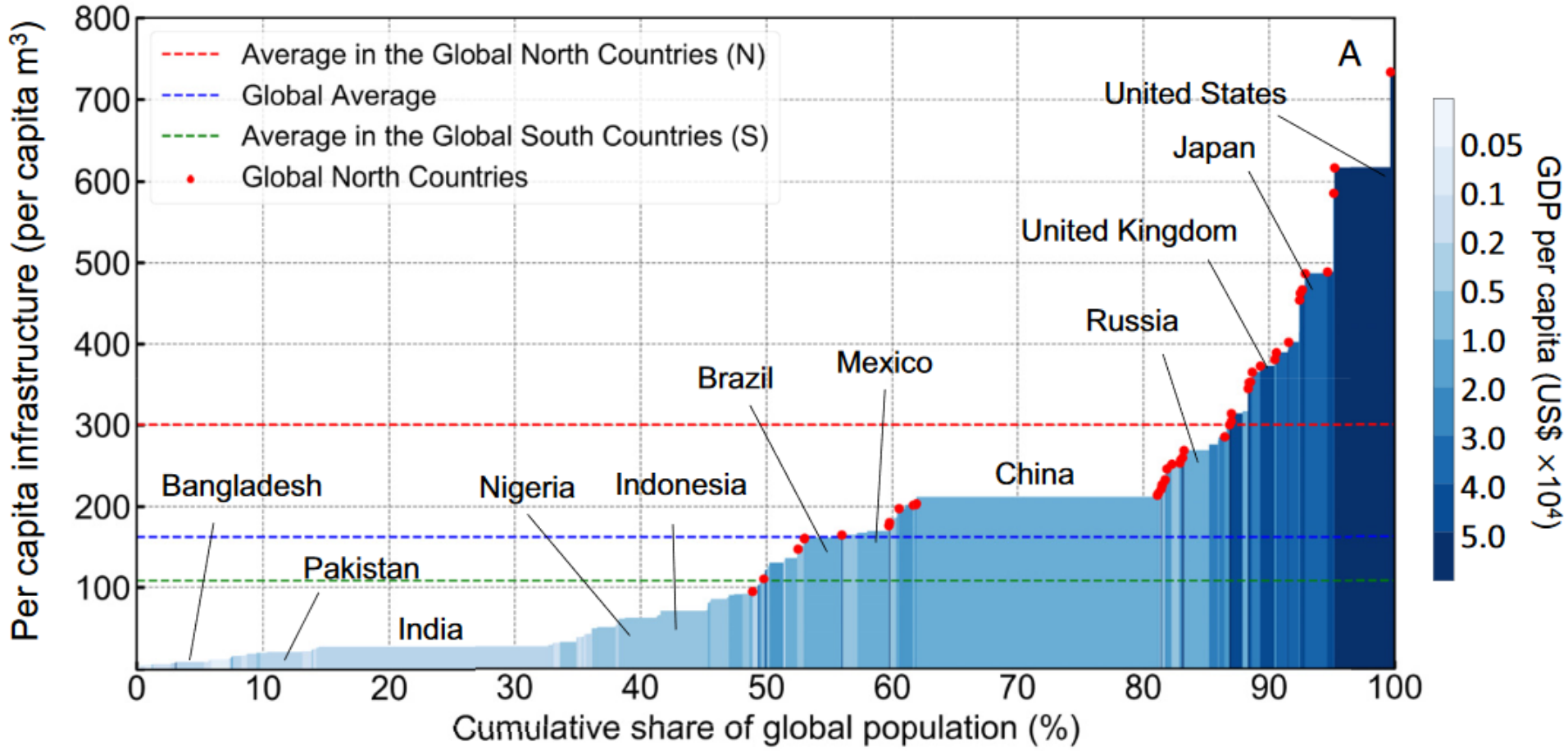
The need for global equality in decarbonisation



Source: https://www.vox.com/future-perfect/23106061/energy-inequity-world-electricity-american-refrigerators

The need for global equality in decarbonisation

"built-up infrastructure in 45 countries in the Global North combined, with ~16% of the global population, is roughly equivalent to that of 114 countries in the Global South, with ~74% of the global population"



Source: Zhou et al. (2022). Satellite mapping of urban built-up heights reveals extreme infrastructure gaps and inequalities in the Global South

For the ‘global north’…

2050 is too late….

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