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The Carbon Challenge - Science and solutions

Live webinar series

Webinar 1

Upcoming webinars

Webinar 2 Wednesday 16 March 12–1pm

- Compliance
- Calculating building carbon footprints

Webinar 3 Wednesday 23 March 12–1pm

- Carbon challenges

Webinar 4 Wednesday 30 March 12–1

- Design and build a low-carbon dwelling

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About us

David Dowdell

Greg Burn

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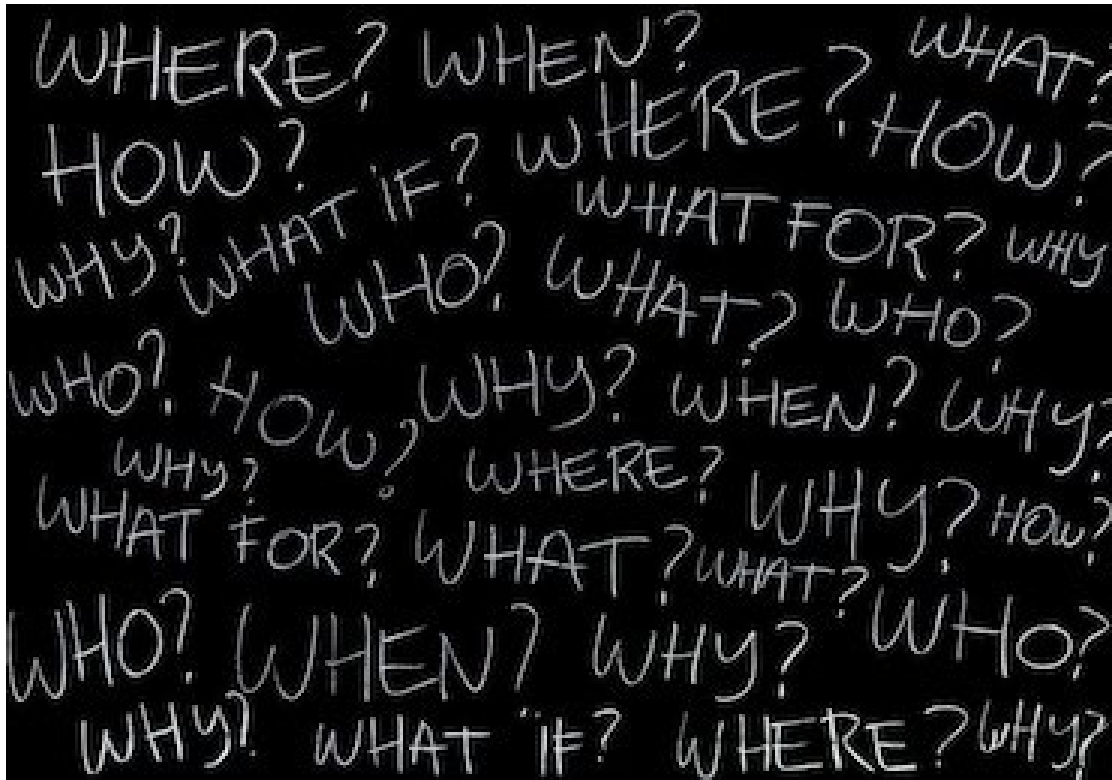
Questions

There will be a separate question and answer session from 1.30–2.30pm following this webinar



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Programme

- Setting the scene
- Carbon and the New Zealand building and construction industry

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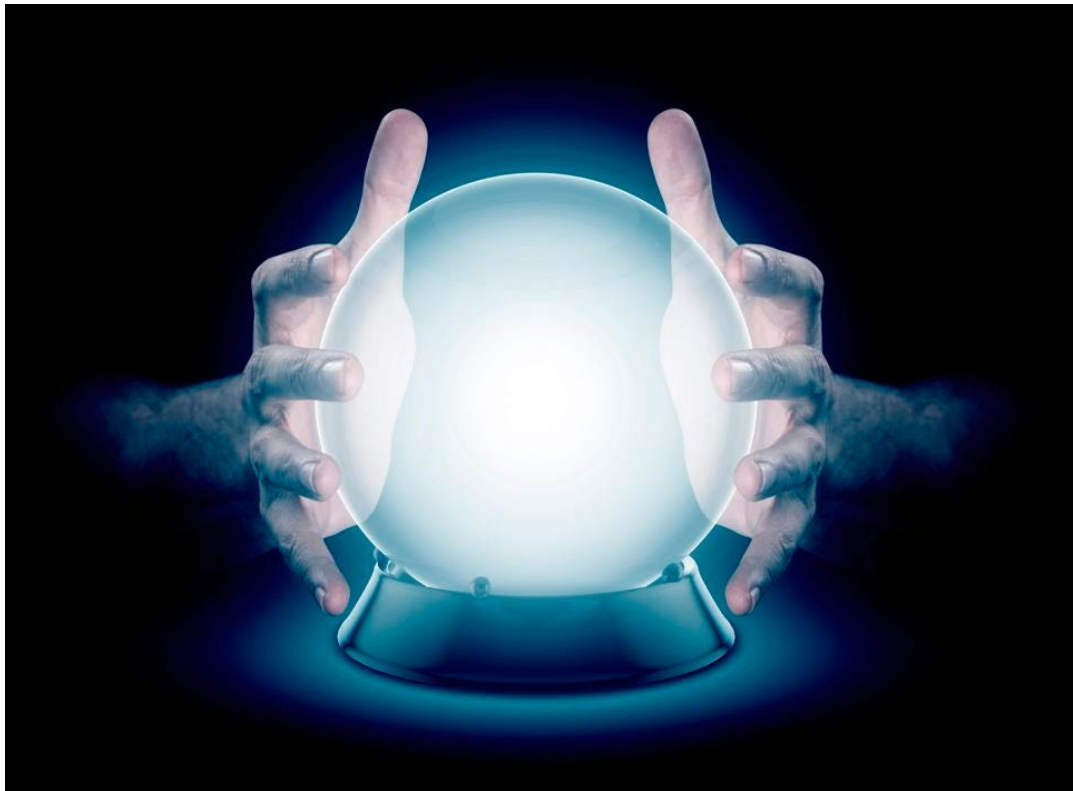
Webinar content

- Research/modelling/science based
- Primary focus on volume residential
- Continually evolving situation
- Realism – carbon emissions reduction represents a challenge to the industry



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Setting the scene

It’s time for action

Atmospheric levels of carbon dioxide (CO_2) are high and continue to rise

Primarily as a result of emissions from the consumption of fossil fuels

Greenhouse gas accumulation has increased the atmosphere’s ability to hold heat

Climate change is the result – yes, it’s real folks!!

We have left it really late – we need to act now!!

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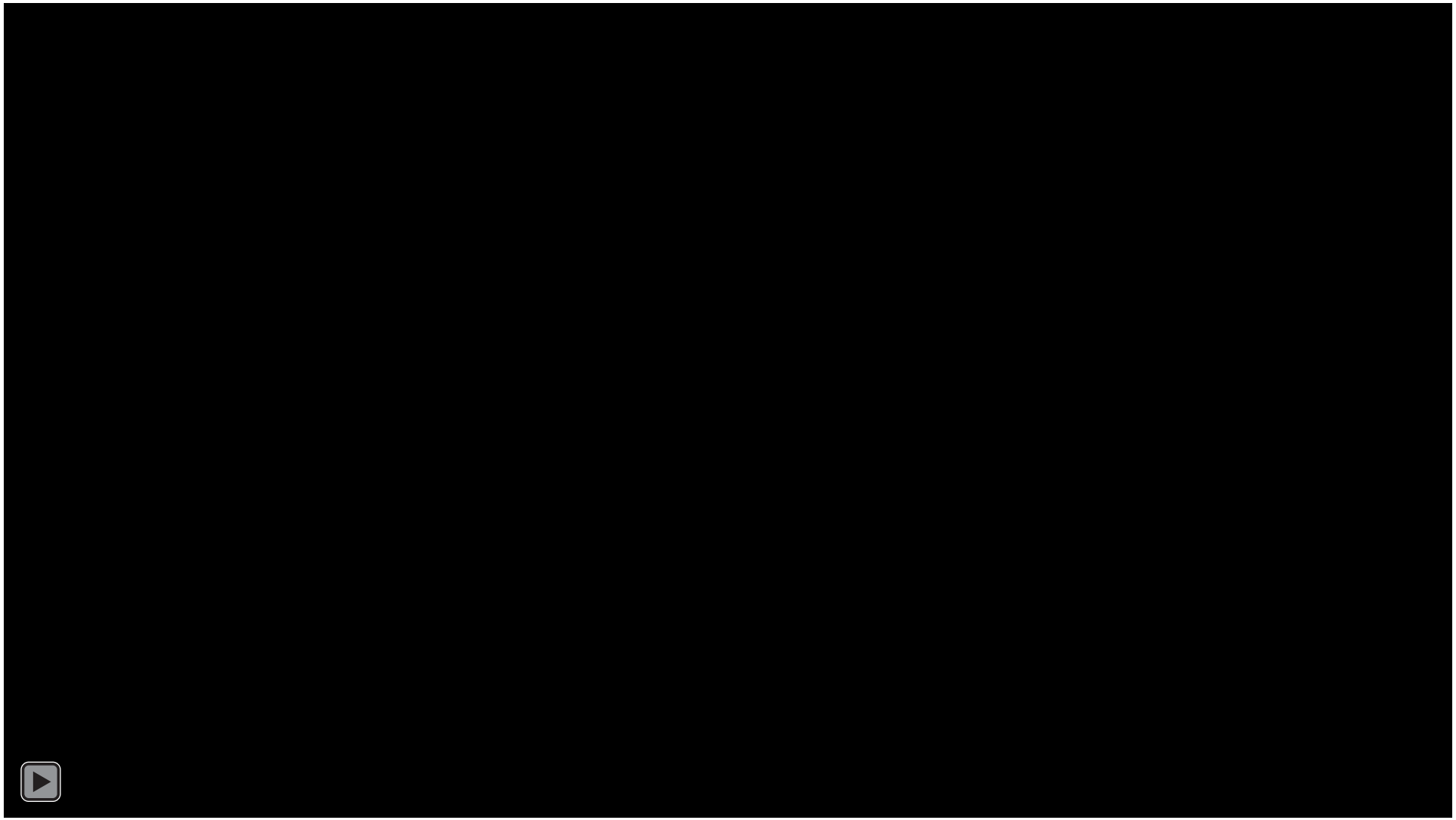
Carbon dioxide emissions



Courtesy of the US National Oceanic and Atmospheric Administration.

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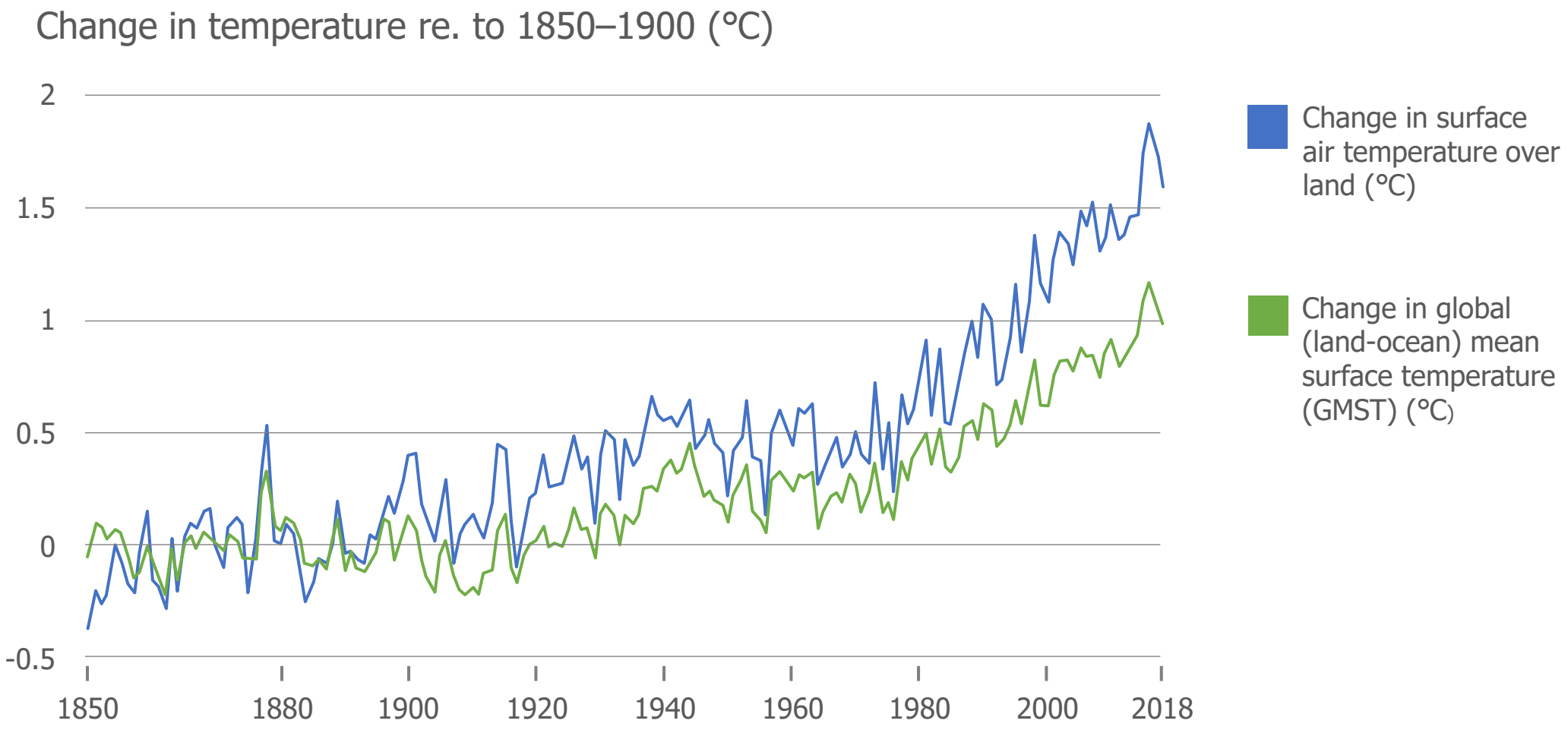
Temperature rise



Source: IPCC (2019) Summary for Policymakers.
In: *Climate Change and Land: An IPCC Special Report*.

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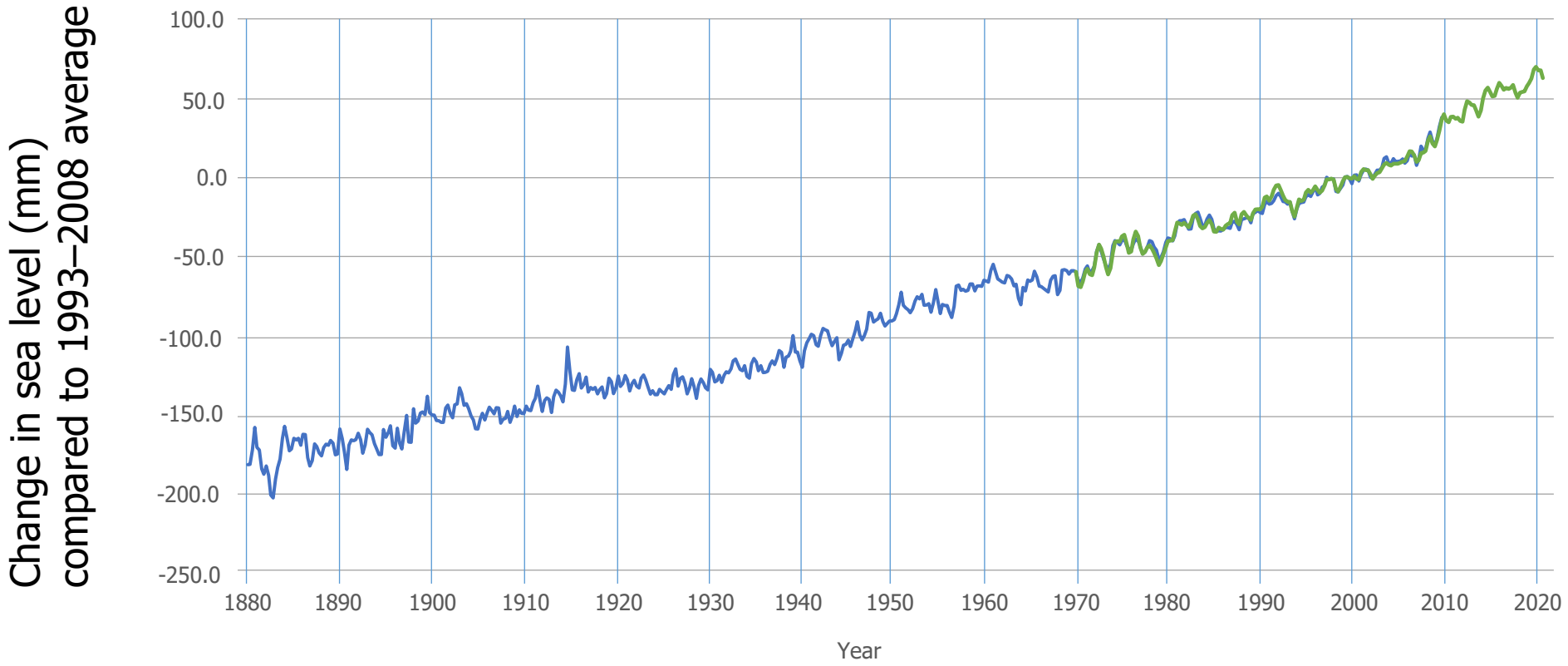
Sea-level rise

- 1901–2018: global mean sea-level rise of 200 mm (150–250 mm)
- High confidence that rate of sea-level rise is increasing: 1.3 mm/yr (1901–1971), 3.7 mm/yr (2006–2018)
- Virtually certain that upper ocean has warmed and extremely likely that human influence is the main driver
- Virtually certain that human-caused CO_2 emissions are the main driver for global acidification of surface open ocean

Sea level since 1880



Obtained from the University of Hawaii Sea Level Centre.

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International and national response

Paris Agreement


PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

1. This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development an efforts to eradicate poverty, including by:

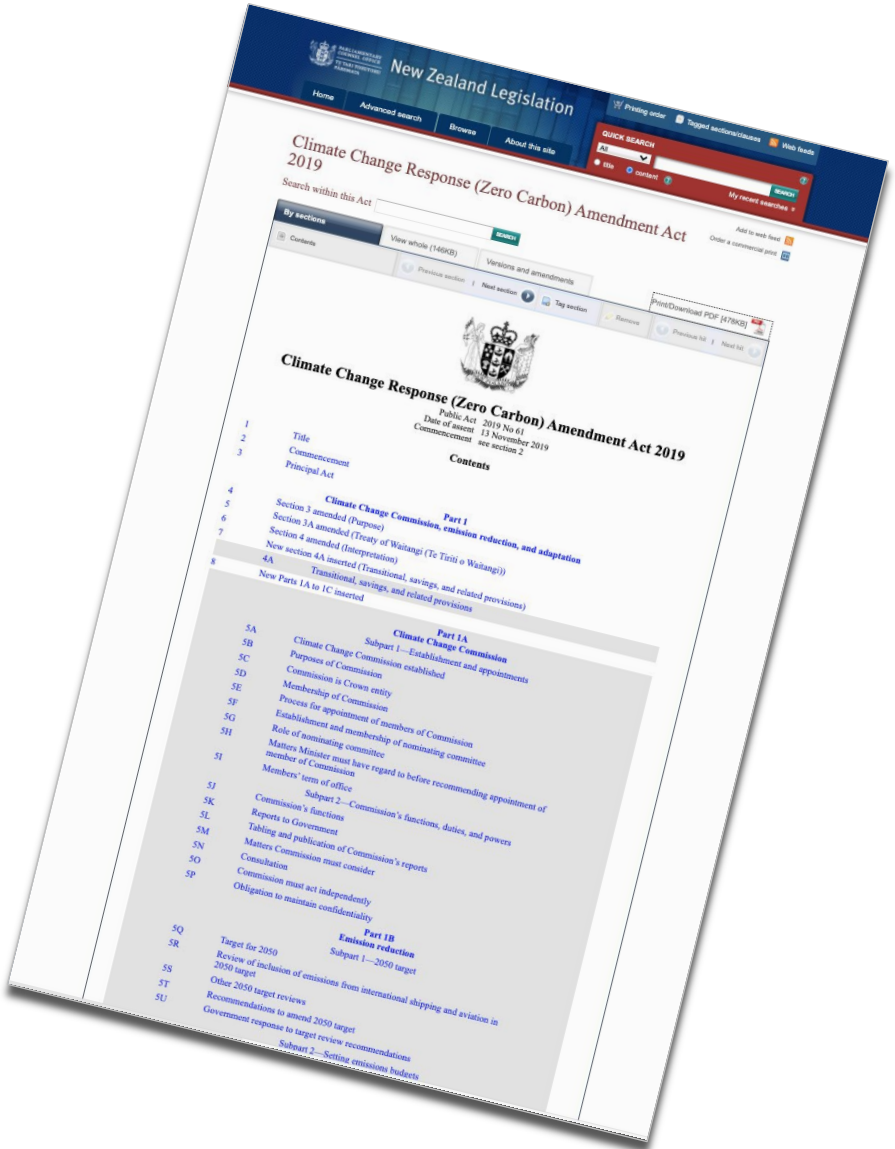
   a. **Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;**

   b. Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and

   c. Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

2. This Agreement will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.

Zero Carbon Act


New Zealand Legislation

Climate Change Response (Zero Carbon) Amendment Act 2019

Climate Change Response (Zero Carbon) Amendment Act 2019

Public Act 2019 No 61
Date of assent 13 November 2019
Commencement see section 2

Contents

1 Title
2 Commencement
3 Principal Act

Part 1
Climate Change Commission, emission reduction, and adaptation

4 Section 3 amended (Purpose)
5 Section 3A amended (Treaty of Waitangi (Te Tiriti o Waitangi))
6 Section 4 amended (Interpretation)
7 New section 4A inserted (Transitional, savings, and related provisions)
8 New Parts 1A to 1C inserted

Part 1A
Climate Change Commission

Subpart 1—Establishment and appointments

5A Climate Change Commission established
5B Purposes of Commission
5C Commission is Crown entity
5D Membership of Commission
5E Process for appointment of members of Commission
5F Establishment and membership of nominating committee
5G Role of nominating committee
5H Matters Minister must have regard to before recommending appointment of member of Commission
5I Members' term of office

Subpart 2—Commission's functions, duties, and powers

5J Commission's functions
5K Reports to Government
5L Tabling and publication of Commission's reports
5M Matters Commission must consider
5N Consultation
5O Commission must act independently
5P Obligation to maintain confidentiality

Part 1B
Emission reduction

Subpart 1—2050 target

5Q Target for 2050
5R Review of inclusion of emissions from international shipping and aviation in 2050 target
5S Other 2050 target reviews
5T Recommendations to amend 2050 target
5U Government response to target review recommendations

Subpart 2—Setting emissions budgets

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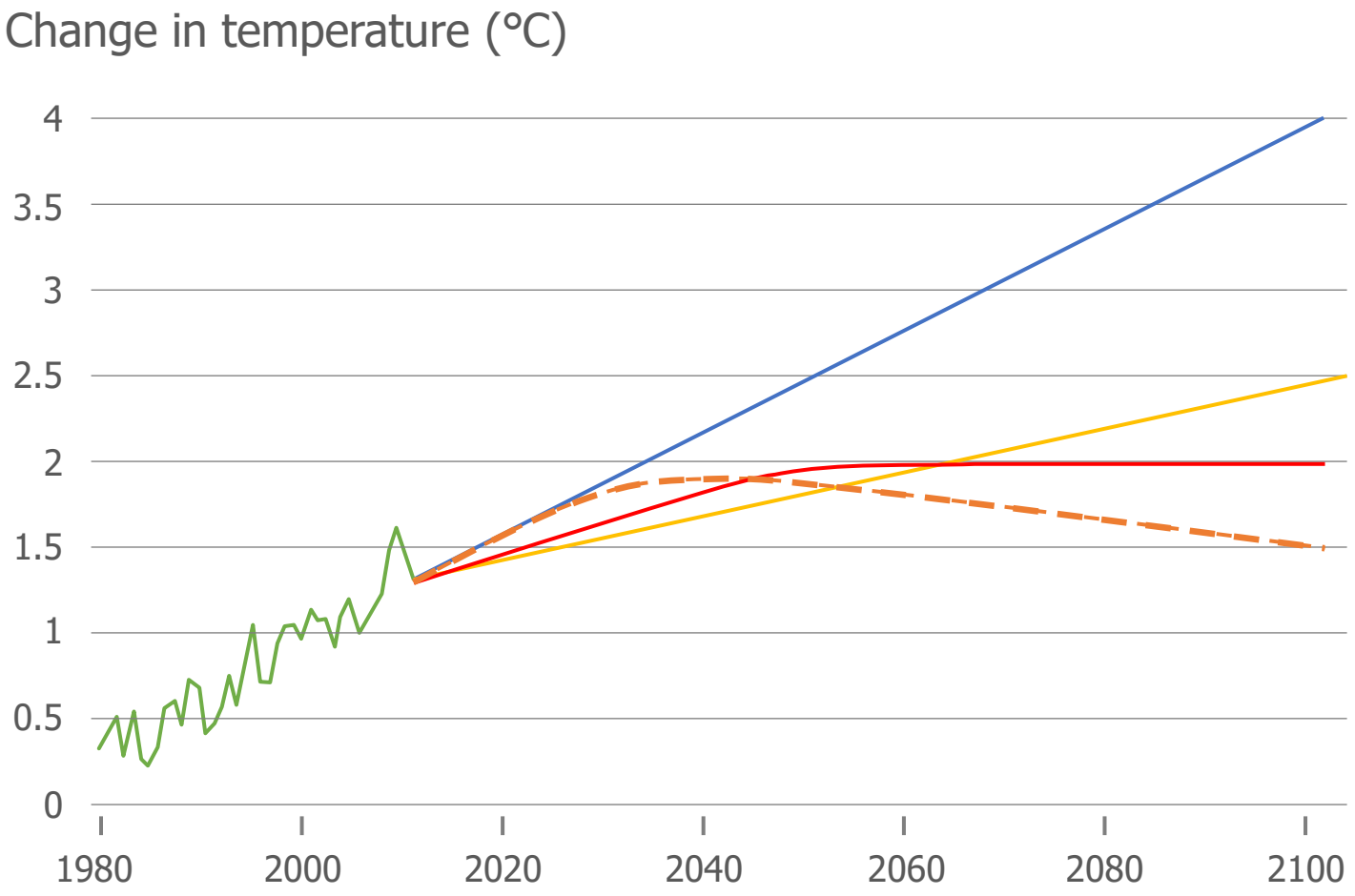
Where to from here?



2018 IPCC report stated that pathways limiting global warming to 1.5°C would require rapid and far-reaching transitions in a number of areas including buildings

Source: Intergovernmental Panel on Climate Change (2018)
Global warming of 1.5°C – Summary for Policymakers.

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Latest information (IPCC 2021)

- Unequivocal that human influence has warmed the atmosphere, ocean and land – widespread and rapid changes have occurred
- In 2019, atmospheric CO_2 concentrations were far higher than at any time in at least 2 million years and concentrations of CH_4 and N_2O were higher than at any time in at least 800,000 years
- Human-induced climate change is already affecting many weather and climate extremes in every region across the globe

- Global surface temperature will continue to increase until at least the mid-century under all emissions scenarios, and global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO_2 and other greenhouse gas emissions occur
- Continued global warming is projected to further intensify the global water cycle, including its variability and the severity of wet and dry events

- Many changes due to past and future greenhouse gas emissions are irreversible, especially changes in the ocean, ice sheets and global sea level

Source: Intergovernmental Panel on Climate Change (2021)
Climate Change 2021 The Physical Science Basis – Summary for Policymakers.

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Key messages

Key messages

- We have left it late
- Fast action is required to dramatically reduce New Zealand carbon emissions
- Building/construction has a major role to play

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Carbon and the New Zealand building and construction industry

New Zealand construction sector

Consumption-based

Includes emissions from imported building materials
Excludes emissions from exported products

- New Zealand carbon footprint is smaller (60 M tonnes CO_2eq p.a.)
- New Zealand construction sector is a significant carbon importer

Production-based

Includes emissions in New Zealand only

- New Zealand carbon footprint is larger (80 M tonnes CO_2eq p.a.)
- New Zealand exports carbon

New Zealand construction sector contributes

16%

of consumption-based carbon emissions

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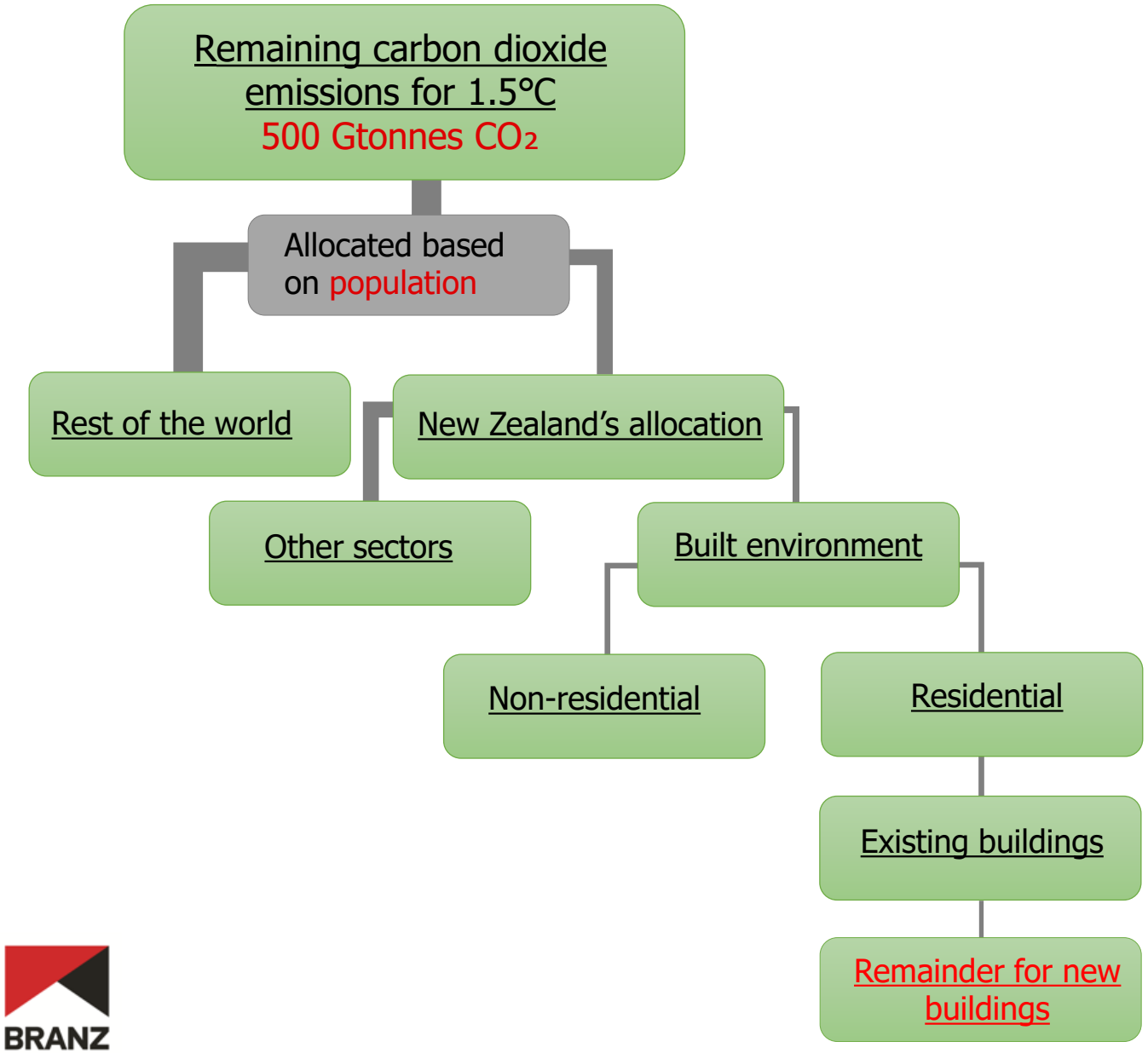
Source: Chandrakumar et al. (2019) Understanding New Zealand's consumption-based greenhouse gas emissions: an application of multi-regional input-output analysis. *International Journal of Life Cycle Assessment*. https://doi.org/10.1007/s11367-019-01673-z

Carbon budgets for new residential buildings



- Finite amount of greenhouse gas emissions to 2050 to stay within 1.5°C warming threshold
- Allocated based on predicted population
- Allocation for residential sector
- Locked emissions for existing buildings allocated first
- Remainder goes to new builds
- Sets maximum carbon footprint for new houses
- Can be assigned based on floor area and/or number of occupants
- Methodology still developing internationally

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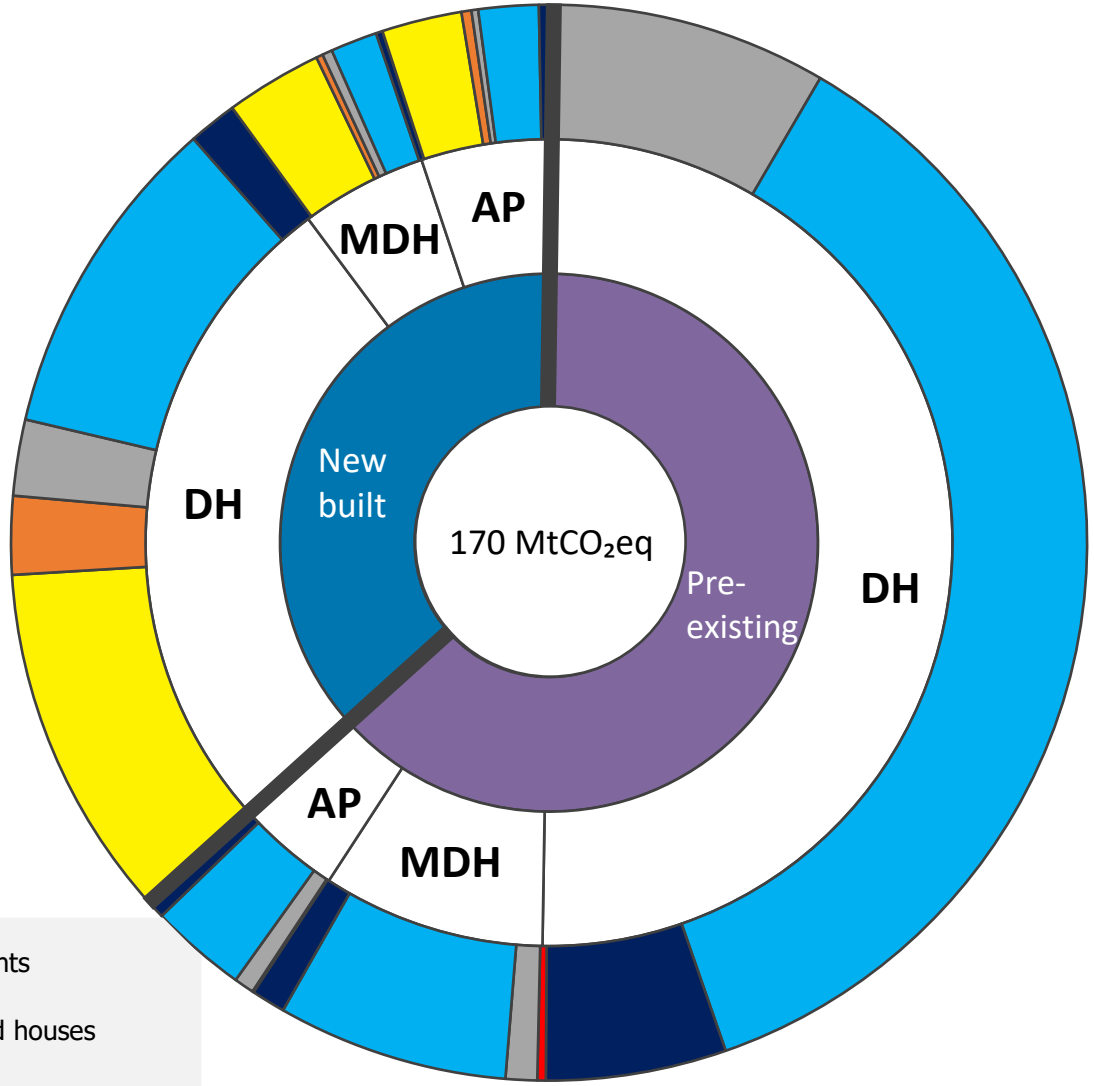
New Zealand residential stock carbon footprint to 2050



AP Apartments

DH Detached houses

MDH Medium-density housing

Manufacture of material

Transport to construction site and transport activity

Maintenance and replacement of material

Energy use

Water

End of life

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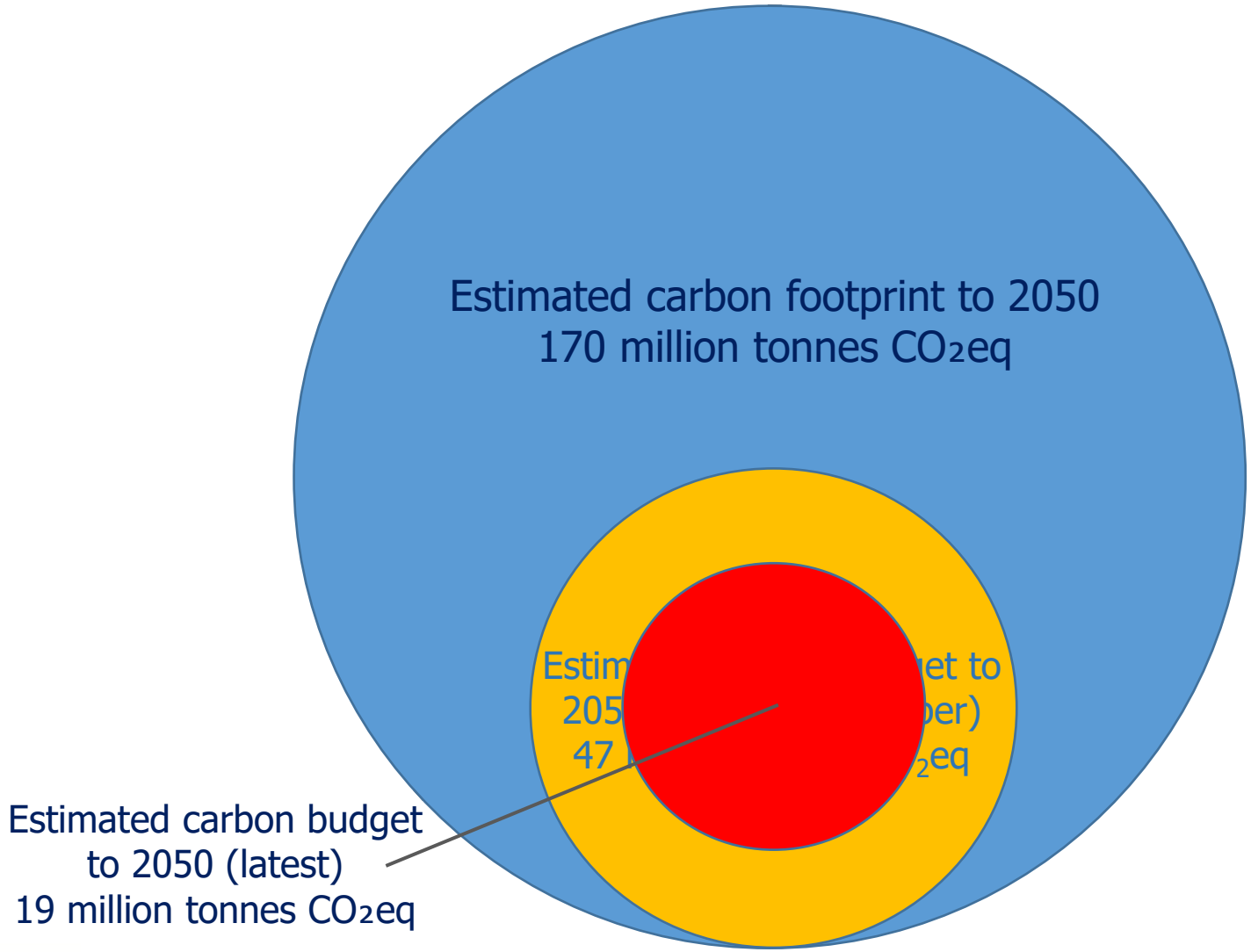
McLaren SJ, Chandrakumar C, Dowdell D, Bullen L and Jaques R (2020) *Application of absolute sustainability assessment to New Zealand residential dwellings.* BEYOND 2020 – World Sustainable Built Environment Conference (November 2020). IOP Conference Series: Earth and Environmental Science 588. doi:10.1088/1755-1315/588/2/022064

New Zealand residential stock carbon footprint to 2050 versus carbon budget



2020 WSBE paper:

- Carbon footprint 3.6 times over available carbon budget
- 72% decrease in residential stock carbon footprint needed

Latest results (2022):

- Carbon footprint 8.4 times over available carbon budget
- 88% decrease in residential stock carbon footprint needed
- Humanity using up available budget too quickly

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McLaren SJ, Chandrakumar C, Dowdell D, Bullen L and Jaques R (2020) *Application of absolute sustainability assessment to New Zealand residential dwellings.* BEYOND 2020 – World Sustainable Built Environment Conference (November 2020). IOP Conference Series: Earth and Environmental Science 588. doi:10.1088/1755-1315/588/2/022064

How are we tracking?

- Global action relatively ineffective to date
- Carbon footprint of New Zealand residential building stock exceeds the carbon budget

- New Zealand residential buildings carbon budget highly likely to be exceeded within 3 years
- Other New Zealand economic sectors will need to make deeper cuts
- Need to be designing and building dwellings that are net zero carbon

Net zero

- Reduce greenhouse gas emissions as low as possible
- Pay $ to offset remaining emissions to get to zero

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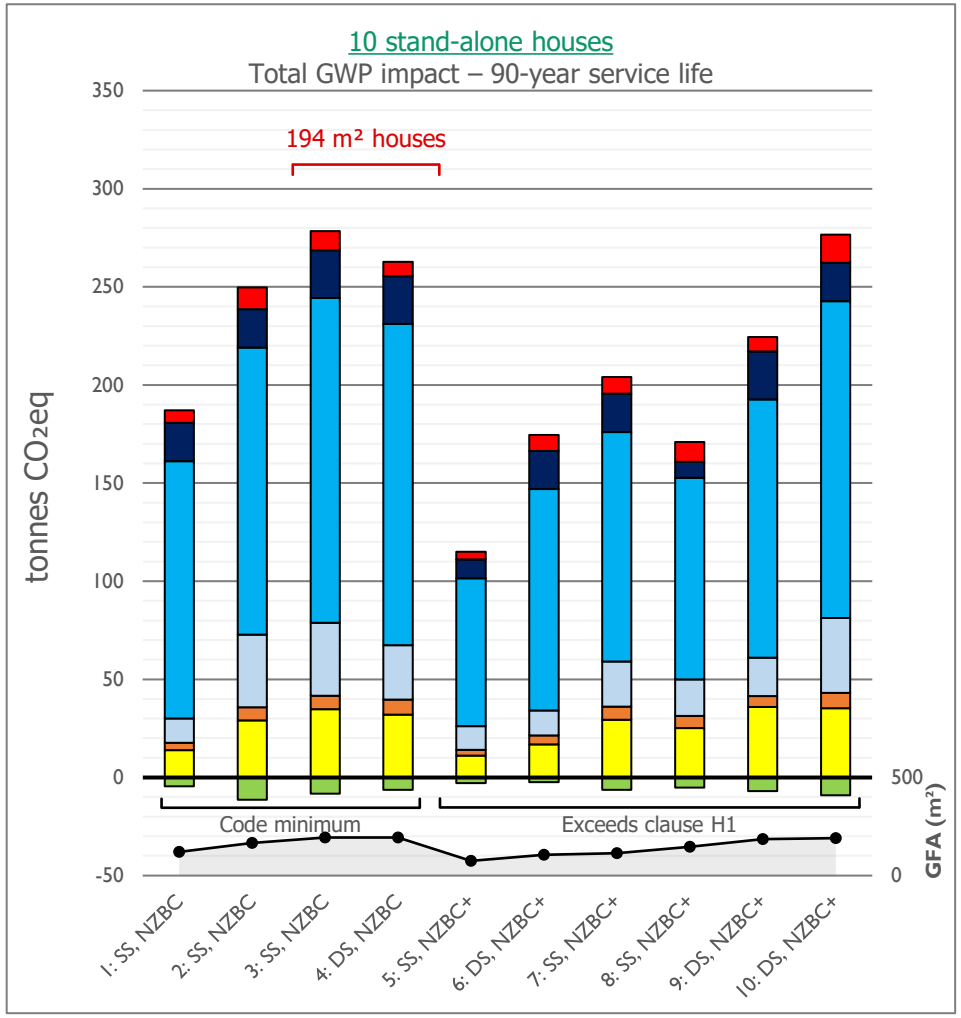
Carbon footprint of case study new stand-alone houses



- Potential environmental benefits beyond the life cycle (module D)
- End of life stage
- Operational water (Use stage)
- Operational energy (Use stage)
- Maintenance and replacement (Use stage)
- Construction process stage
- Product stage
- Gross floor area

SIMULATED IN…
- AUCKLAND
- WELLINGTON
- CHRISTCHURCH

…GRAPHS SHOW **AVERAGE**

INTERNAL TEMPERATURE…
18°C - 25°C
…MAINTAINED

WITHOUT BIOGENIC CARBON

- Modelled emissions over 90-year service life
- Some materials missing – e.g. electrical, plumbing, kitchen and bathroom units, flashings, spouting, hot water cylinder
- Current materials manufacturing technology – this should progressively decarbonise over time
- Some increase in renewables supplying grid electricity
- Energy – includes heating and cooling, hot water, lighting, plug-in appliances

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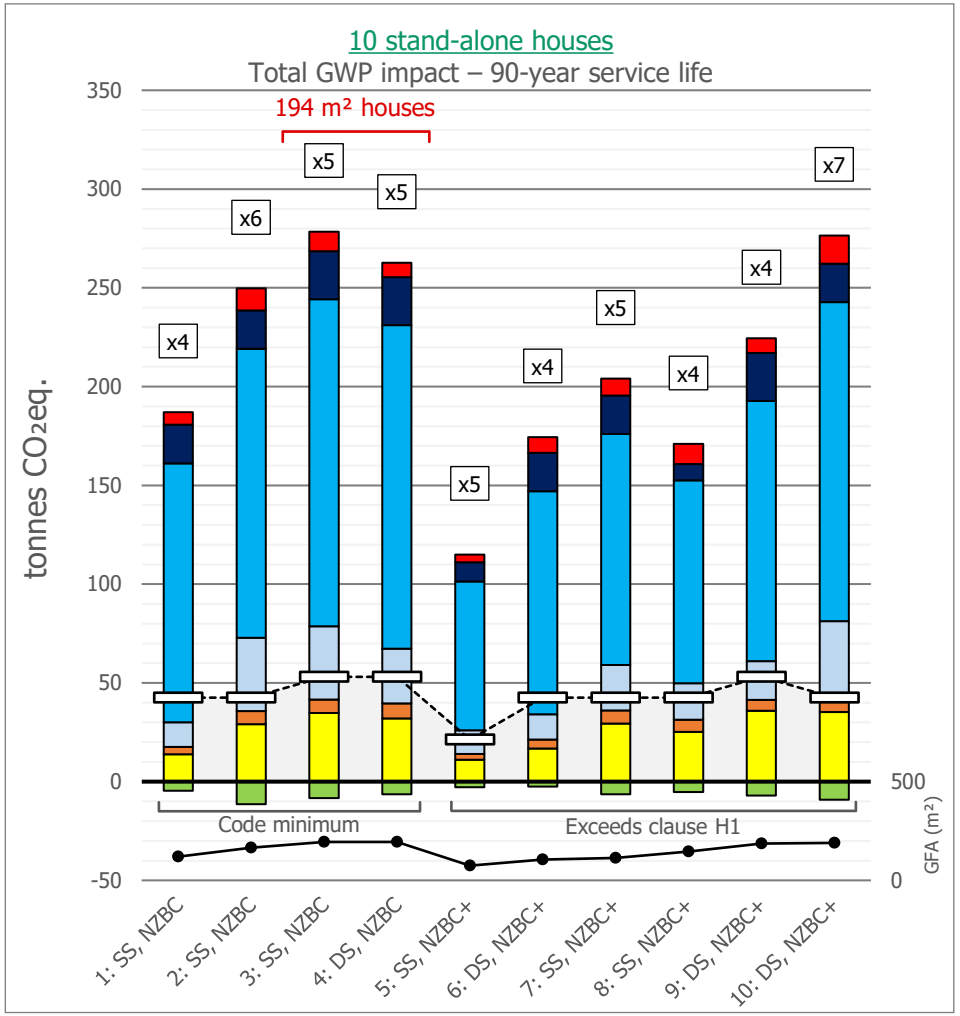
Carbon footprint of case study new stand-alone houses versus carbon budget



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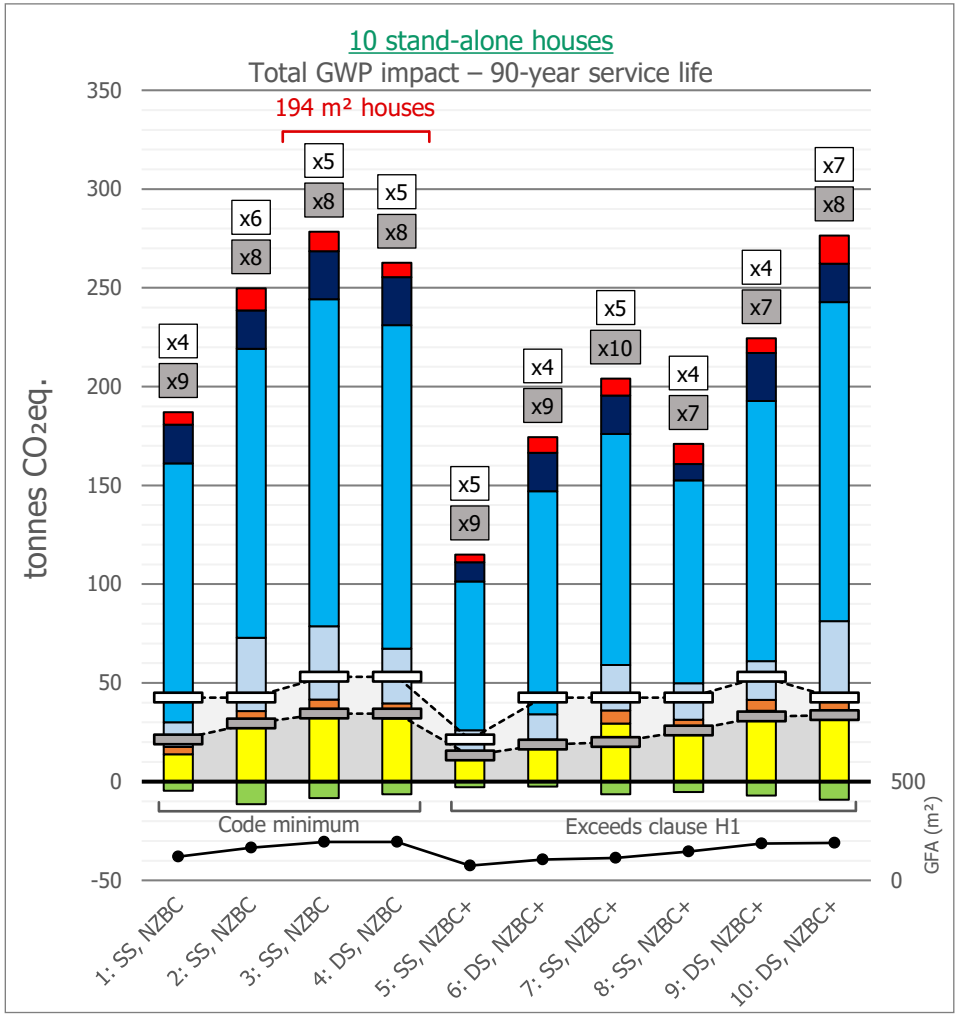
Carbon footprint of case study new stand-alone houses versus carbon budget



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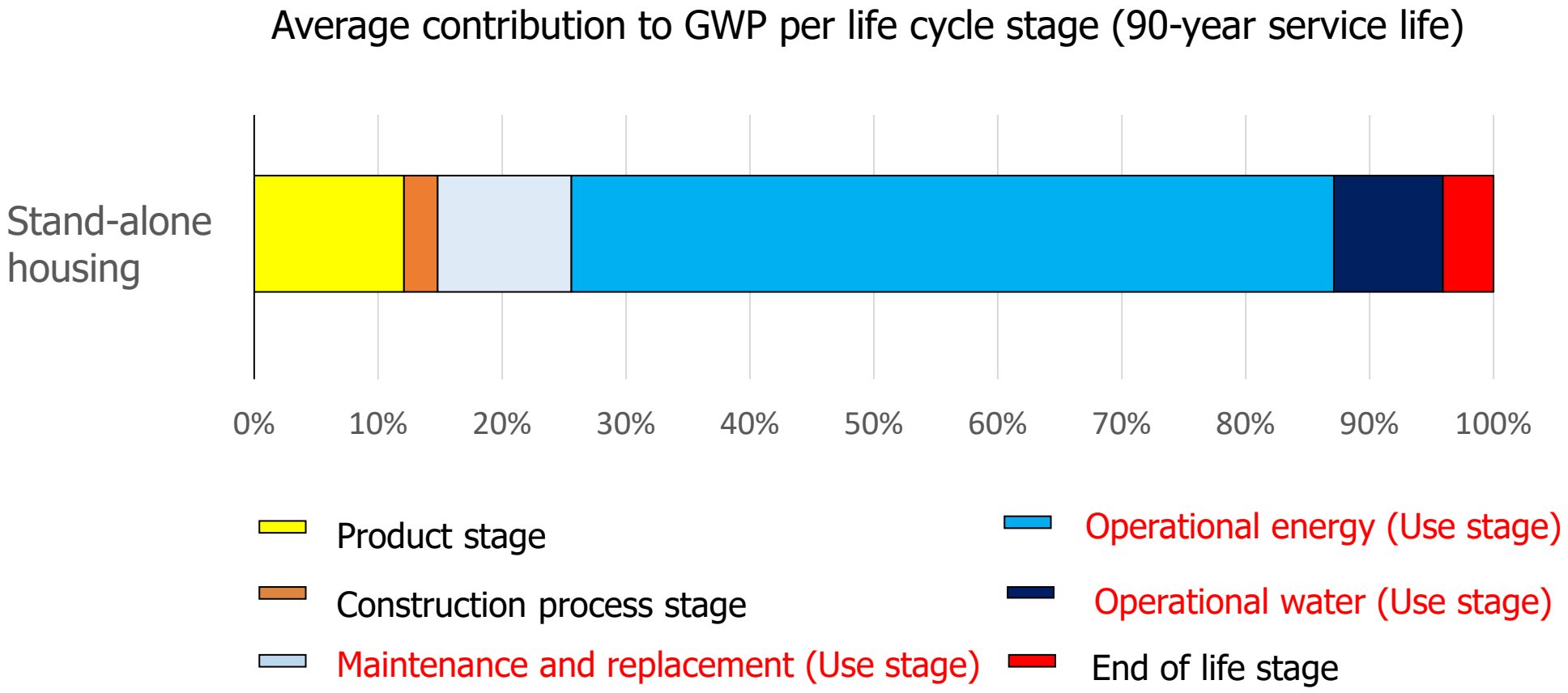
Contribution by life cycle stage



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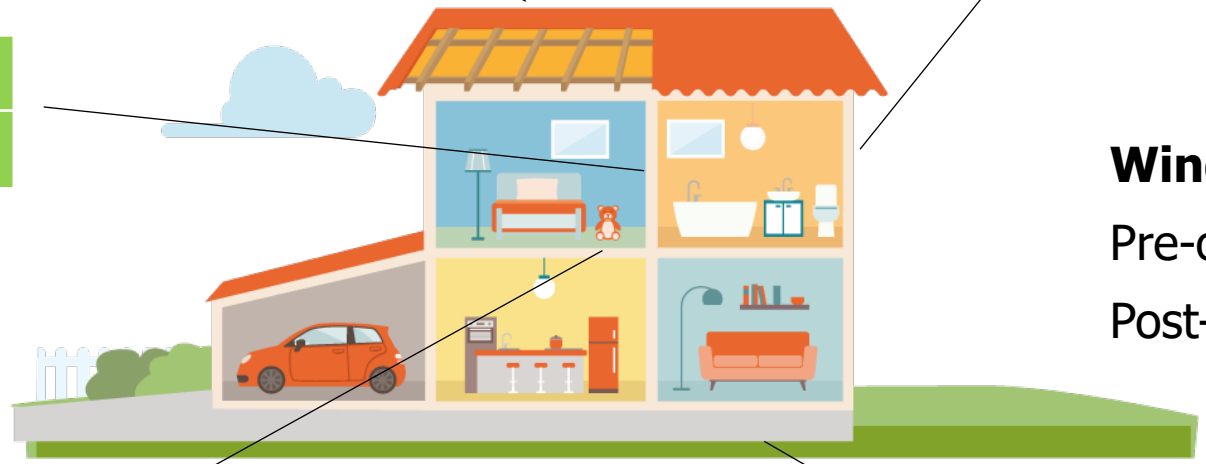
Where is the embodied carbon in a house?

Roof	**%**
Pre-occupation	9
Post-occupation	9

Exterior walls	**%**
Pre-occupation	12
Post-occupation	6

Interior walls	**%**
Pre-occupation	2
Post-occupation	2



Windows/doors	**%**
Pre-occupation	6
Post-occupation	9

Interior finishes	**%**
Pre-occupation	3
Post-occupation	22

Floor slab	**%**
Pre-occupation	17
Post-occupation	1

Mid-floor	**%**
Pre-occupation	2
Post-occupation	<1

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Key messages

Key messages

- Construction sector imports a lot of carbon
- Residential stock carbon footprint exceeds the available carbon budget by more than 8 times
- Case study new builds exceed their available budgets by up to 16 times
- High-performance houses are not necessarily lower carbon
- We need a rapid, widespread, significant reduction of the carbon footprints of dwellings

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Key organisations

A number of organisations are focused on improving building performance:

- NZGBC
- Passive House Institute New Zealand
- Eco Design Advisors
- SUPERHOME movement
- Lifemark
- Beacon Pathway
- BRANZ

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Useful links

BRANZ zero-carbon built environment research programme
www.branz.co.nz/environment-zero-carbon-research/transition/

Intergovernmental Panel on Climate Change
https://www.ipcc.ch/

World Meteorological Organization
https://public.wmo.int/en

Contact: david.dowdell@branz.co.nz

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Thanks

We really appreciate the effort you have made to attend

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