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The Carbon Challenge - Science and solutions

Live webinar series

Webinar 2

Upcoming webinars

Webinar 3 Wednesday 23 March 12-1pm

- Carbon challenges

Webinar 4 Wednesday 30 March 12-1pm

- Design and build a low-carbon dwelling

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About us

David Dowdell

Greg Burn

Sponsors

Firth

Kingspan | Thermakraft

KNAUF INSULATION

NZGBC
TE KAUNIHERA HANGANGA TAUTAIO

Resene
the paint the professionals use

XLAM™

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Supported by

Building Research Levy

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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

- Compliance
- Calculating building carbon footprints

Webinar content

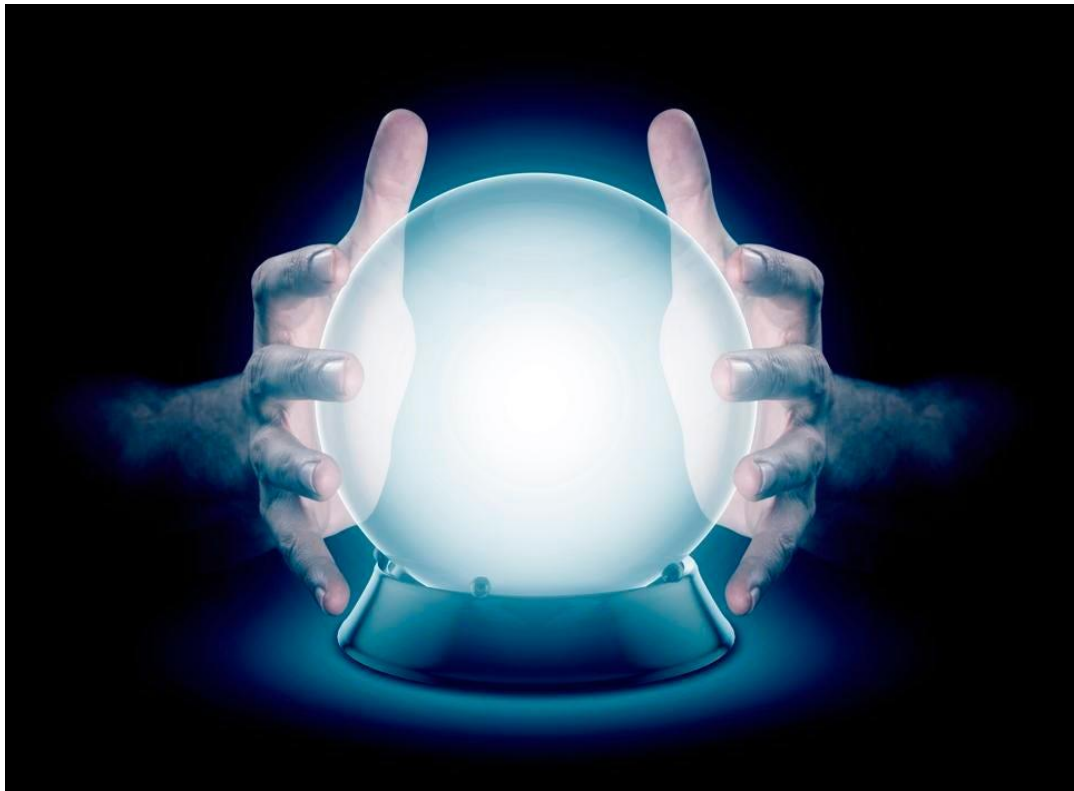
Research/modelling/science based

Primary focus on volume residential

Continually evolving situation

Realism – carbon emissions reduction represents a challenge to the industry

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



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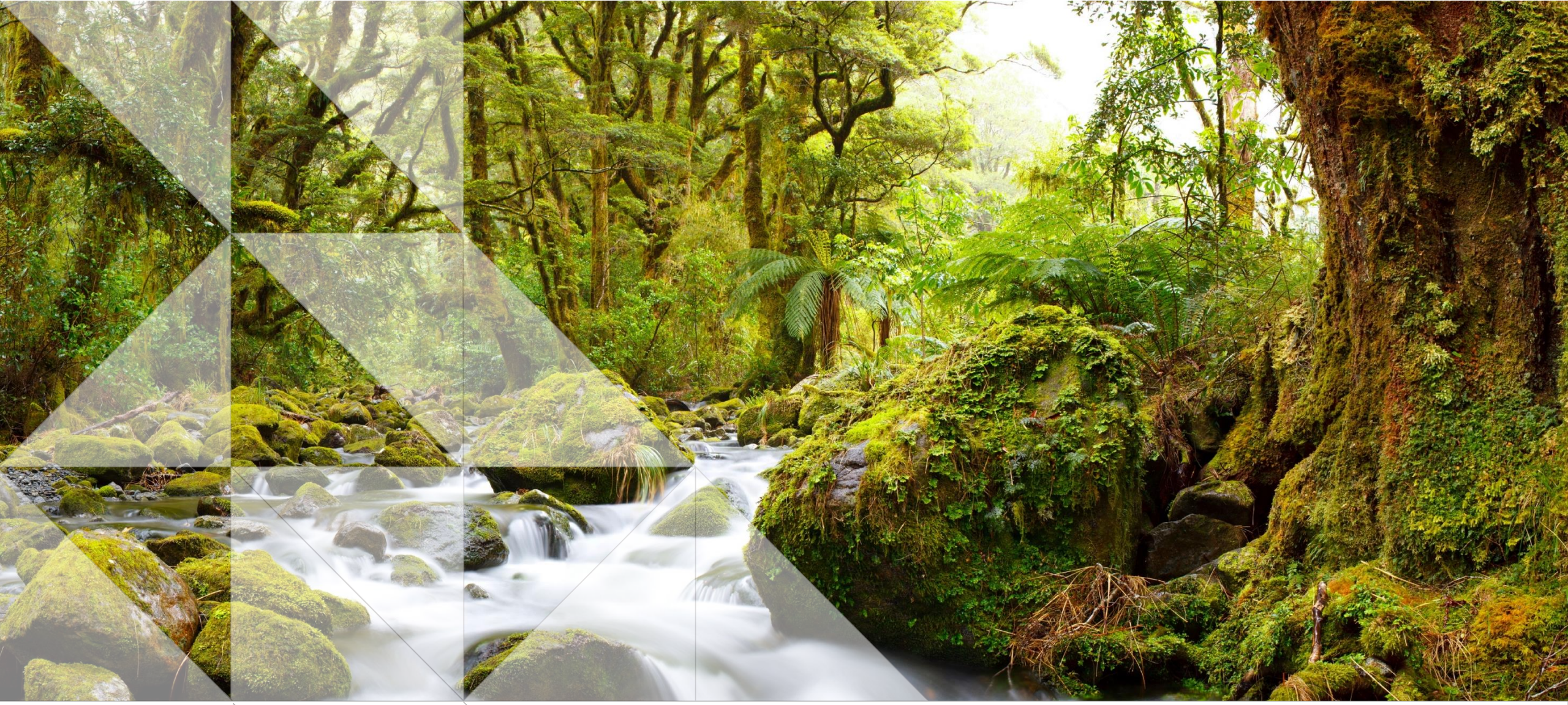

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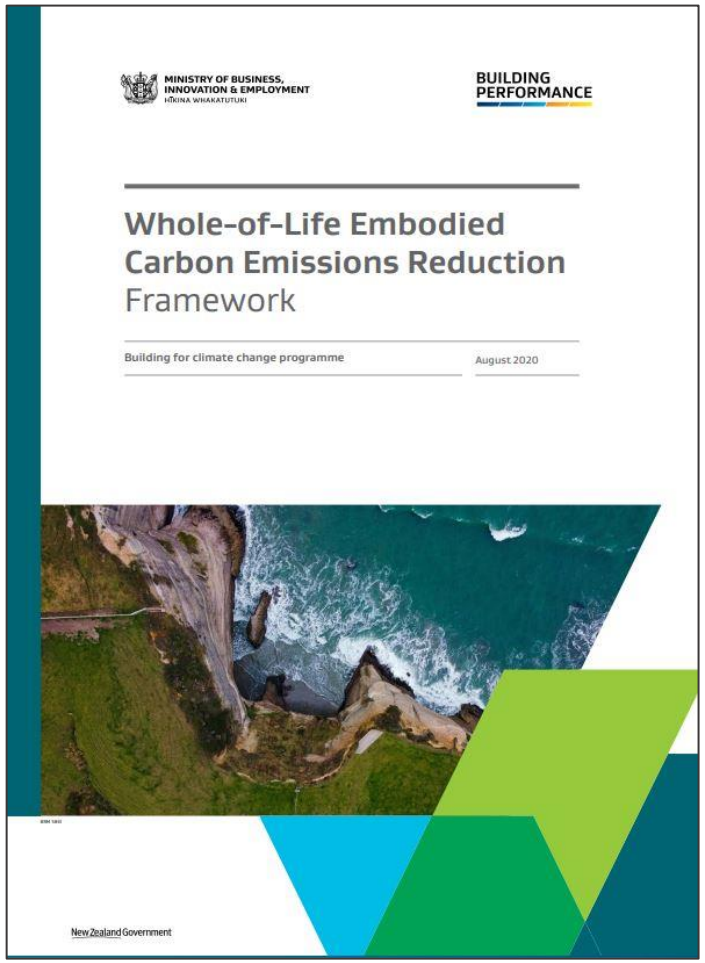
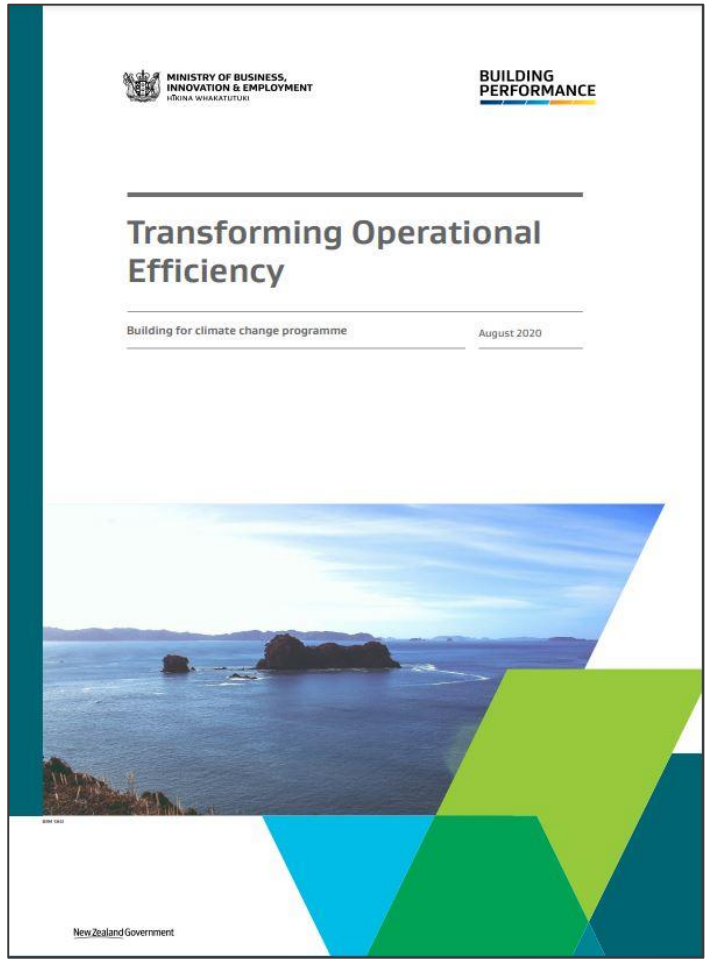
Compliance

Building for Climate Change Consultation





374 submissions

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Embodied carbon emissions reduction framework

Three main objectives:

- New build efficiency
- Material efficiency
- Carbon intensity

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Transforming operational efficiency

Three main objectives:

- Reduce operational carbon emissions
- Reduce water use
- Improve health and wellbeing of occupants by improving buildings' indoor environment quality (IEQ)

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Indoor Environment Quality

Important that operational efficiency is not considered in isolation from IEQ

New builds must be:

- Warm/cool
- Dry
- Healthy

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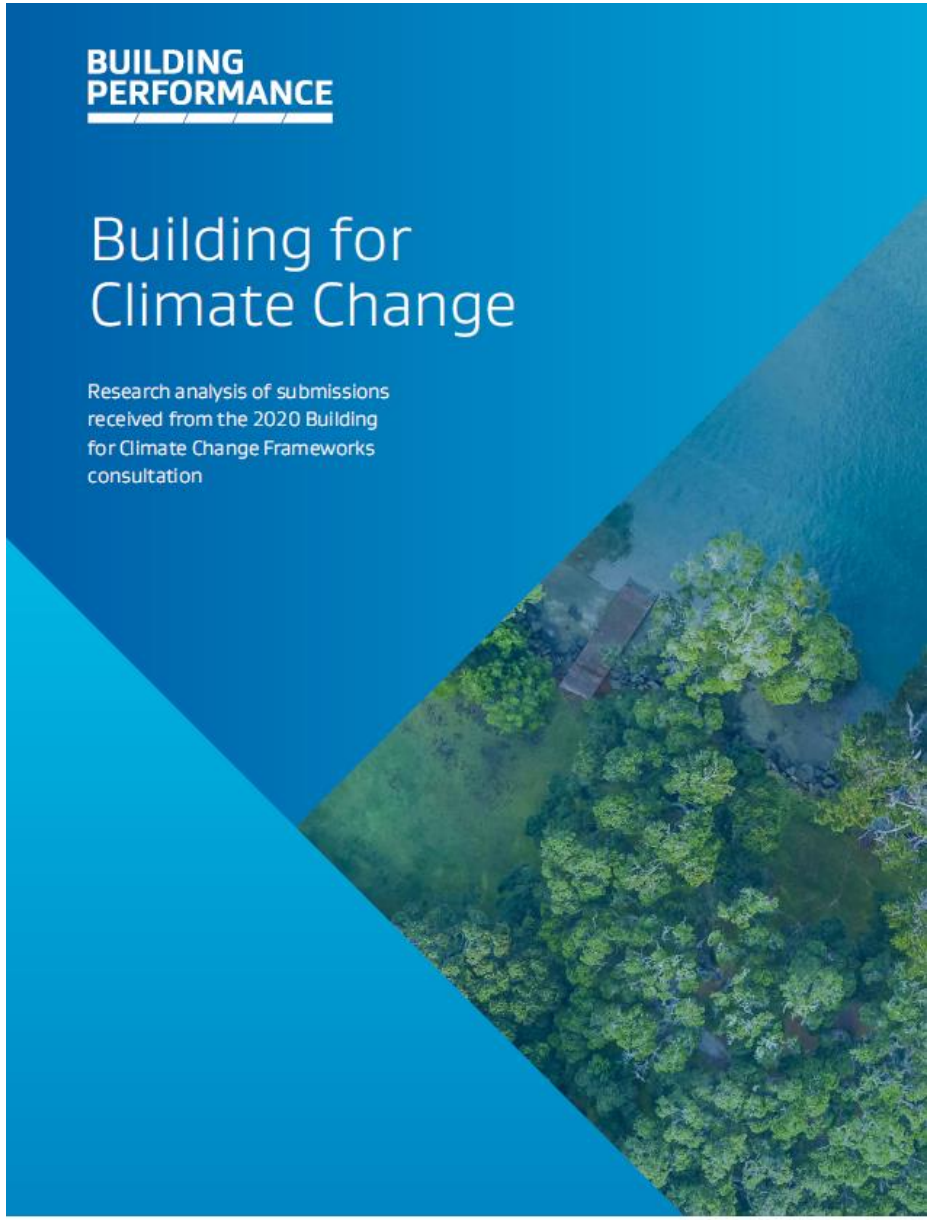
Building for Climate Change submissions

Research analysis of submissions received from the 2020 Building for Climate Change Frameworks consultation

Published May 2021

- **92%** agreed sector needs to take action to reduce emissions
- **95%** said measures should be included to improve operational efficiency
- **87%** agreed initiatives to reduce whole-of-life embodied carbon in buildings should be included



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MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

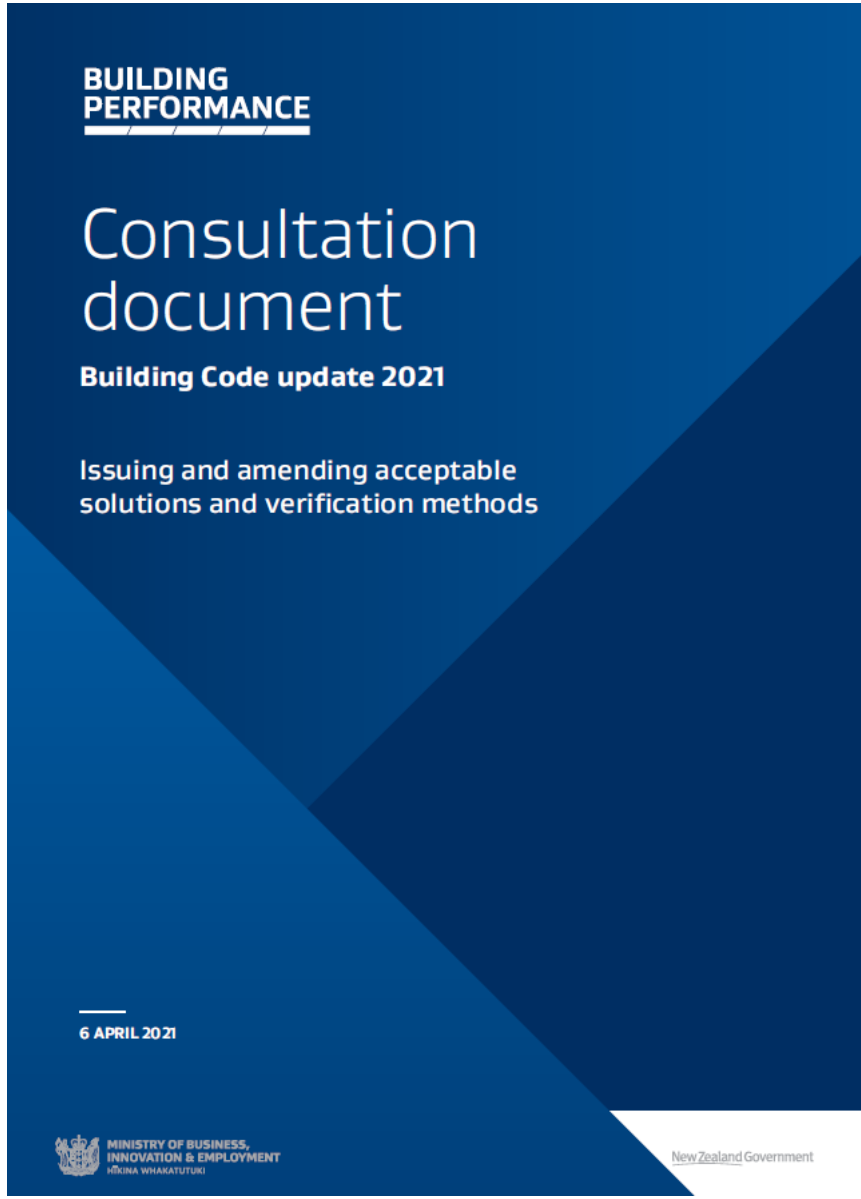
New Zealand Government

H1 Energy Efficiency consultation

Energy efficiency for housing and small buildings

Drafts of proposed H1/AS1 and H1/VM1

Published April 2021 – includes consultation on other Building Code clauses



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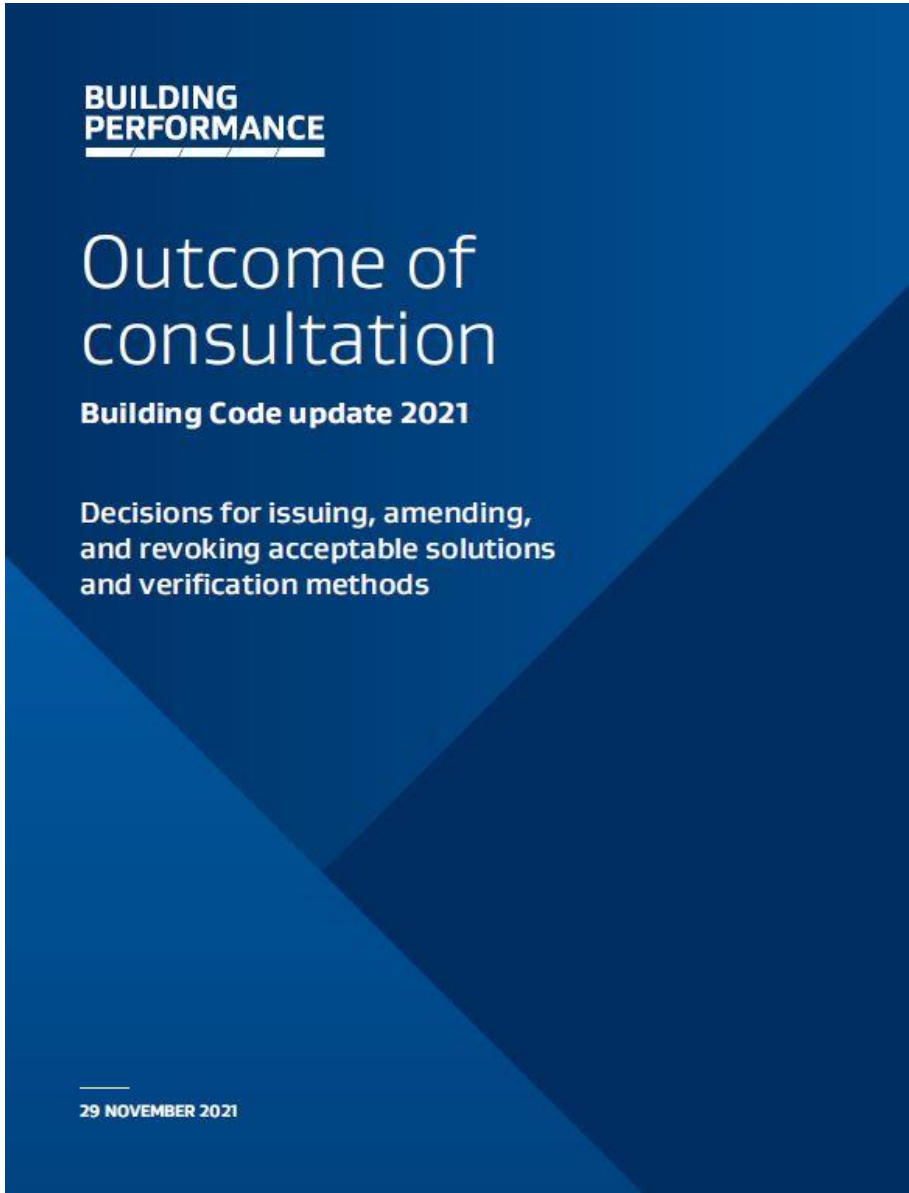
Climate change response timeframes

2024 - 2029

- New Building Code compliance pathway for operational efficiency
- Introduction of mandatory disclosure of embodied carbon of new buildings
- Phased introduction of embodied carbon caps for new buildings
- Confirm emissions reduction approach for existing buildings

Methodologies, data sources, tools, resources and other technical infrastructure for whole-of-life carbon assessment to be developed

Published November 2021



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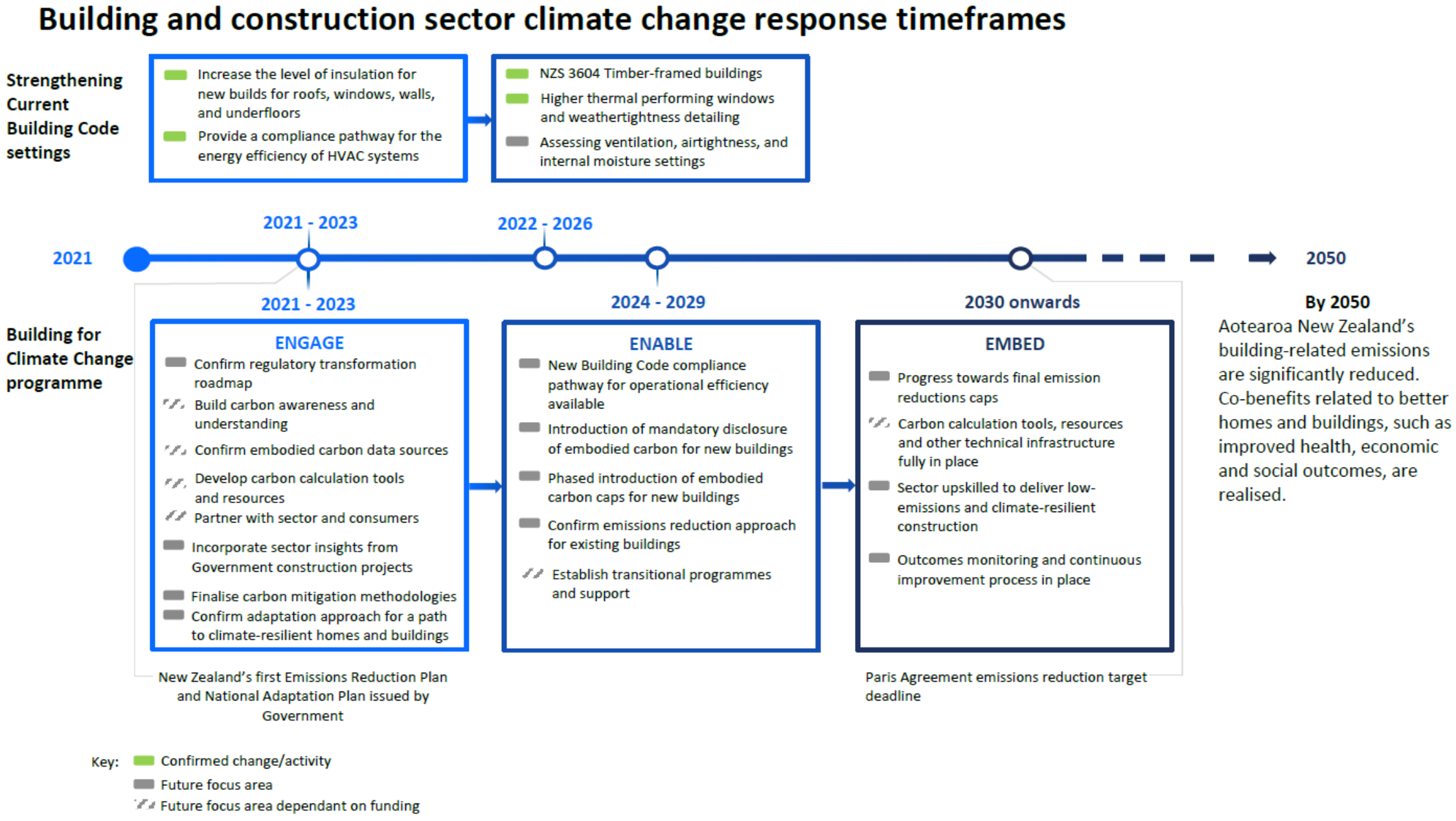
2021 – 2050 response timeframes



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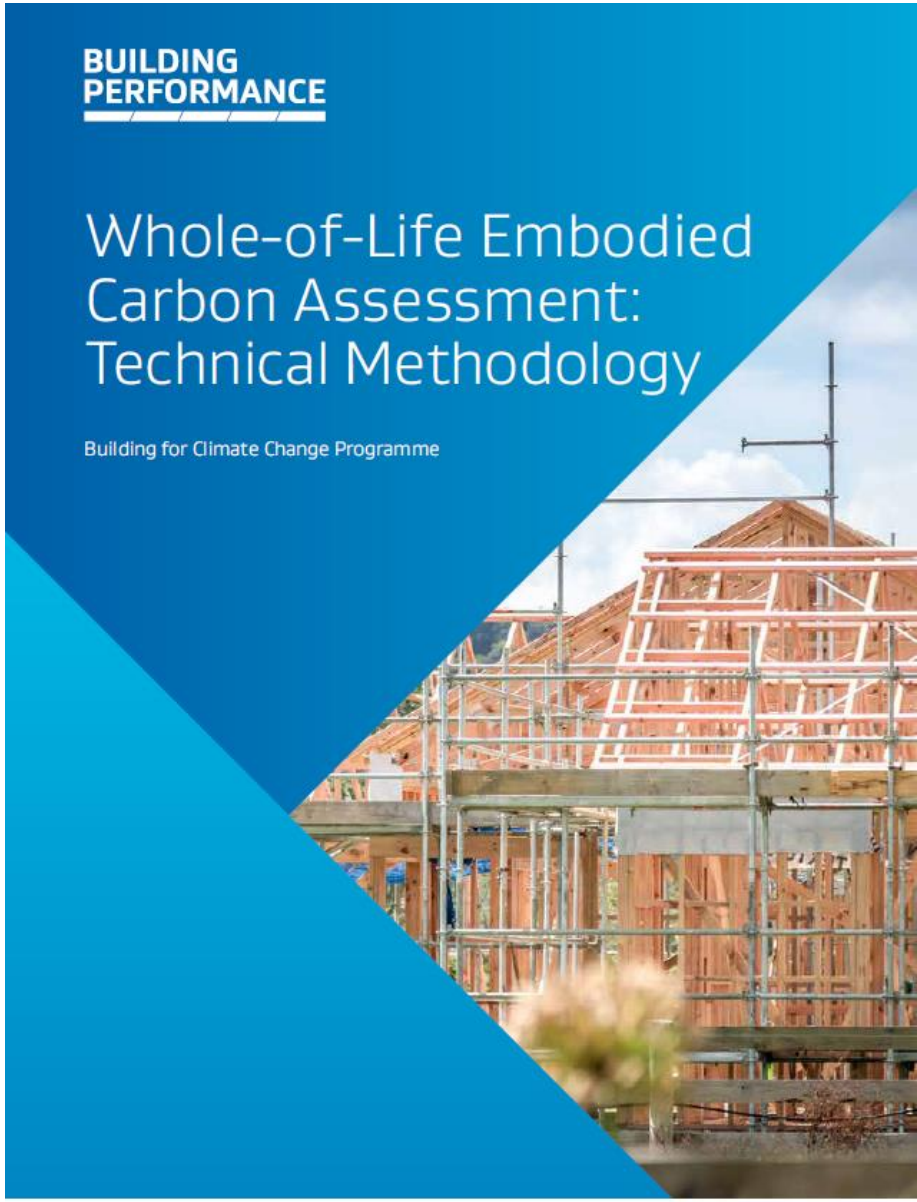
Whole-of-Life Embodied Carbon Assessment

This document sets out a proposed methodology for assessing the embodied carbon of new buildings

(as will be required if proposals to implement the regulation of embodied carbon proceed)

Published February 2022

https://www.building.govt.nz/getting-started/building-for-climate-change/



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New H1/AS1 and H1/VM1

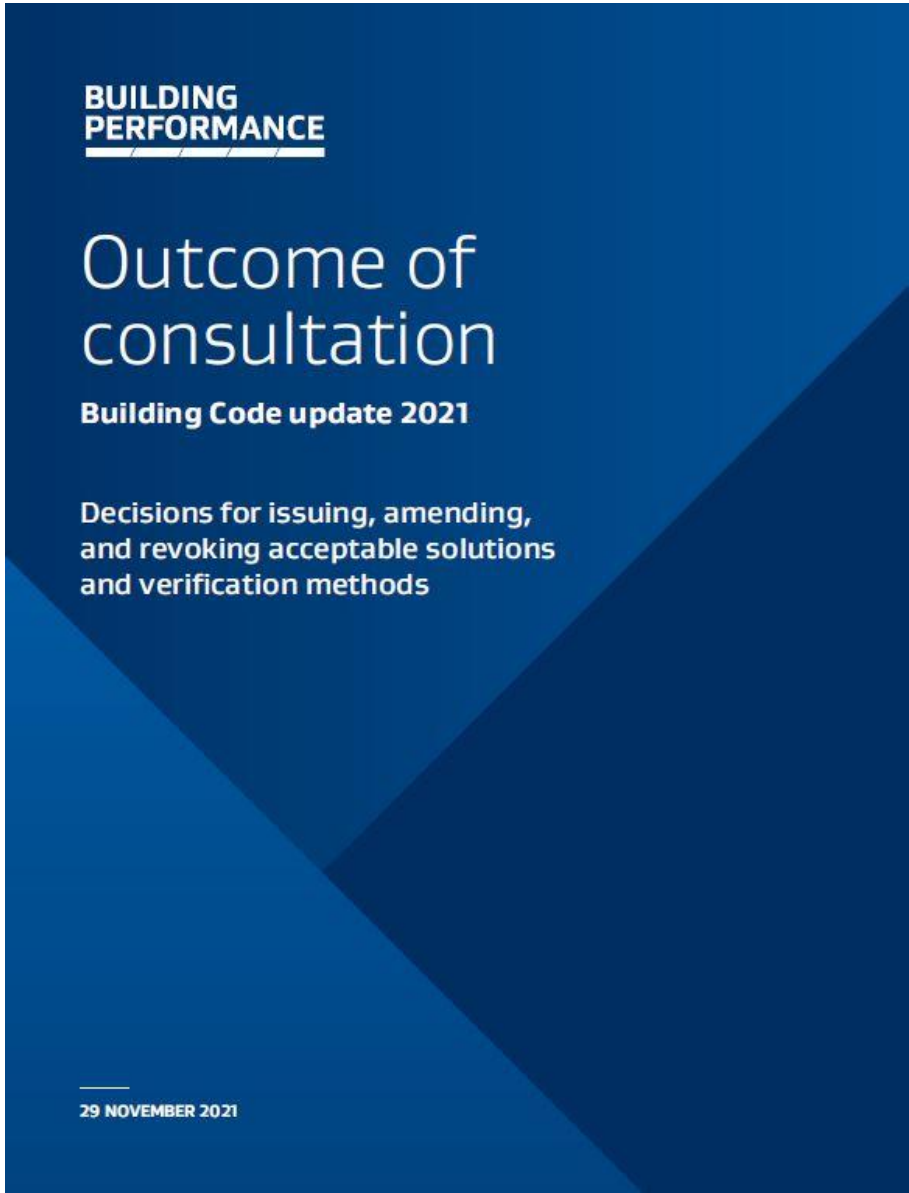
Proposed 5th edition of H1/AS1 and H1/VM1

Step forward in thermal performance to improve:

- Energy efficiency
- Indoor environment quality

Biggest energy efficiency changes to the Building Code in more than a decade

Working towards a reduction in operational carbon emissions



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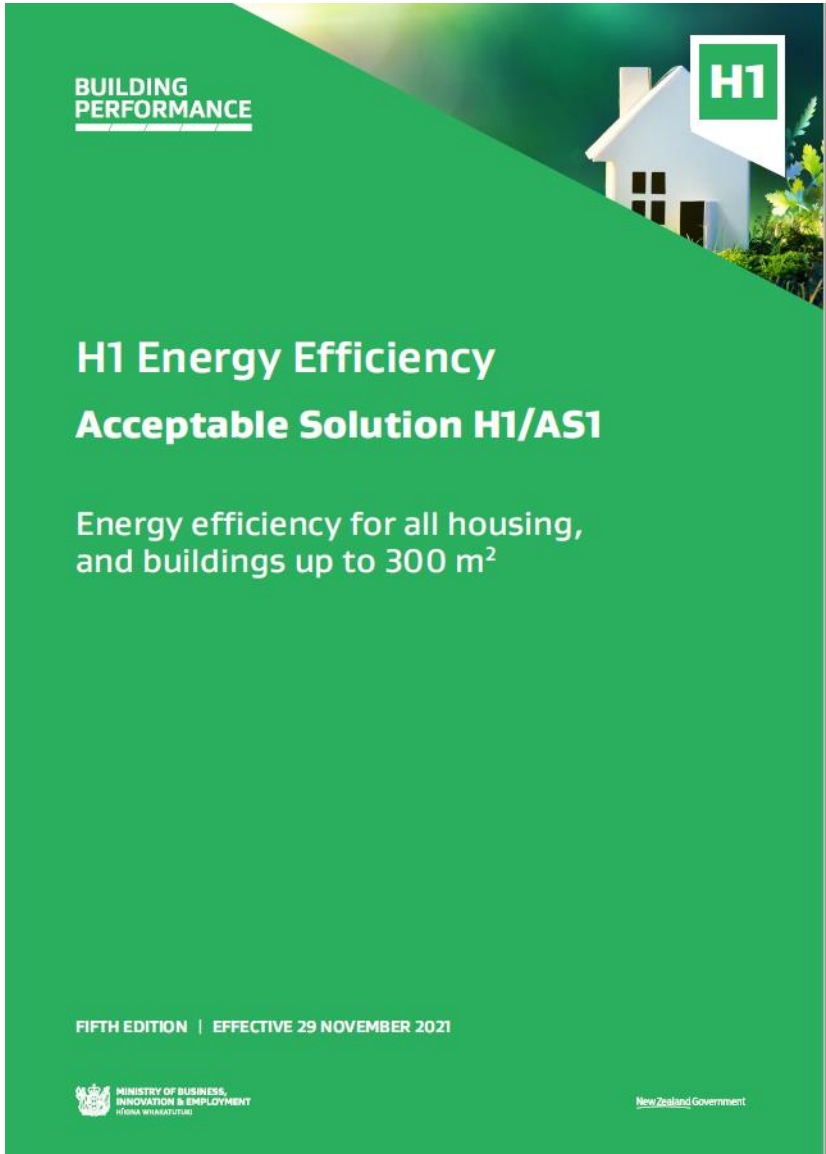
H1/AS1 & H1/VM1 Fifth edition

Energy efficiency for all housing, and buildings up to 300 m²

Effective from 29 November 2021

Fourth edition can be used for compliance to 2 November 2022



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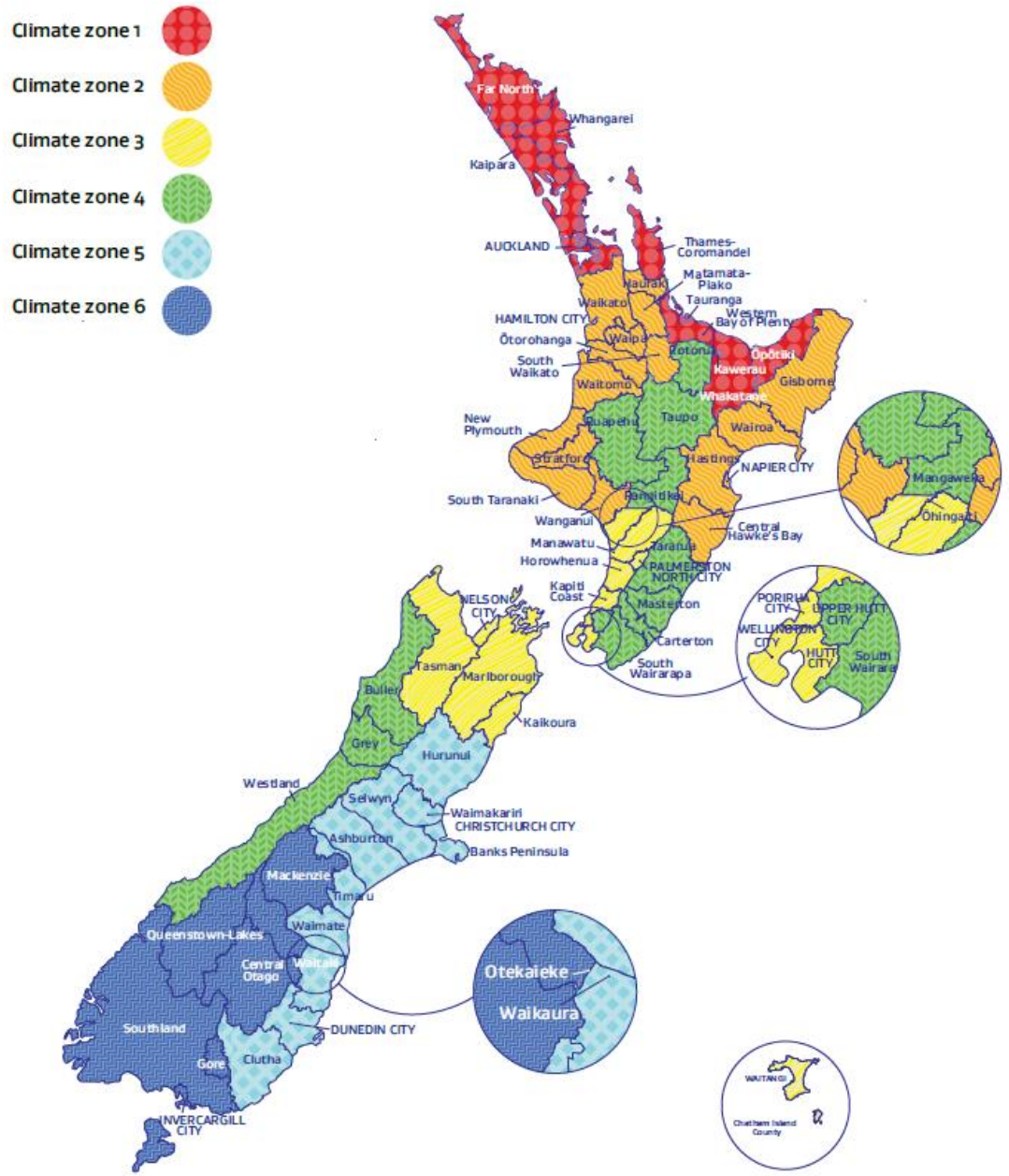
Climate zone changes

6 climate zones

More accurately relate to specific climates within regions



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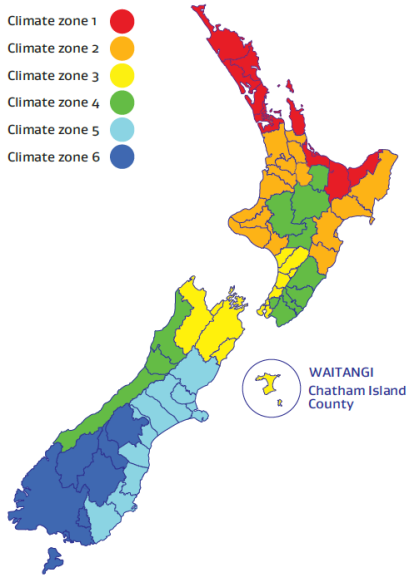
Roof insulation

TABLE 1.5: Roof insulation – Comparison of R-values from consultation to the new minimums

Options	Climate zone					
	1	2	3	4	5	6
Status quo	R2.9		R2.9/3.3		R3.3	
Option 1. Halfway to international standards	R2.9	R3.3		R3.7		R4.2
Option 2. Comparable to international standards	R5.0	R5.4	R6.0	R6.6	R7.0	R7.4
Option 3. Going further than international standards	R6.6	R7.0	R7.4	R7.8	R8.4	R9.0
New minimums for H1/AS1 and H1/VM1	R6.6↑					



* Current R2.9 – R3.3 increased to R6.6

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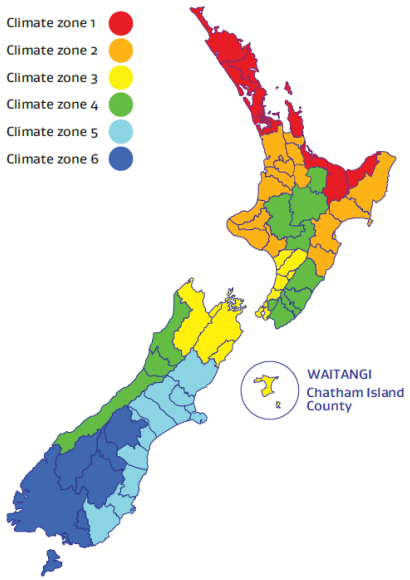
Windows

TABLE 1.6: Windows – Comparison of R-values from consultation to the new minimums

Options	Climate zone					
	1	2	3	4	5	6
Status quo	R0.26					
Option 1. Halfway to international standards	R0.26	R0.29		R0.33		R0.39
Option 2. Comparable to international standards	R0.39	R0.42	R0.45	R0.49	R0.55	R0.62
Option 3. Going further than international standards	R0.48	R0.52	R0.55	R0.62	R0.68	R0.76
New minimums for H1/AS1 and H1/VM1 effective 29 November 2021 until 1 November 2023	**R0.37↑**		**R0.46↑**		**R0.50↑**	*
New minimums for H1/AS1 and H1/VM1 effective 2 November 2023	**R0.46↑**		**R0.46**		**R0.50**	*

To support the new requirements, we have also revised H1/AS1 and H1/VM1 to include a new calculation procedure and table of values for determining the R-values of windows.



* Current R0.26 increased to R0.46 – R0.50

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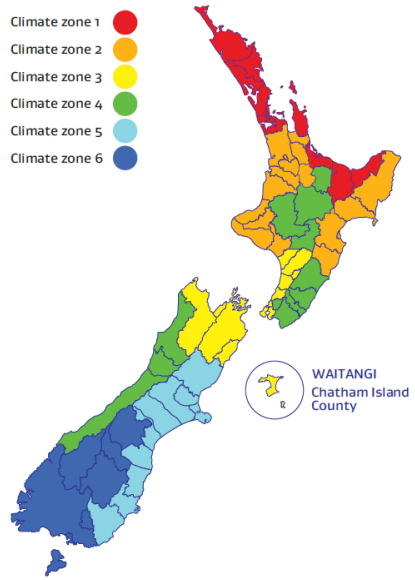
Wall insulation

TABLE 1.7: Wall insulation – Comparison of R-values from consultation to the new minimums

Options	Climate zone					
	1	2	3	4	5	6
Status quo	R1.9		R1.9/2.0		R2.0	
Option 1. Halfway to international standards	R1.9	R2.2			R2.4	
Option 2. Comparable to international standards	R2.4	R2.6	R2.8	R3.2	R3.5	R3.8
Option 3. Going further than international standards	R2.9	R3.2	R3.5	R3.8	R4.4	R5.0
New minimums for H1/AS1 and H1/VM1	**R2.0↑**			**R2.0**		



* Current R1.9 increased to R2.0

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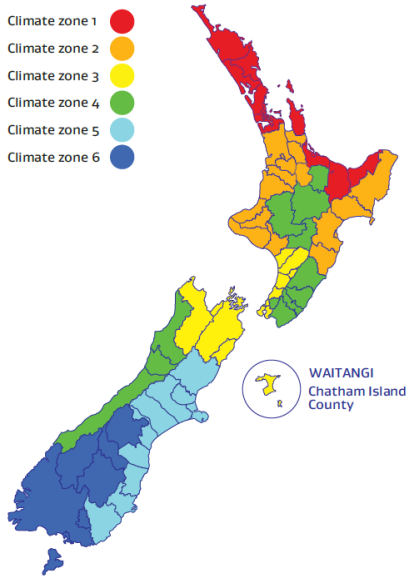
Underfloor insulation

TABLE 1.8: Underfloor insulation – Comparison of R-values from consultation to the new minimums

Options	Climate zone 1	2	3	4	5	6	
Status quo	R1.3						
Option 1. Halfway to international standards	R1.3	R1.3	R1.9	R1.9	R2.2		
Option 2. Comparable to international standards	R1.9	R2.2	R2.5	R2.8	R3.2	R3.6	
Option 3. Going further than international standards	R2.5	R2.8	R3.2	R3.6	R4.2	R4.8	
New minimums for H1/AS1 and H1/VM1 for slab-on-ground floors	R1.5↑	R1.5↑	R1.5↑	R1.5↑	R1.6↑	R1.7↑	*
New minimums for H1/AS1 and H1/VM1 for other floors	R2.5↑			R2.8↑	R3.0↑		*



* Current R1.3 increased to R1.5 – R1.7 for slabs
  Current R1.3 increased to R2.5 – R3.0 for other floors

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MBIE Procurement Guide

Rule 7: When the Rules apply – new construction works

Explains that the Rules apply to procurement processes for new construction works that meet or exceed the relevant value threshold.

1. The Rules apply:
   a. to the procurement of goods or services or works for new construction works, when
   b. the maximum total estimated value (Rule 8) of the procurement meets or exceeds the value threshold of $9 million (excluding GST).
2. To estimate the maximum total estimated value (Rule 8) for new construction works an agency **must** take into account all:
   a. related services (eg design, architecture, engineering, quantity surveying, and management consultancy services)
   b. types of goods (eg construction material, health and safety equipment)
   c. phases of the construction through to completion
   d. subcontracted goods, services and works.

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Key messages

- New H1/AS1 & H1/VM1
- New compliance pathways for operational and embodied carbon are coming from 2024
- Proposed methodology for assessing embodied carbon
- Accelerated requirements for Government builds

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Calculating building carbon footprints

What is a carbon footprint?

Reflects additional contribution to climate change

- Calculated, not measured
- Reflects potential effect of emission of different greenhouse gases
  - Potency
  - Lifetime

Potency relative to carbon dioxide = "global warming potential (GWP)":

- Carbon dioxide = 1
- HFC 134a (refrigerant) = 1400

Typical carbon footprint units

- kg CO_2eq, kg CO_2e, tonnes CO_2eq, tonnes CO_2e

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Carbon footprint

Carbon footprint should:

- Reflect effect of emissions over a specified period (usually 100 years)
- Include all greenhouse gases
- Cover the full life cycle of the building

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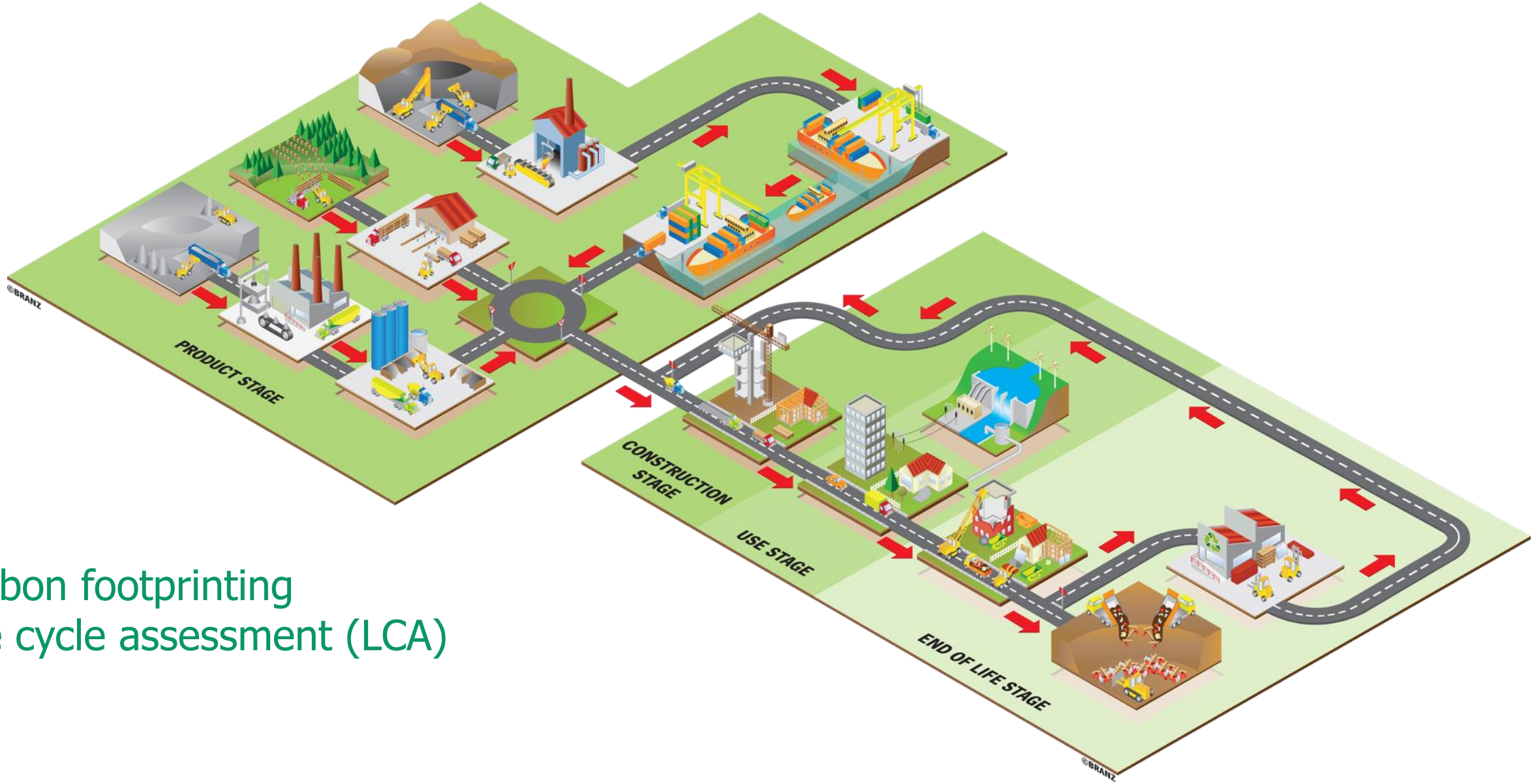
How is a carbon footprint calculated?



Carbon footprinting
Life cycle assessment (LCA)

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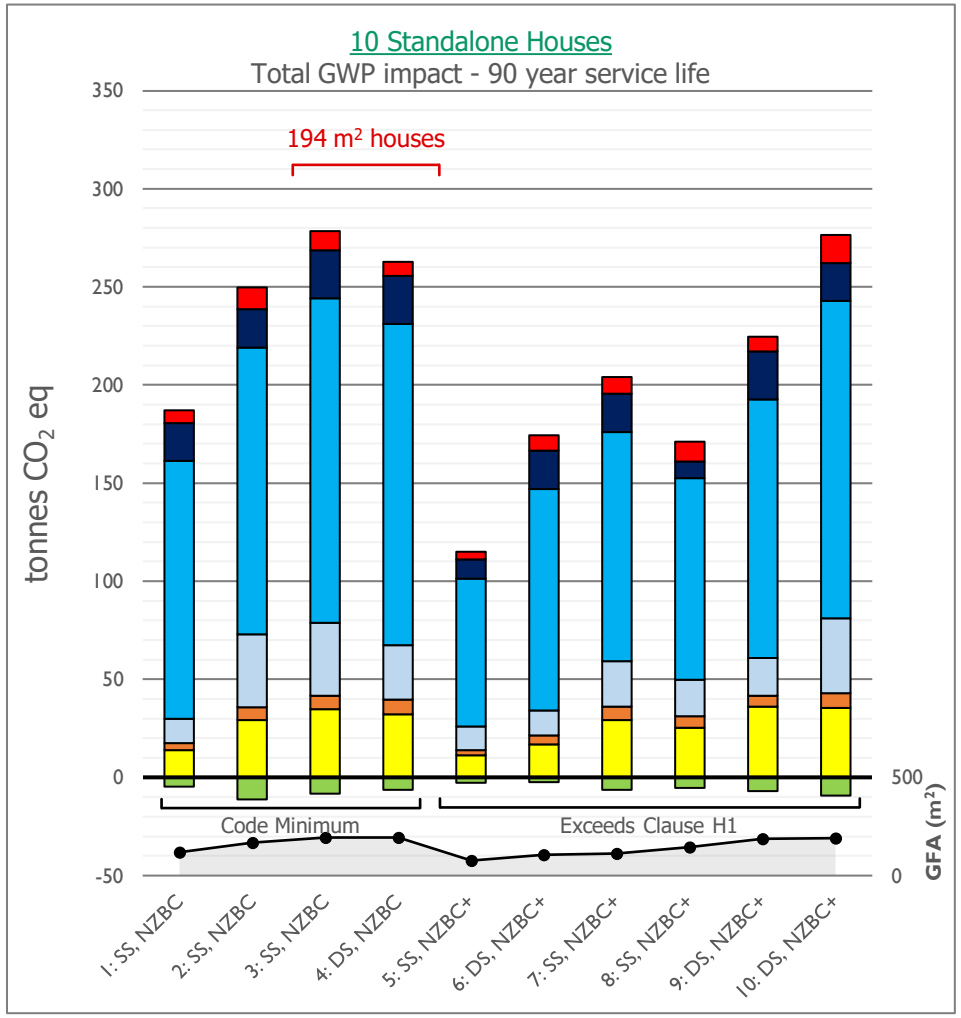
Carbon footprint of case study new stand-alone houses



- Potential environmental benefits beyond the life cycle (module D)
- End of life stage
- Operational water (Use stage)
- Operational energy (Use stage)
- Maintenance & 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 + cooling, hot water, lighting, plug-in appliances.

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How do I start calculating embodied carbon footprints?

SIMPLER

Typical stand alone houses

↓

CO_2RE (BRANZ):

- Residential wall, floor, roof construction
- Carbon footprints per m^2
- BRANZ House Insulation Guide (5th edition)
- PHINZ HPCD Handbook (a few)
- Whole-of-life embodied carbon only

Allows you to see lower carbon constructions that can deliver desired R values

HECC (NZGBC)

- Includes CO_2RE database
- Select wall, floor, roof, window constructions
- Insert m^2 areas for each

Calculates whole-of-life embodied carbon
Can be used by anyone

MORE COMPLEX

Unusual or complex dwelling:

- Apartments

↓

Generate key input data:

- Material types
- Material quantities

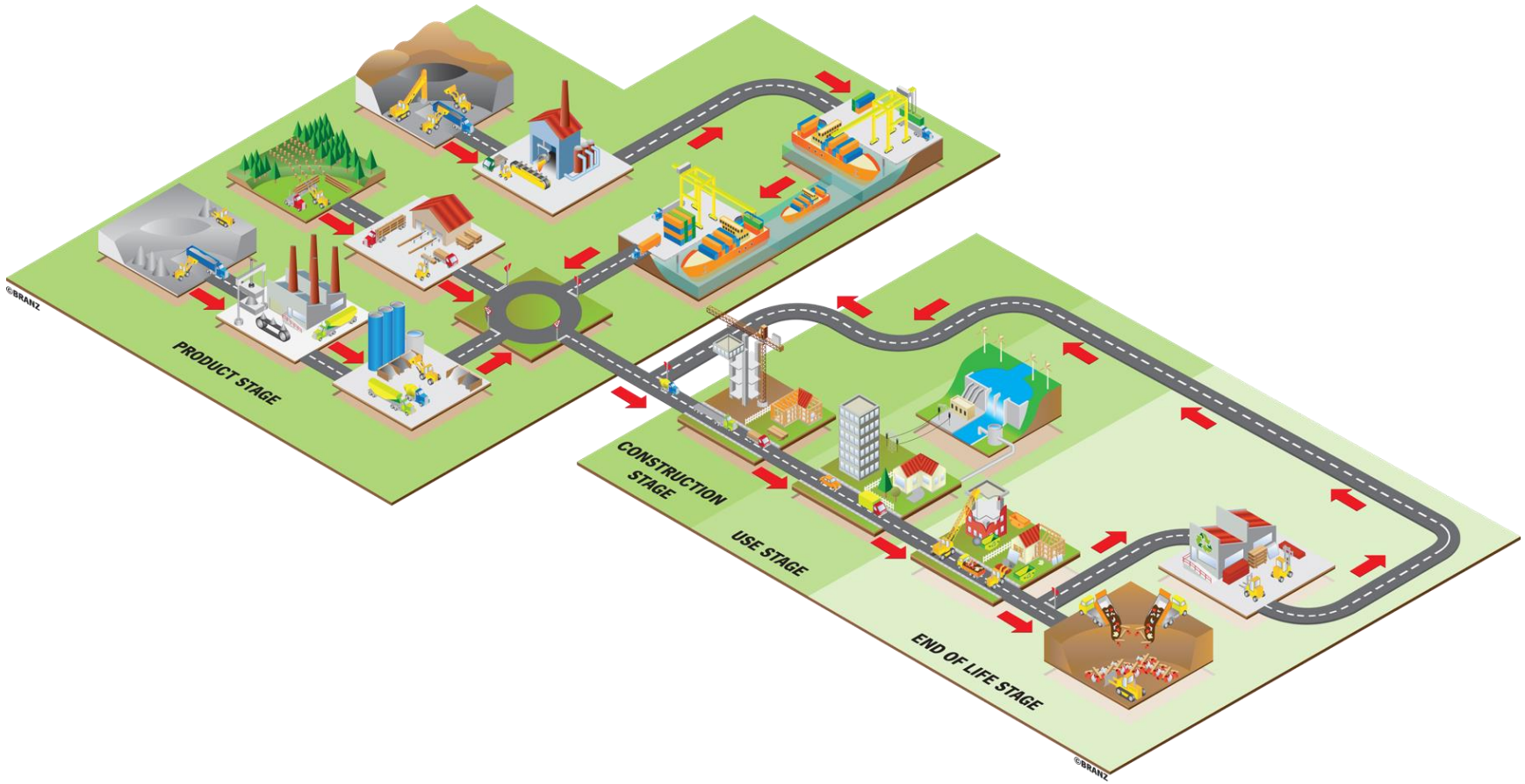
↓

Whole-of-life building LCA tool

Examples include:

- LCAQuick v3.5 (BRANZ tool, Excel, free)
- Etool (proprietary, web-based, licence required)
- OneClick LCA (proprietary, web-based, licence required)

SIMPLER method



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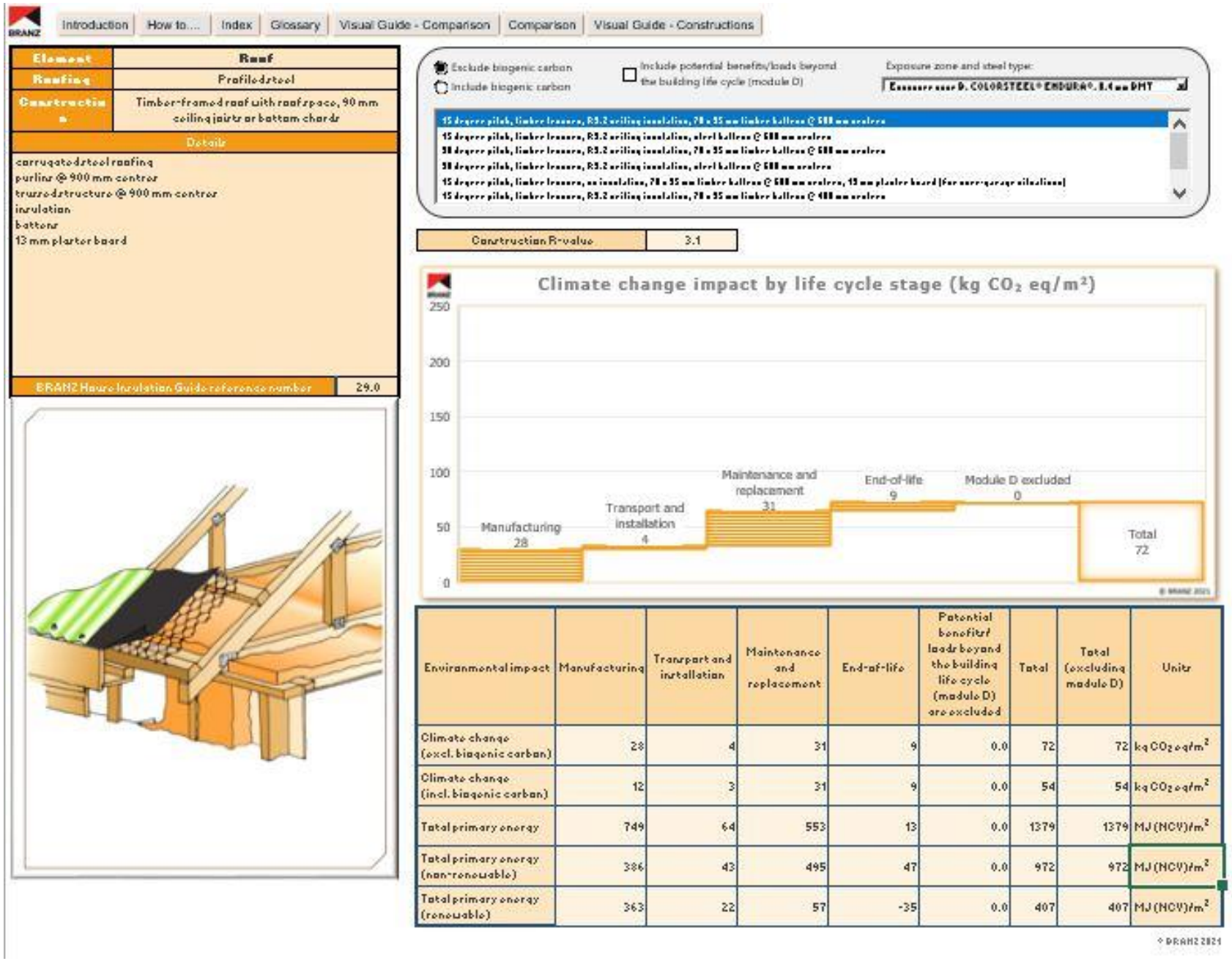
CO_2RE

Description

HIG reference

Image (from HIG)



Drop down list of variants

Construction R value

Visual whole-of-life embodied carbon results / m^2

Tabulated whole-of-life embodied carbon and energy results / m^2

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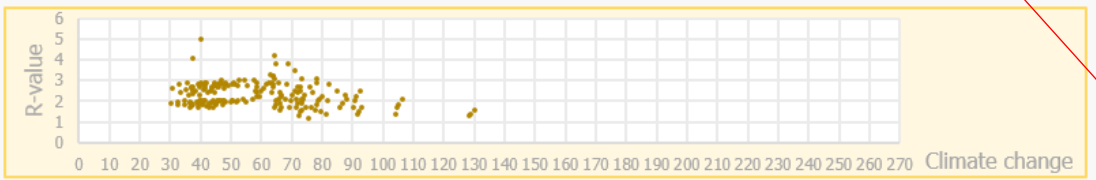
CO_2RE

1. Tailor parameters here (or leave blank):
   - Type of floor
   - Desired construction R value
   - Higher or lower carbon concrete

2. CO2RE orders constructions that meet or exceed desired construction R value here, from lowest whole-of-life embodied carbon to highest

Floors

type: any
minimum R-value: 0
Concrete carbon content: lower



BRANZ	Top 2 to 11	Description	Materials-related climate change impact kg CO_2 eq/m^2	R-value m^2 °C/W
2	119.12	Suspended timber - Closed perimeter, bulk insulants without lining, 90/140 mm joists 90 x 45 mm joists @ 600 mm centres, 19 mm CD slip tongue ply flooring (no dwangs), R2.6 insulation, A/P ratio 4.0	30.8	2.6
3	119.0	Suspended timber - Closed perimeter, bulk insulants without lining, 90/140 mm joists 140 x 45 mm joists @ 600 mm centres, 19 mm CD slip tongue ply flooring (no dwangs), R1.6 insulation, A/P ratio 4.0	32.6	2.0
4	119.5	Suspended timber - Closed perimeter, bulk insulants without lining, 90/140 mm joists 90 x 45 mm joists @ 400 mm centres, 19 mm CD slip tongue ply flooring (no dwangs), R1.6 insulation, A/P ratio 4.0	32.7	1.8
5	119.8	Suspended timber - Closed perimeter, bulk insulants without lining, 90/140 mm joists 140 x 45 mm joists @ 600 mm centres, 19 mm CD slip tongue ply flooring (no dwangs), R2.6 insulation, A/P ratio 4.0	33.1	2.8

Note: CO_2RE does not contain all possible residential wall, floor, roof constructions in its database:
- Mainly taken from BRANZ House Insulation Guide (5th edition)

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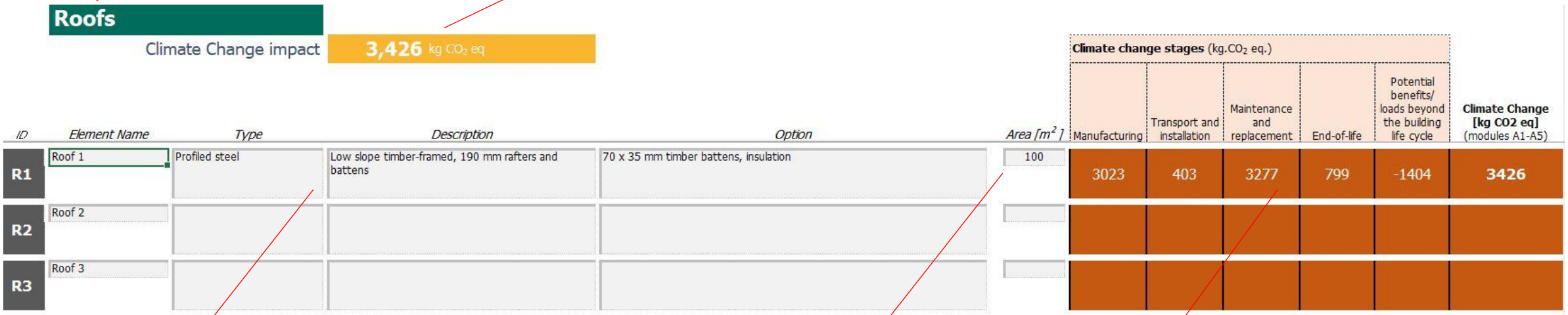
HECC

1. Select building element

5. HECC displays total pre-occupation element carbon footprint



Roofs

Climate Change impact **3,426** kg CO_2 eq

ID	Element Name	Type	Description	Option	Area [m^2]	Climate change stages (kg.CO_2 eq.)					
						Manufacturing	Transport and installation	Maintenance and replacement	End-of-life	Potential benefits/ loads beyond the building life cycle	**Climate Change [kg CO2 eq]** (modules A1-A5)
R1	Roof 1	Profiled steel	Low slope timber-framed, 190 mm rafters and battens	70 x 35 mm timber battens, insulation	100	3023	403	3277	799	-1404	**3426**
R2	Roof 2										
R3	Roof 3										

2. Select roof type(s) in design

3. Insert area (m^2)

4. HECC displays construction whole-of-life embodied carbon impacts by life cycle stage

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HECC – summary page

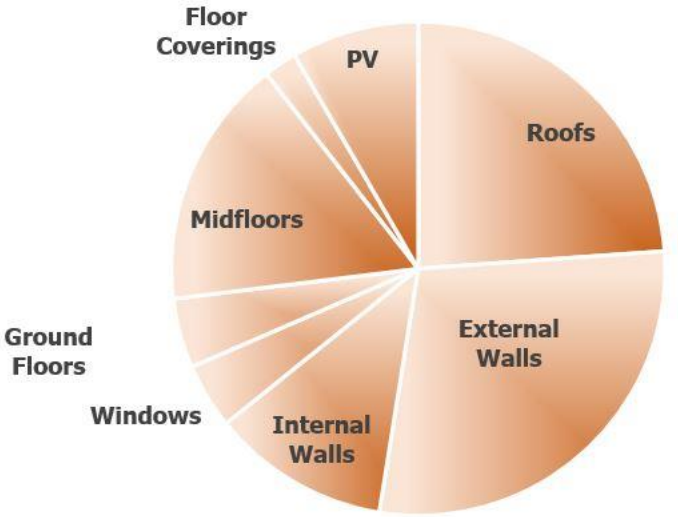
Pre-occupation carbon footprint

Results

Total Climate Change Impact (A1-A5)	**14,351** kg CO_2 eq
Climate Change Impact Intensity	**144** kg CO_2 eq/m²

	Climate Change [kg CO2 eq]				
	A1-A5	**B**	**C**	**D**	**Total**
Roofs	3,426	3,277	799	-1,404	6,098
External Walls	4,113	4,144	1,336	-278	9,314
Internal Walls	1,676	1,335	919	-144	3,786
Windows	614	1,246	9	-445	1,425
Ground Floors	654	0	80	-47	687
Midfloors	2,355	590	1,057	-124	3,878
Floor Coverings	313	1,353	25	0	1,691
PV	1,200	30	40	-100	1,170
Total	**14,351**	**11,975**	**4,265**	**-2,542**	**28,048**

Climate Change Impact - modules A1-A5



Introduction | Summary | Roofs | External Walls | Internal Walls | Windows | Ground Floors | Midfloors | Floor Coverings | PV | Custom ...

Displays total whole-of-life embodied carbon footprint, divided by elements and life cycle stages

Pre-occupation contribution analysis

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Tool locations

www.branz.co.nz/calculators-tools/

HECC www.nzgbc.org.nz (select Green Homes / Technical Resources)

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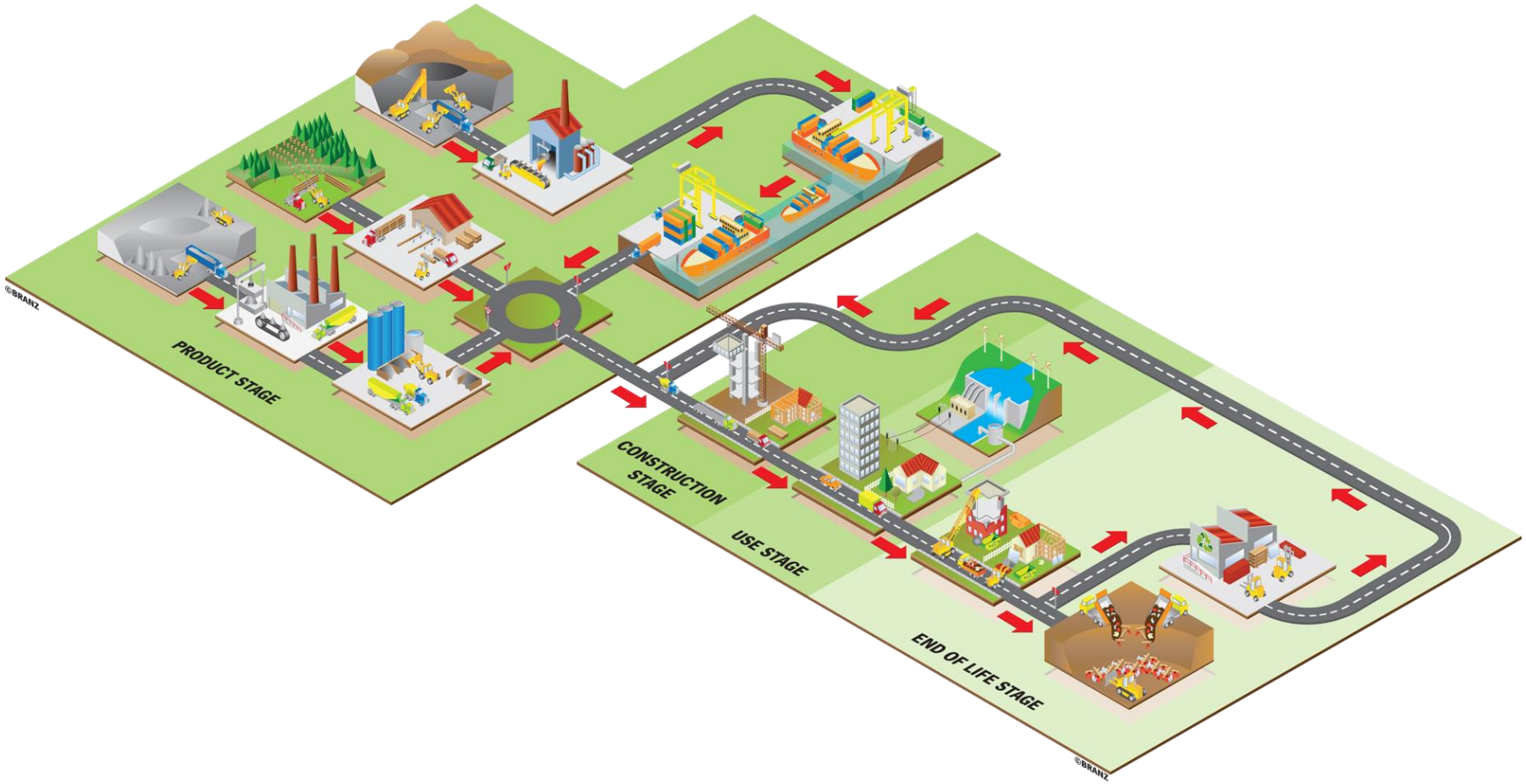
More COMPLEX



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List of materials and quantities

Materials quantities may be volumes, areas, masses

- Can be extracted from BIM (if you have one)
- If using BIM, take care with modelling:
  - Timber framing ratio
  - Hollow volumes vs solid volumes
  - Concrete compressive strength
  - Reinforcing steel
  - Surface area information

Further information: Berg et al. (2016) BRANZ SR350 study report

LCAQuick guide for ArchiCAD users

- Written by architects for architects
- Available at:

  www.branz.co.nz/environment-zero-carbon-research/framework/lcaquick/

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LCAQuick guide for ArchiCAD users

Using ArchiCAD to provide BIM data for LCAQuick calculations | V.1 2020 | September

Use a building LCA tool (or engage someone)

Fundamentally, they…..

- take a list of material types and quantities, and……..
- multiply by material specific carbon intensities (manufacturing, end-of-life)

Example:

material A (m^3) x carbon intensity (kg CO_2eq/m^3) = material A carbon footprint

A: Concrete (20 MPa)	24 m^3	x	225 kg CO_2eq/m^3	=	5,400 kg CO_2eq

material B (m^2) x carbon intensity (kg CO_2eq/m^2) = material B carbon footprint

B: Plasterboard	272 m^2	x	1.08 kg CO_2eq/m^2	=	294 kg CO_2eq

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Some options

LCAQuick v3.5

- BRANZ developed tool and database for NZ buildings
- Excel based
- Free - BRANZ also provides free training and support
- Library of NZ residential, office and school buildings
- Includes carbon budget

EToolLCD

- Developed in Australia, now used worldwide
- Web-based
- Revit plug-in
- Licence required
- Training and support

One Click LCA

- Developed in Europe, now used worldwide
- Web-based
- Revit plug-in
- Licence required
- Training and support

www.branz.co.nz/calculators-tools/

https://etoolglobal.com/about-etoollcd/

www.oneclicklca.com/construction/

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Calculating operational carbon footprints

Need an estimate of:

- Energy use (kWh/year) and source(s) of supply
- Water use

Energy demand estimate from:

- BRANZ Annual Loss Factor (ALF) tool https://alf.branz.co.nz/ (heating only)
- Energy simulation expertise

Modelled energy demand results → Input to building LCA tool

- If doing a Homestar assessment, ECCHO (Energy & Carbon Calculator for Homes) is an option

Water use defaults: www.branz.co.nz/buildinglca (select "Data") or embedded in LCAQuick v3.5

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Be(a)ware

Building LCA tools are not created equally!!!

- Different underlying materials data e.g. source(s)
- Embedded assumptions e.g. material service life
- Functionality

In absolute terms, unlikely that tools will yield the same or similar carbon footprint result for the same building

DON'T BE PUT OFF!!!

Use results to iteratively reduce or design out environmental impacts i.e. compare design iteration carbon footprints to previous iterations/pre-set threshold

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Data

Need for a national construction database:

- Accessible by all building LCA tools
- Comprehensive
- Updated regularly

Already starting to happen in other countries e.g. UK

POTENTIAL ENVIRONMENTAL IMPACT

17.5MPa STANDARD

PER 1m³ OF STANDARD READY-MIXED CONCRETE

Firth Batching Plant	Global warming potential	Ozone depletion potential	Acidification potential of soil and water	Eutrophication potential	Formation potential of tropospheric ozone	Abiotic depletion potential (elements)	Abiotic depletion potential (fossil fuels)
	kg CO_2 eq.	kg CFC 11 eq.	kg SO_2 eq.	kg PO_4^{3-} eq.	kg C_2H_2 eq.	kg Sb eq.	MJ, NCV
North Island Average	**208**	**1.61E-12**	**0.309**	**0.0725**	**0.00683**	**6.49E-06**	**1,080**
Auckland Airport	231	1.76E-12	0.397	0.0944	0.0214	7.71E-06	1,270
Auckland Albany	213	1.69E-12	0.312	0.0728	0.00190	7.37E-06	1,130
Auckland City	198	1.61E-12	0.284	0.0661	0.00746	7.01E-06	1,030

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Other free BRANZ carbon footprint tools

CO_2NSTRUCT 2.0

- Materials/products embodied carbon database
- Product stage (modules A1 – A3)
- Data quality indicator

CO_2MPARE

- Thresholds for building carbon footprints (average, high, low)
- Case study residential and office buildings
- Embodied and operational carbon
- Carbon budget
- Energy use intensity and top contributing materials

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www.branz.co.nz/calculators-tools/

Other free BRANZ LCA tools

LCAPlay

- Facilitates testing of early design options – size, structure etc
- Precedes LCAQuick
- Commercial buildings only
- Building life cycle carbon footprints (and other environmental indicators)

Watch this space: Webinars coming from April on all BRANZ carbon footprint / LCA tools (and the NZGBC HECC Tool)

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www.branz.co.nz/calculators-tools/

When should I start considering carbon emissions……

NOW!

Improve your carbon literacy
Use the free BRANZ and NZGBC tools and/or license a proprietary tool
Talk to clients about carbon
Consider carbon in design

Share your learnings

Don't panic – a lot more consultation and guidance to come

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Key messages

- Free BRANZ and NZGBC tools available now
- Proprietary tools also available
- Start now!
- BRANZ can provide free training and support to help get you started. Contact us: david.dowdell@branz.co.nz

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Key organisations

Number of organisations 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/

Building LCA:
www.branz.co.nz/buildinglca

BRANZ tools including LCAQuick, LCAPlay, CO_2NSTRUCT, CO_2RE, CO_2MPARE:
www.branz.co.nz/calculators-tools/

NZGBC HECC tool:
www.nzgbc.org.nz (select Green Homes / Technical Resources)

Building LCA case studies:
www.branz.co.nz/pubs/case-studies/lcaquick/

MBIE Building for Climate Change:
www.mbie.govt.nz/building-and-energy/building/building-for-climate-change/

Contact: david.dowdell@branz.co.nz

Thanks again to our sponsors

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Upcoming webinars

Webinar 3 Wednesday 23 March 12-1pm

- Carbon challenges

Webinar 4 Wednesday 30 March 12-1pm

- Design and build a low-carbon dwelling

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Thanks

We really appreciate the effort you have made to attend

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