

Innovative Solutions to our Housing Challenges

Andrea Stocchero

Scion

Guy Marriage

Victoria University of Wellington, First Light Studio, PrefabNZ

Speaker's Science Forum

Aotearoa New Zealand

Speaker's Science Forum

Aotearoa New Zealand



Sustainable Wood for a Sustainable Future

Andrea Stocchero
Wellington, 09 June 2021



The challenges



More challenges



The Four Capitals

LIVING STANDARDS FRAMEWORK

Intergenerational wellbeing relies on the growth, distribution, and sustainability of the Four Capitals. The Capitals are interdependent and work together to support wellbeing. The Crown-Māori relationship is integral to all four capitals. The LSF is being continually developed and the next iteration of the framework will consider the role of culture, including Māori culture, as part of the capitals approach in more detail.



Natural Capital

This refers to all aspects of the natural environment needed to support life and human activity. It includes land, soil, water, plants and animals, as well as minerals and energy resources.



Social Capital

This describes the norms and values that underpin society. It includes things like trust, the rule of law, cultural identity, and the connections between people and communities.



Human Capital

This encompasses people's skills, knowledge and physical and mental health. These are the things which enable people to participate fully in work, study, recreation and in society more broadly.

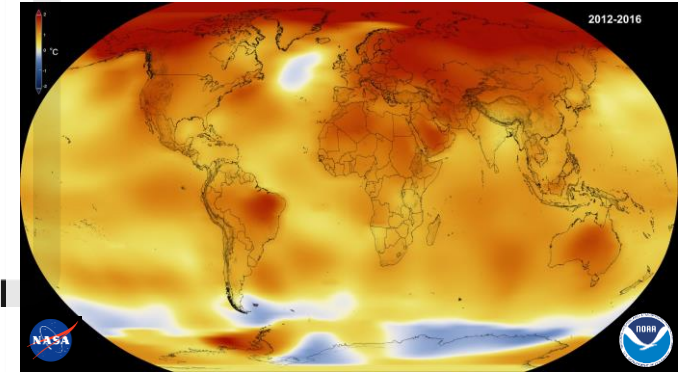
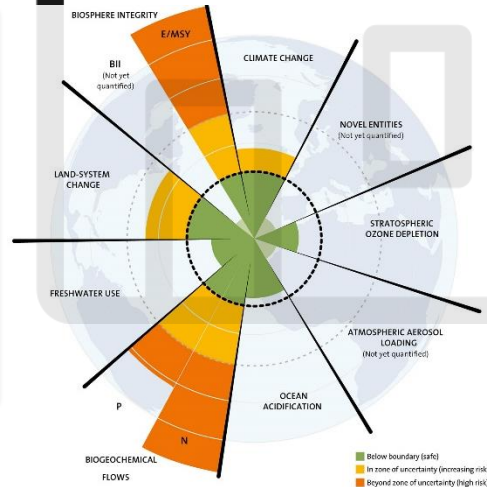


Financial / Physical Capital

This includes things like houses, roads, buildings, hospitals, factories, equipment and vehicles. These are the things which make up the country's physical and financial assets which have a direct role in supporting incomes and material living conditions.



Earth Overshoot Day



The opportunity



Why sustainably sourced wood products can be an answer?



Wood is a performing material

Wood is proven

Light-weight and strong

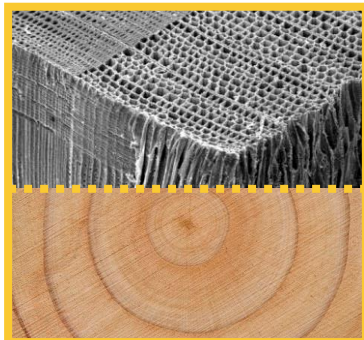
Thermal performance

Resilient and durable by design

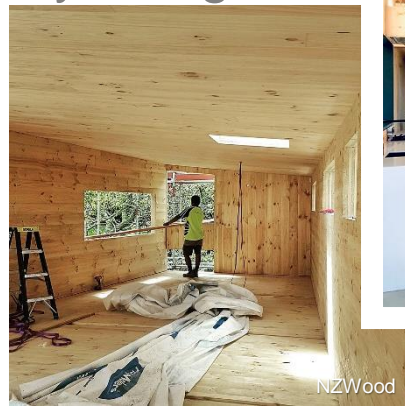
Variety of products

Workable

Biophilic



NZWood

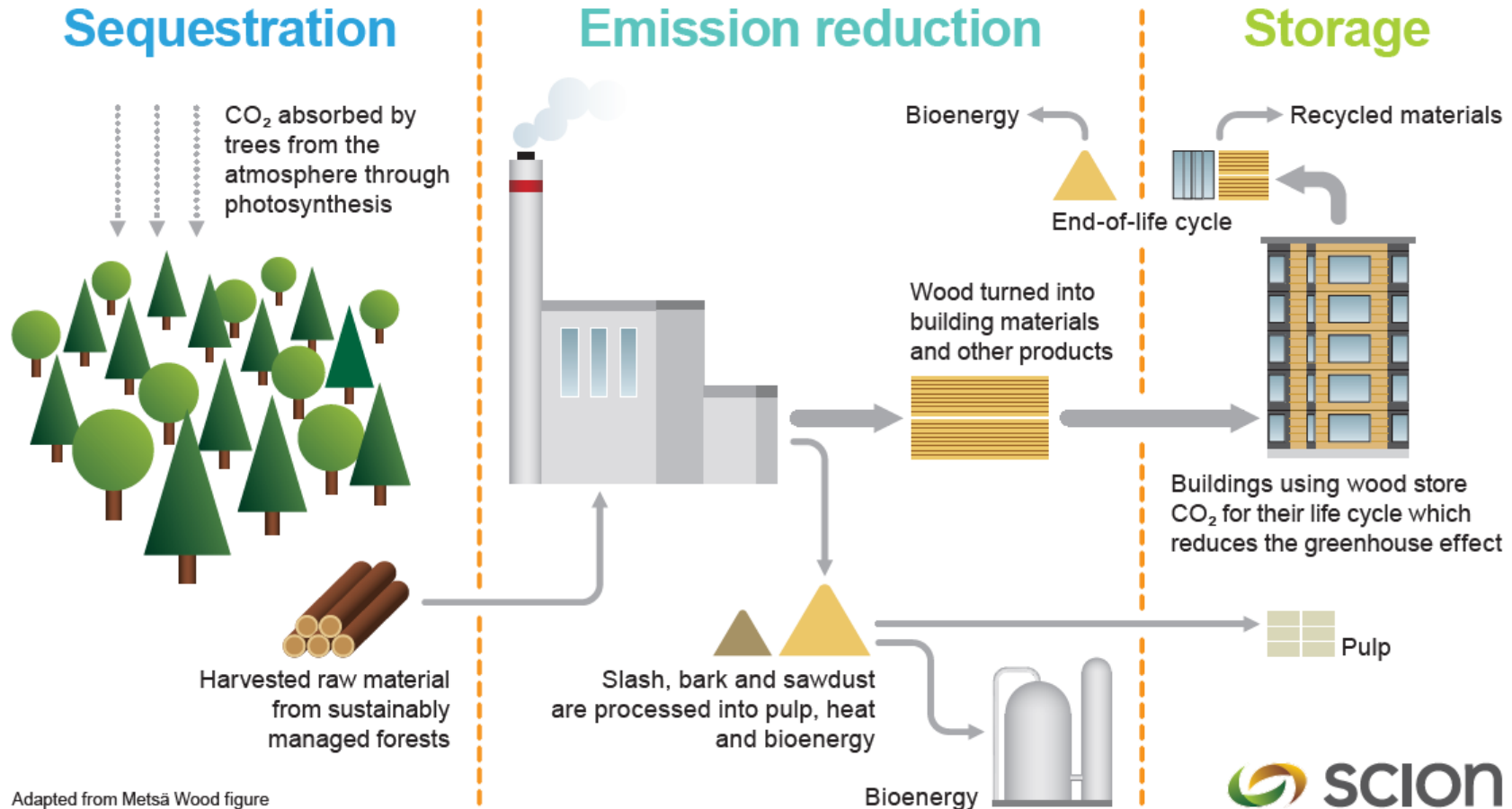


NZWood



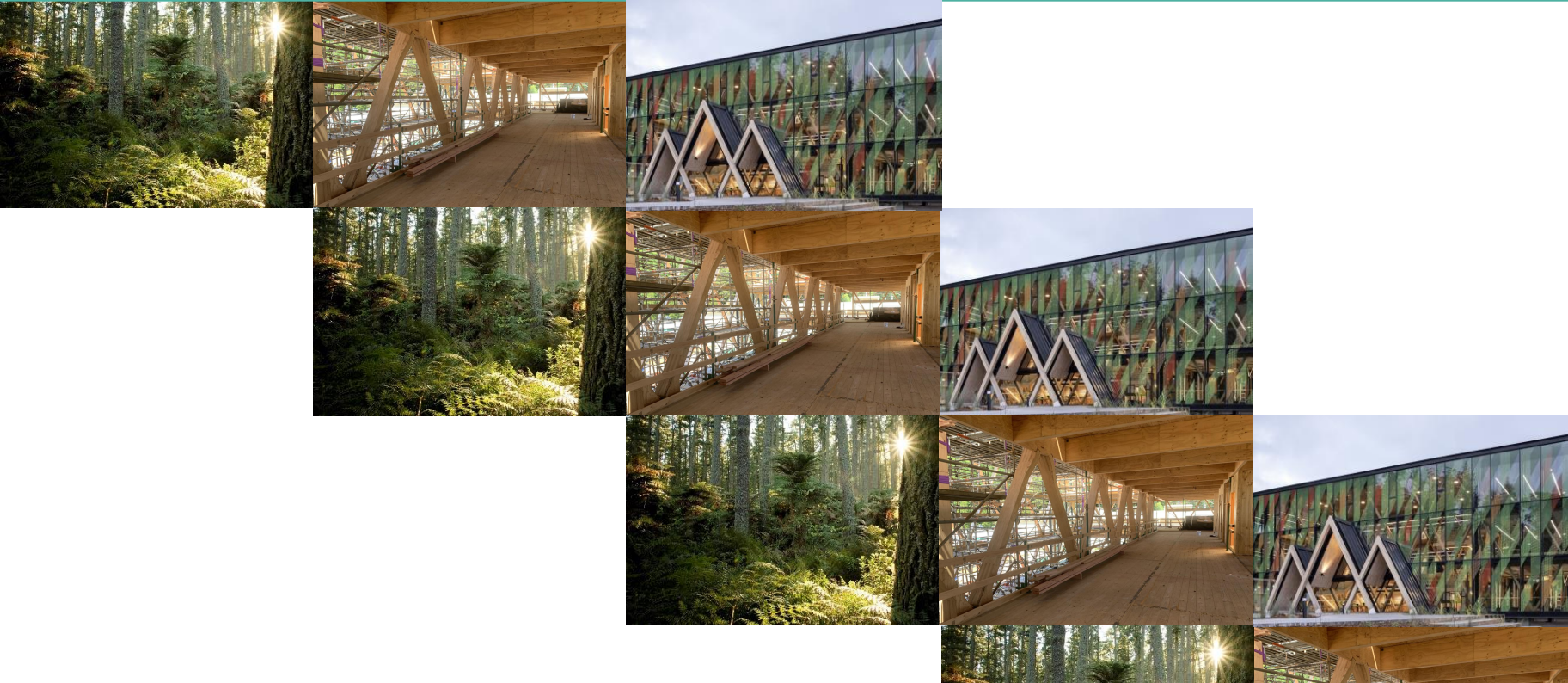
NZWood

The Biogenic carbon cycle of sustainable wood products



Adapted from Metsä Wood figure

The forest-wood products “carbon pump”



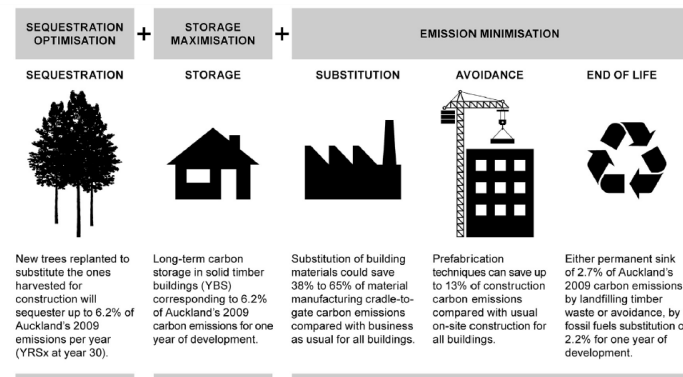


Fig. 3. Greenhouse gas mitigation benefits of applying Urban Equilibrium strategy for the Auckland City case study.

nature
sustainability

PERSPECTIVE

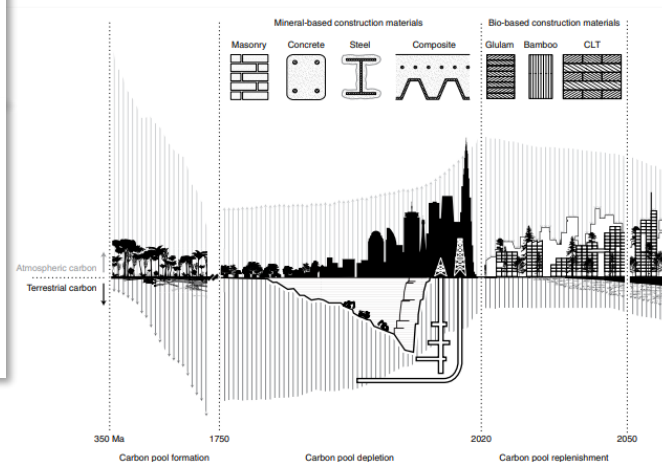
<https://doi.org/10.1038/s41893-019-0462-4>

Perspective | Published: 27 January 2020

Buildings as a global carbon sink

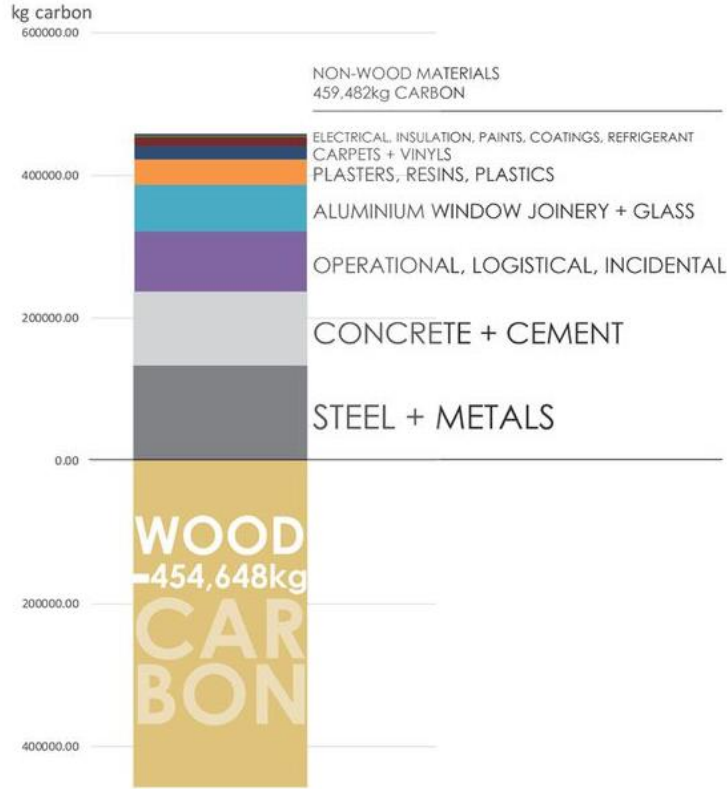
Galina Churkina , Alan Organschi, Christopher P. O. Reyer, Andrew Ruff, Kira Vinke, Zhu Liu, Barbara K. Reck, T. E. Graedel & Hans Joachim Schellnhuber

Nature Sustainability **3**, 269–276(2020) | Cite this article



Building for Climate Change

“Reducing emissions from buildings during their construction and operation”



EMBODIED CARBON AT COMPLETION

Source: RTA STUDIO



Scion's Te Whare Nui o Tuteata

© RTA STUDIO

The NZ productive forests capacity

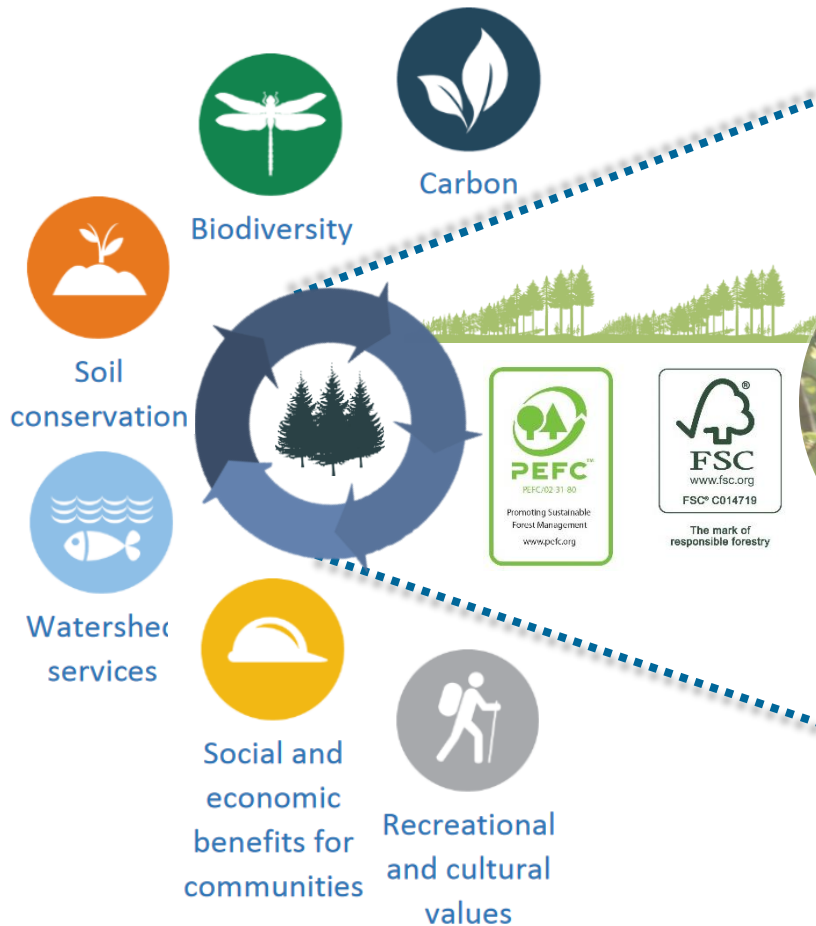


Scion's Te Whare Nui o Tuteata



**35 minute re-growth time
within NZ Radiata Pine forests**

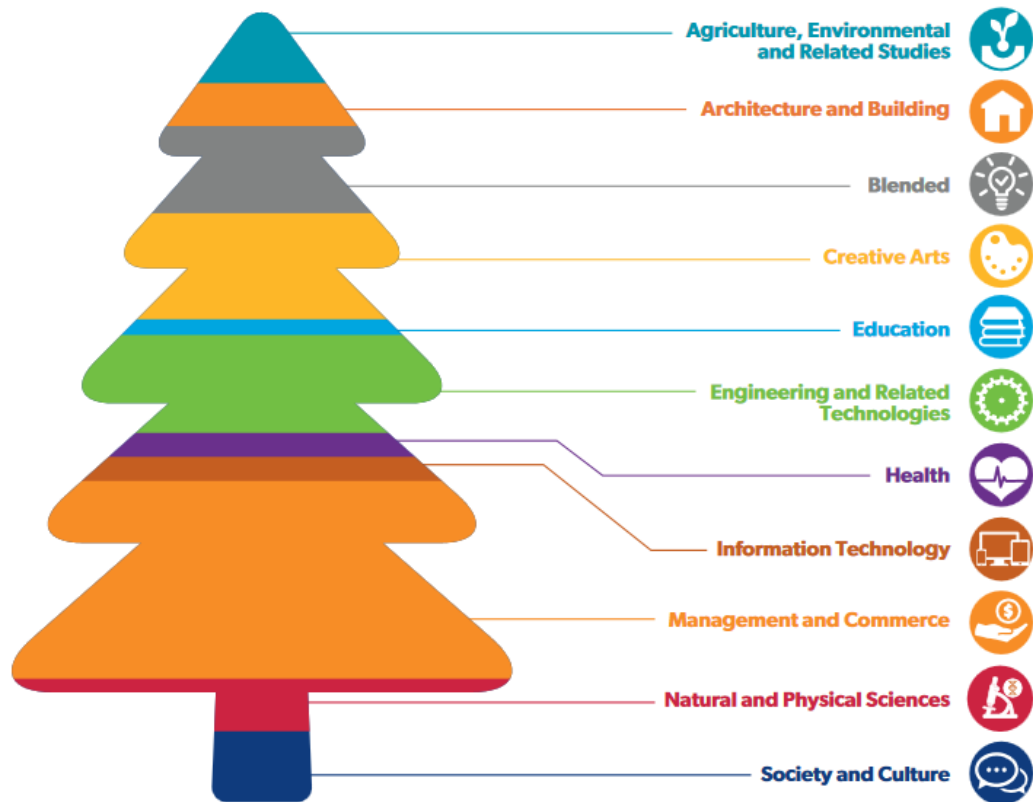
Sustainably managed planted forests



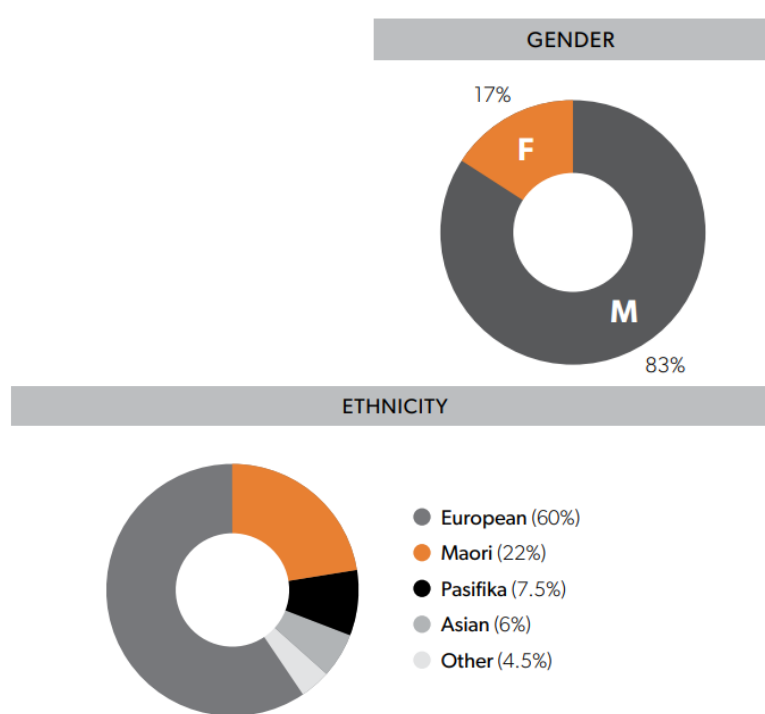
© RTA STUDIO

© RTA STUDIO

Diversity within the forestry & wood processing workforce



Source: Stats NZ Integrated Data Infrastructure (IDI)¹²



Source: Ministry for Primary Industries

The New European Bauhaus: How can the wood sector engage, contribute and co-create?

**Circular bio-based materials and solutions
for a sustainable, affordable and beautiful
transformation of the built environment**



“We know that the construction sector can even be turned from a carbon source into a sink, if organic building materials like wood and smart technologies like AI are applied.”

Ursula von der Leyen

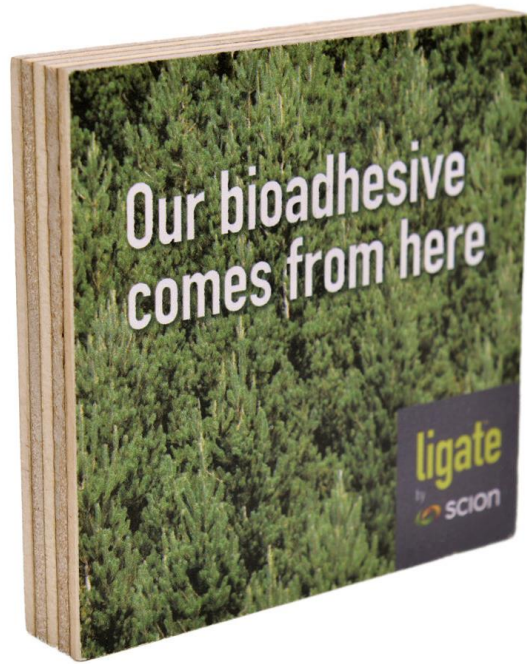
President of the European Commission

State of the Union Address, 16/09/2020

Building the Future with Sustainably Sourced Wood

Examples of New Zealand innovations with Engineered Wood
Products and the forest-based bioproducts

Transitioning towards renewable biobased

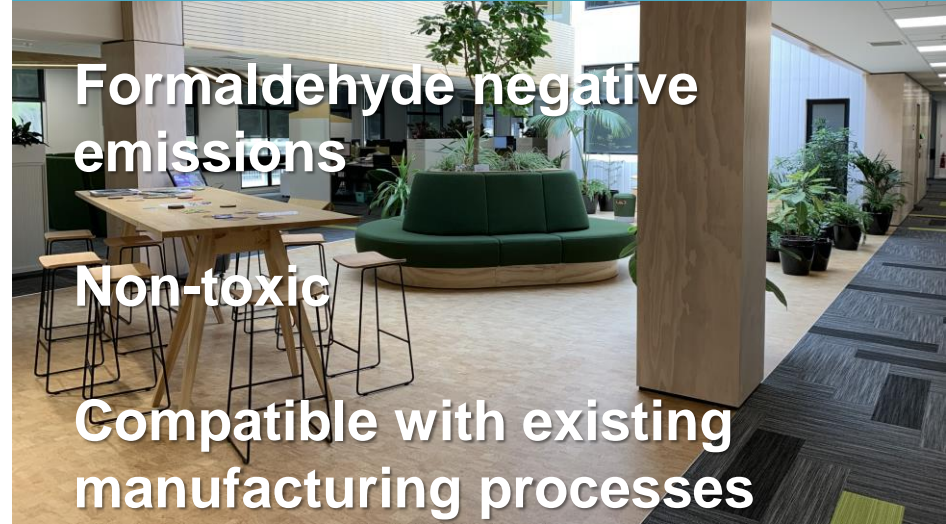


100% biobased, renewable ingredients

Formaldehyde negative emissions

Non-toxic

Compatible with existing manufacturing processes



References:



Engineering wood for performance



© WET, Scion



Optimising value recovery from
trees and short rotation forests

High-performance products from
low-grade wood

© WET, Callaghan Innovations

References:



WOOD ENGINEERING
TECHNOLOGY

OEL™ Optimised Engineered Lumber

 **scion**
FORESTS ■ PRODUCTS ■ INNOVATION

Digital manufacturing and prefabrication



© Thomas Seear-Budd , photographer



© Thomas Seear-Budd , photographer

Minimising waste

Accelerated off-site production
Reduced construction timeframes
Reduced cost of construction

© Thomas Seear-Budd , photographer

References: CLICK-RAFT system

CMA+U

MAKERS FABRICATION



Architecture: Chris Moller Architecture + Urbanism

Structure:

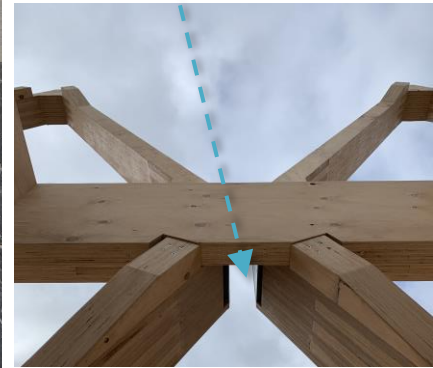
Dunning Thornton

Construction:

Makers Fabrication



Timber design and engineering innovation



References: Scion's Te Whare Nui o Tuteata
Architecture: Irving Smith Architects, RTA Studio
Structure: Dunning Thornton Consultants

Low-damage seismic performance



2016 Kaikoura earthquake Magnitude 7.8



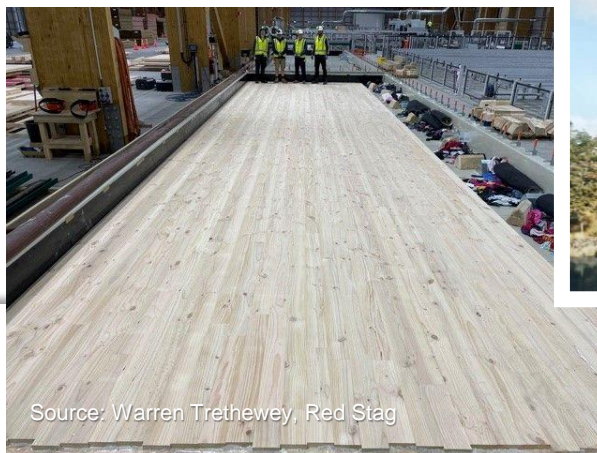
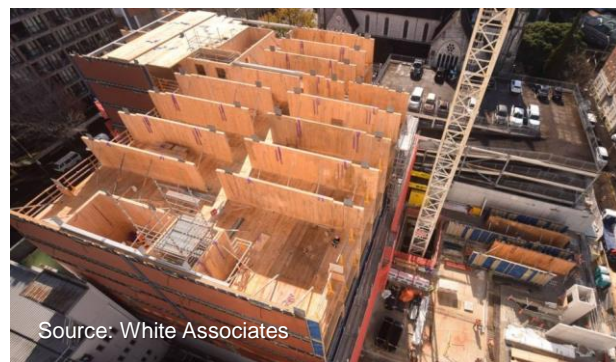
The building was undamaged and could be occupied by emergency response group



References:



Engineered wood residential at scale



Conclusions



Building with sustainable, locally grown wood can help address multiple dimensions of our housing challenge, including climate change mitigation, while contributing to intergenerational wellbeing in Aotearoa New Zealand.

New Zealand's sustainably managed planted forests provide on-going carbon sequestration and ecosystem services while regenerating raw materials for current and future generations.

New Zealand manufactured wood products that can substitute for carbon-intensive and non-renewable materials and store carbon for long-term.

New Zealand has an established forest and wood products sector and is home to world leading timber innovation and design.

Thank you

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Prosperity from trees *Mai i te ngahere oranga*

Scion is the trading name of the New Zealand Forest Research Institute Limited

Housing Innovations

Speaker's Science Forum

EXPLORE

DISCOVER

SHARE

ROYAL
SOCIETY
TE APĀRANGI

Guy Marriage



VICTORIA UNIVERSITY OF
WELLINGTON
TE HERENGA WAKA

Who am I ?

Guy Marriage

B Arch, M Arch, FNZIA

Senior Lecturer

at Victoria University of Wellington

Architect

registered in UK and NZ

Director

and Architect at

First Light Studio

Board

member at

PrefabNZ

11

years in London,

20

years in New Zealand

19

years lecturing in Construction

75

articles and papers published

9

months building a house on Grand Designs NZ

2

books *Tall: the Design and Construction of High-Rise Architecture*

and *Modern Apartment Design*



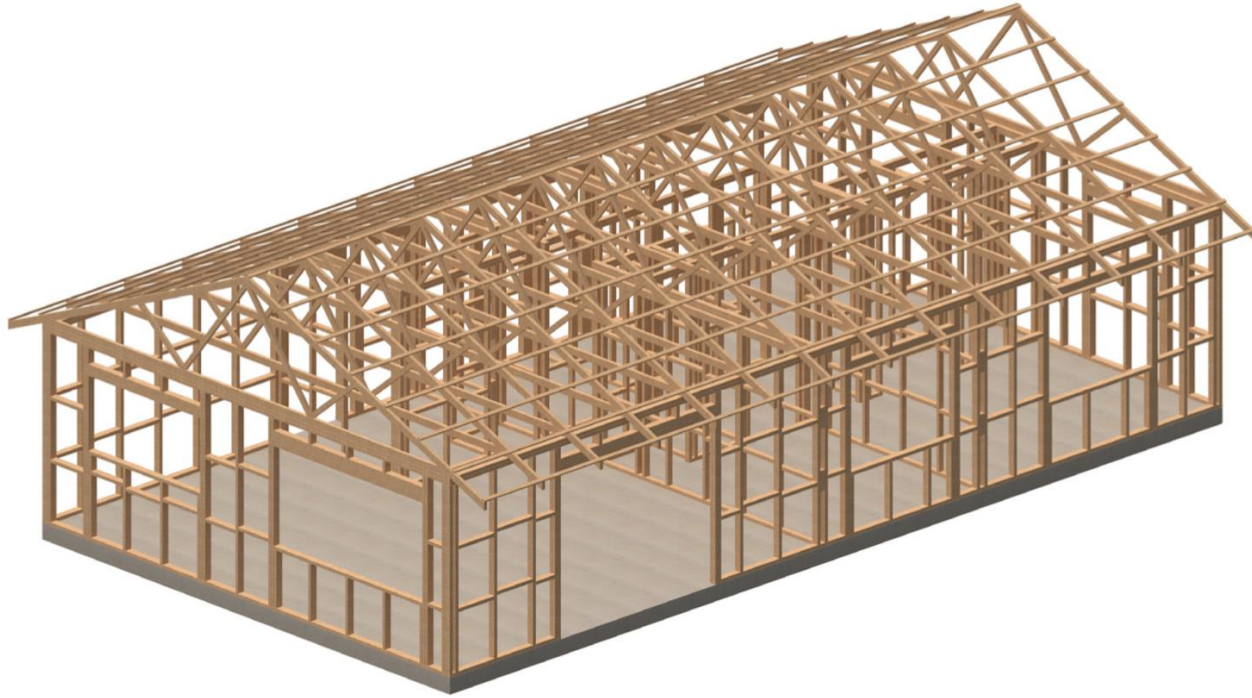


Figure 11: NZS3604 timber framing

Standard NZS 3604 house building

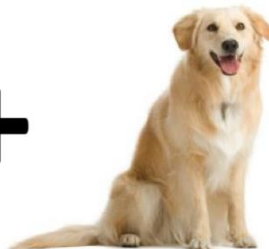
Several hundred pieces of timber + many thousand nails & screws



+



+



=



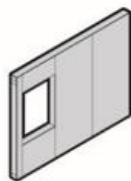
Standard NZ house building

One builder, one Ute, one dog = (eventually) one house

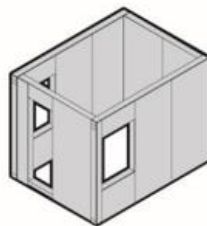
What prefab in New Zealand looks like



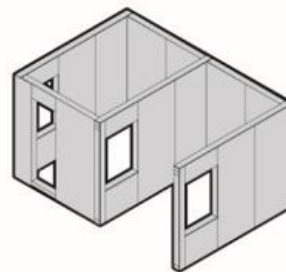
Component



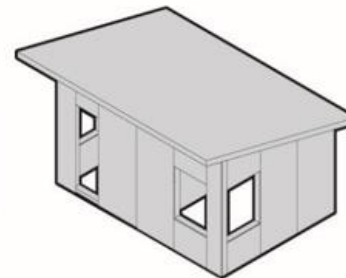
Panel



Volume

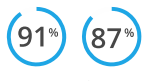


Hybrid
(Pod + panel)



Complete
building

▶ QUALITY



of new houses have defects
of houses have quality defects

BRANZ SR316 2014

▶ TIME



of construction time can be reduced through offsite construction.

PrefabNZ Value Case 2014

▶ DESIGN



prefab does not mean repetitive design or standardised housing outcomes.

PrefabNZ Value Case 2014

▶ PRODUCTIVITY



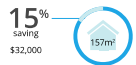
Price Waterhouse Coopers estimates a

$$10\% \uparrow \text{G.D.P.} = 1\% \uparrow \text{G.D.P.}$$

10% lift in construction industry productivity equates to a 1% lift in Gross Domestic Product.

PWC 2010

▶ COST



Prefab delivery can mean a saving of about 15% in total construction cost – \$32,000 for a 157m² house.

PrefabNZ Value Case 2014

▶ SUSTAINABILITY



International research points to waste minimisation savings in the order of 2.5% of the traditional tender price.

PrefabNZ Value Case 2014

▶ HEALTH + SAFETY



Reducing time at height on site reduces health and safety incidents.

PrefabNZ Value Case 2014



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Wellington 6140
New Zealand

www.prefabnz.com





Woodford

Size: 100.5m²



[FIND OUT MORE](#)



Riversdale

Size: 109.5m²



[FIND OUT MORE](#)



Havelock

Size: 109.5m²



[FIND OUT MORE](#)



Kuratau

Size: 109.5m²



[FIND OUT MORE](#)



Thames

Size: 109.5m²



[FIND OUT MORE](#)



Marlborough

Size: 118.5m²

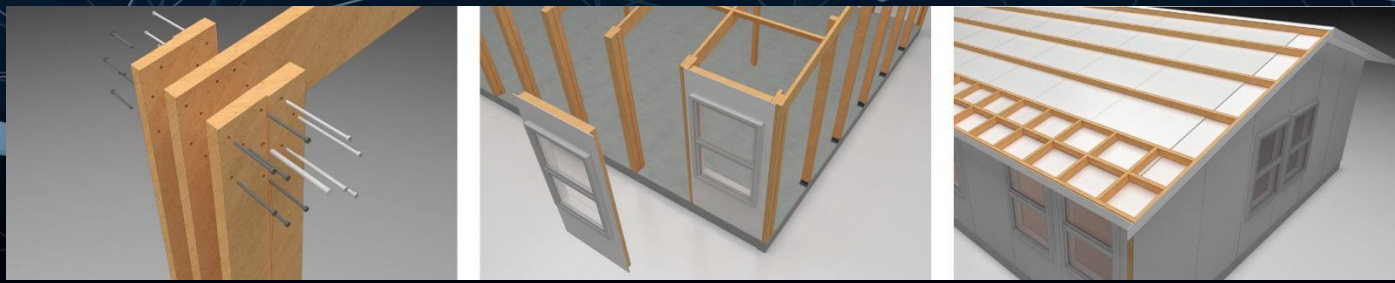


[FIND OUT MORE](#)



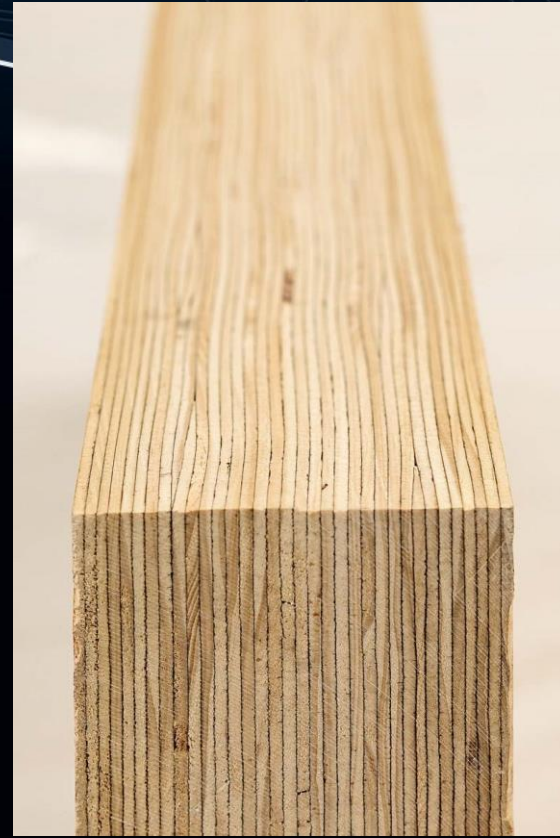
EasyBuild

Wide range of homes available, ex Masterton, NZ



EasyBuild

Full build \$257,000 + GST, Home kit \$128,000 + GST, plus Land



Engineered timber products

← Cross Laminated Timber (CLT), Laminated Veneer Lumber (LVL) →

CLT = Cross Laminated Timber



New Zealand's first completely CLT house, 2013



Makers of
Architecture



Makers of
Architecture

ex
Victoria
University



Warrander Studio, Chch

Makers of Architecture, Wellington

External cladding system is applied to CLT box after the structure is complete, or in some cases the cladding comes pre-installed on the pre-fabricated wall panels.

Servicing of all fixtures must be carefully thought out and planned before the building is assembled so that wiring and piping is not visible in the completed building.

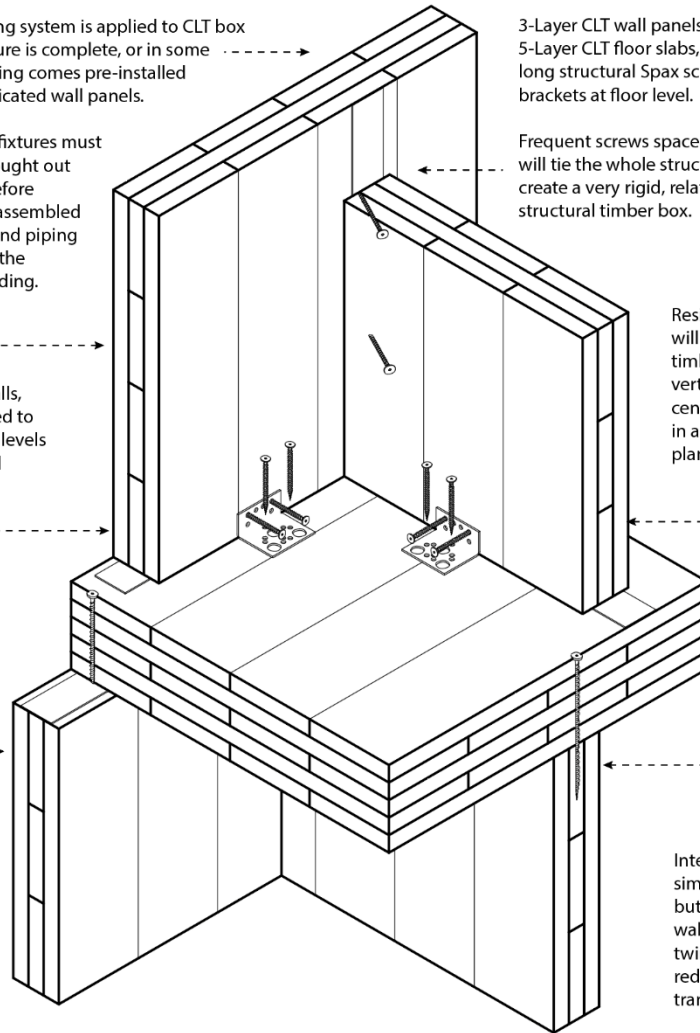
External CLT walls, vertically aligned to extremely high levels of accuracy and tolerance

3-Layer CLT wall panels connect to 5-Layer CLT floor slabs, typically with long structural Spax screws and / or brackets at floor level.

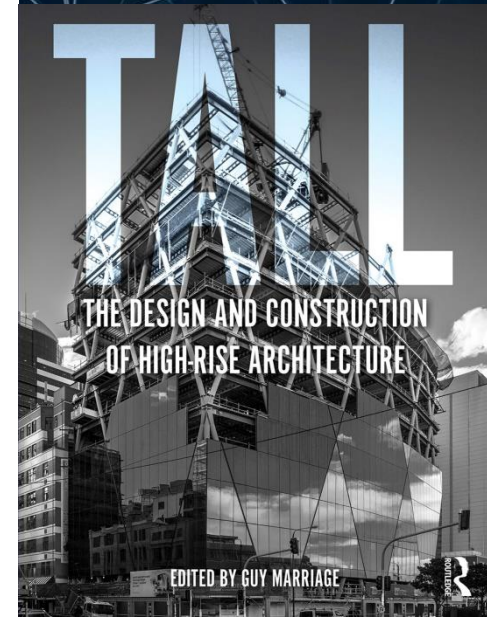
Frequent screws spaced at regular intervals will tie the whole structure together to create a very rigid, relatively light-weight, structural timber box.

Residential buildings will have structural timber walls aligned vertically, at closer centres than those in a commercial open-plan office floor.

Internal walls will be simple 3-Layer CLT, but inter-tenancy walls may need to be twin wall system to reduce acoustic transference.



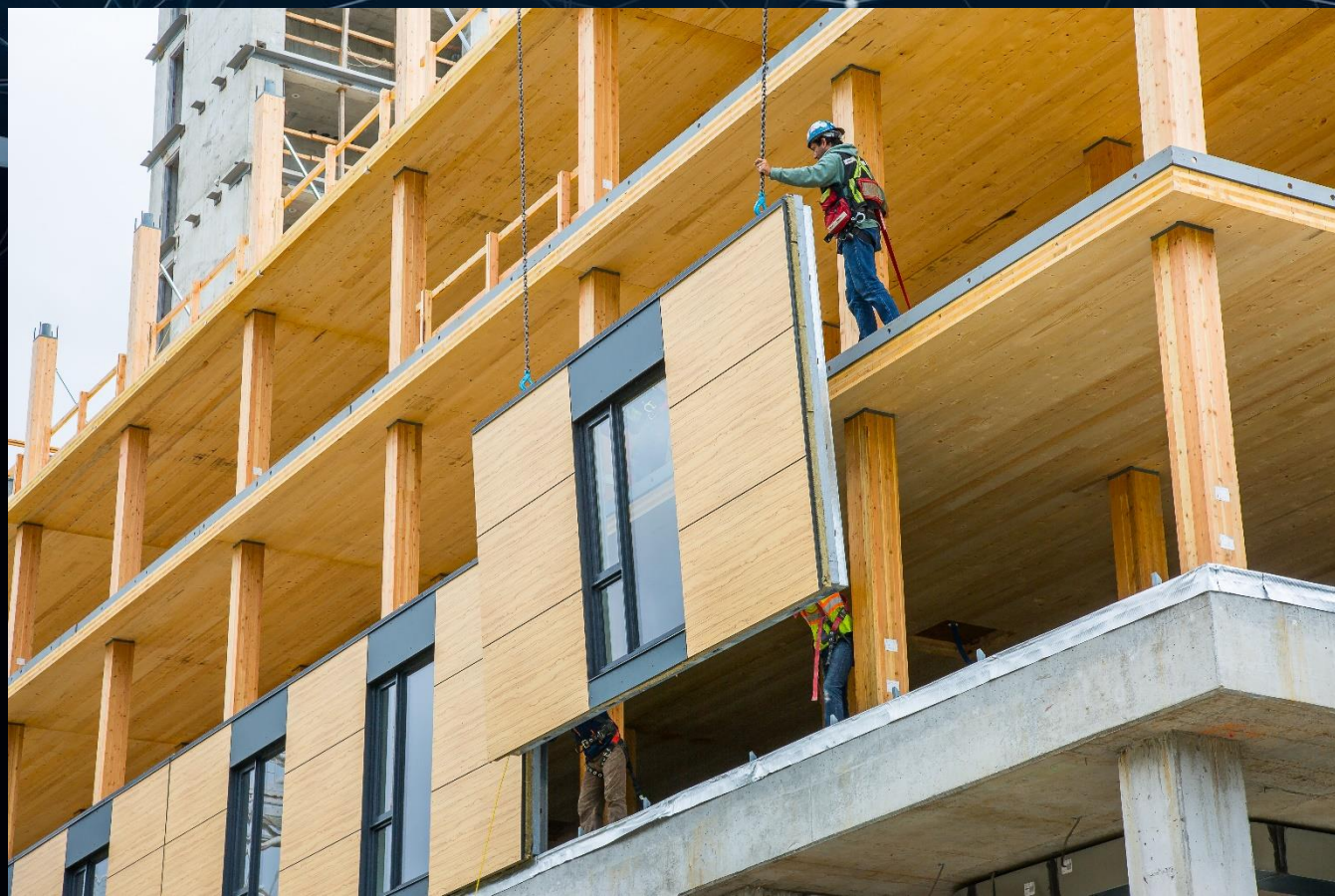
CLT joints are
screwed or
bolted - or 3D
routed





Dalston Works - London

100% CLT timber building by Waugh Thistleton Architects, UK



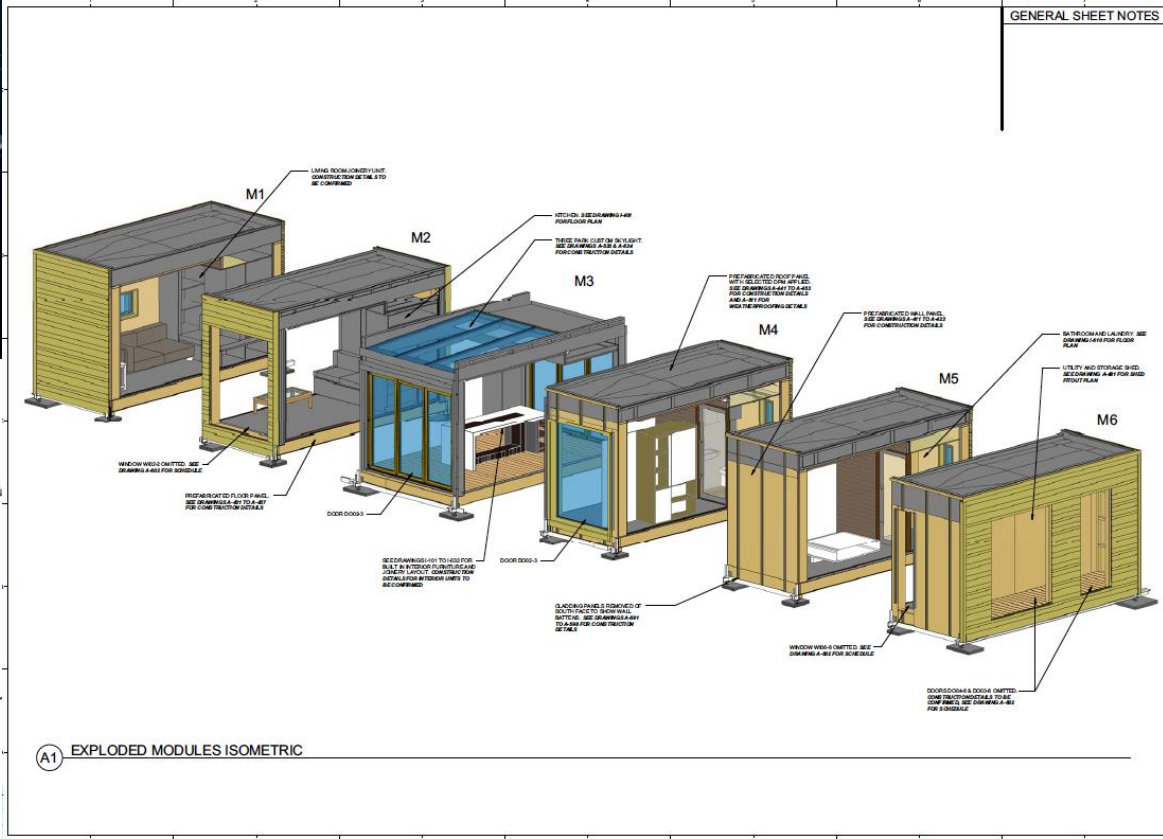
Brock Commons UBC - Vancouver

18 storey CLT student housing by Acton Ostry Architects, Canada

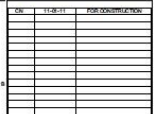


Our housing system is poor – is there an alternative?

Dull and boring, grey, anaemic, and built individually – Why?

The logo for First Light, featuring a stylized graphic of two vertical bars with horizontal lines extending from their tops, and the text "FIRST LIGHT" below it.

CONSULTANTS
TENNENT + BROWN ARCHITECTS
DUNNING THORNTON CONSULTANTS LTD
LEAP ALLIANCE LTD
LOCAL AUTHORITY: DUNDEE CITY COUNCIL



SHEET TITLE:	
A	EXPLODED MODULES SCHEMATIC

First Light House

Six separate modules posted to America



FIRST LIGHT^{NZ}

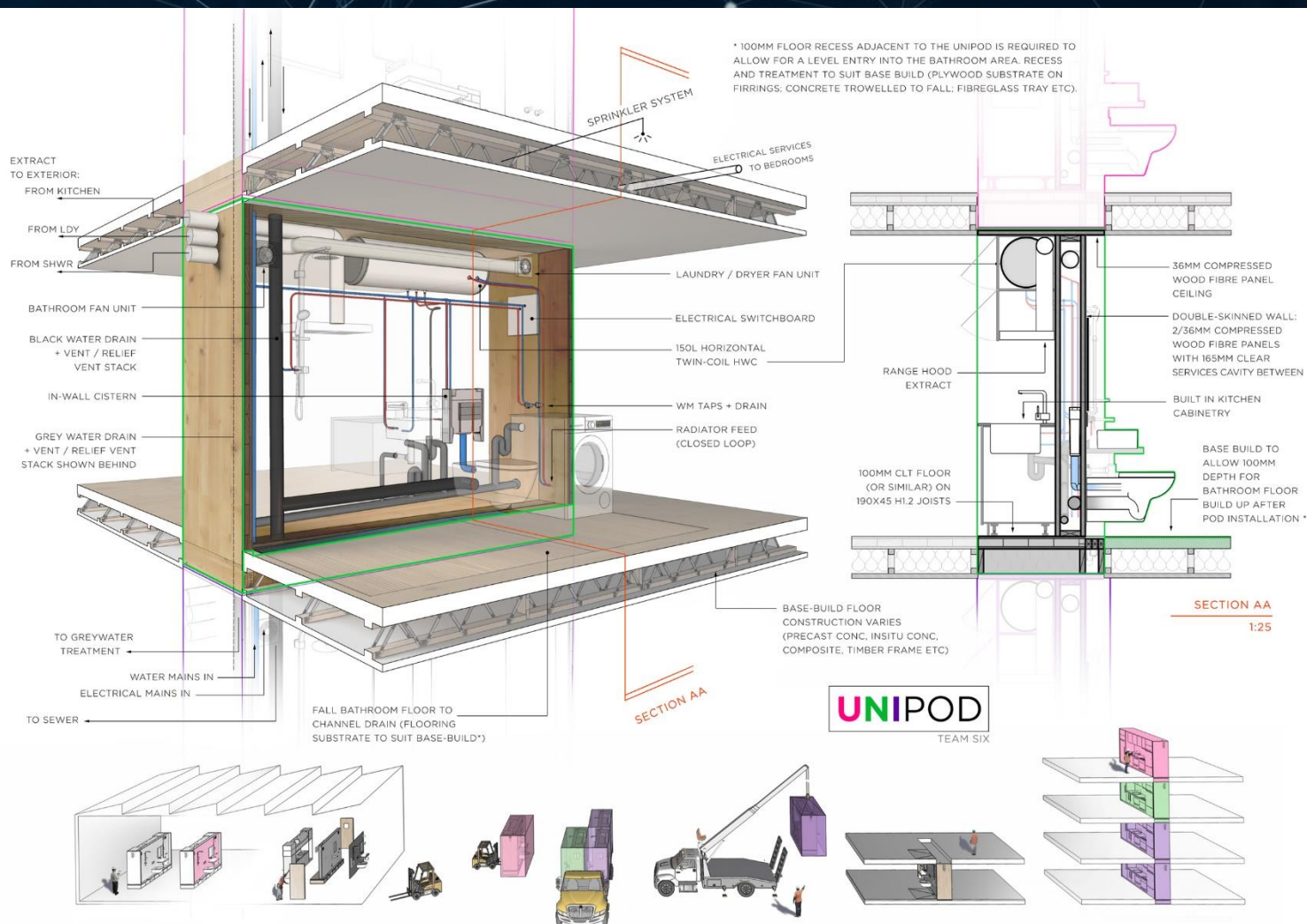
Solar-powered,
energy generating,
water-storing,
adjustable levelling,
earthquake-proof,
leak-proof,
moveable,
dismountable,
dismantle-able,
speedily erectable,
modular designed,
prefabricated,
medal winning,
and world's most travelled house.
Humble too.



FIRST LIGHT^{NZ}

First Light House

The world's most well-travelled house – from NZ to USA & back again



Uni-Pod

Smart, fully
connected wall by
First Light



BATHROOM ONE SIDE



KITCHEN THE OTHER

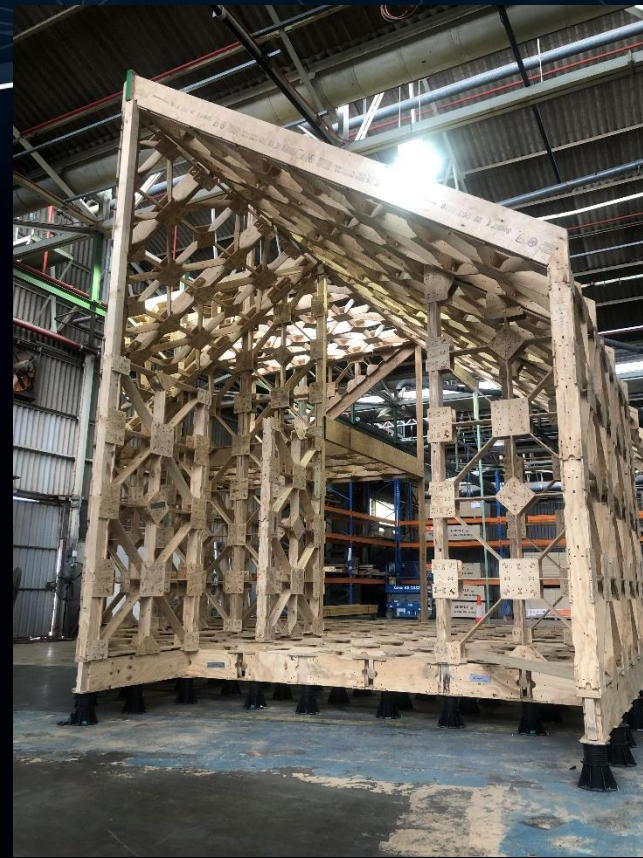
Uni-Pod

Smart, fully connected wall by First Light



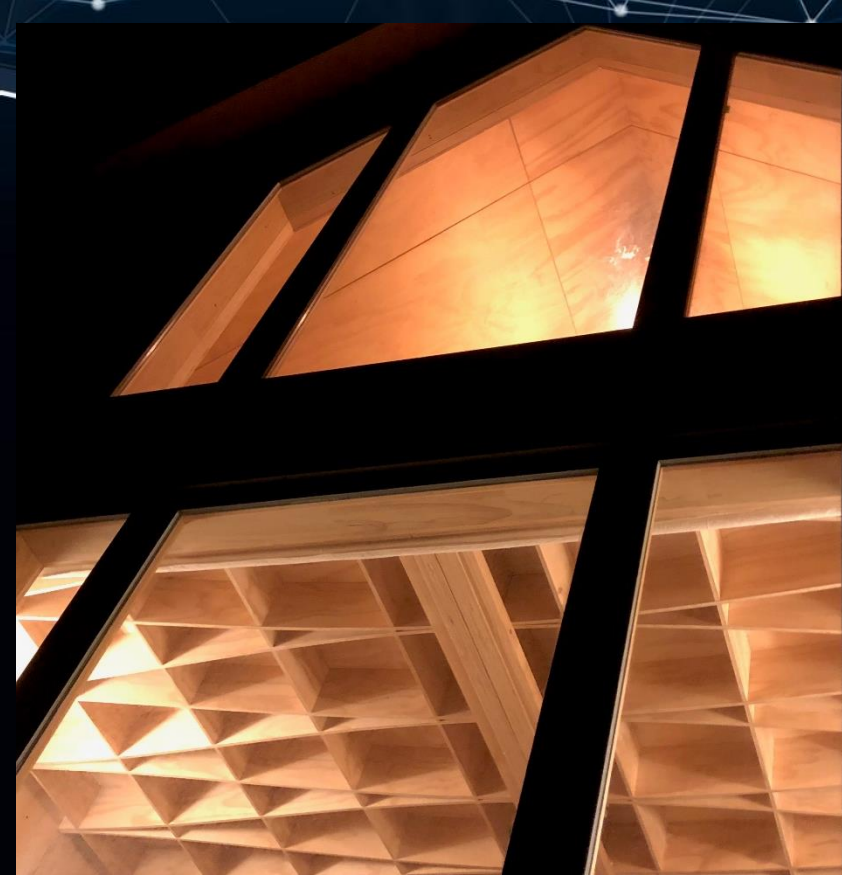
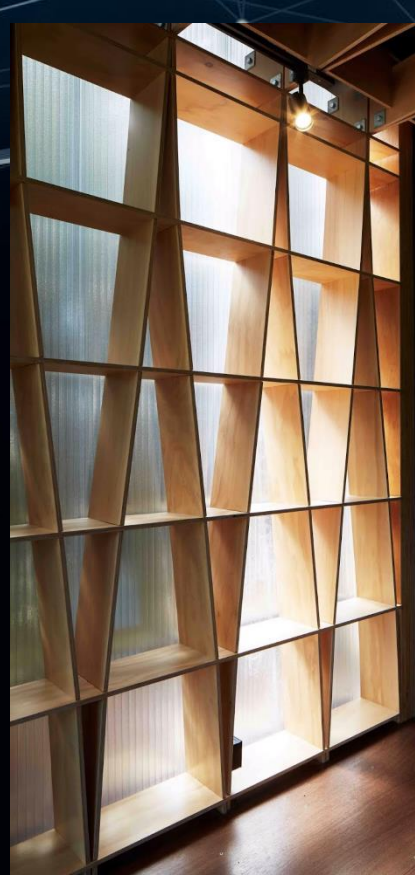
XFrame™

Victoria University Masters student project 2018 – Ged Finch



XFrame™

No screws, no nails, timber simply clips together + some bolts



Click Raft

Invented by Chris Moller



7 External Wall Cassette Installation Complete

M8RX External Wall Panel installation complete and bolts tightened

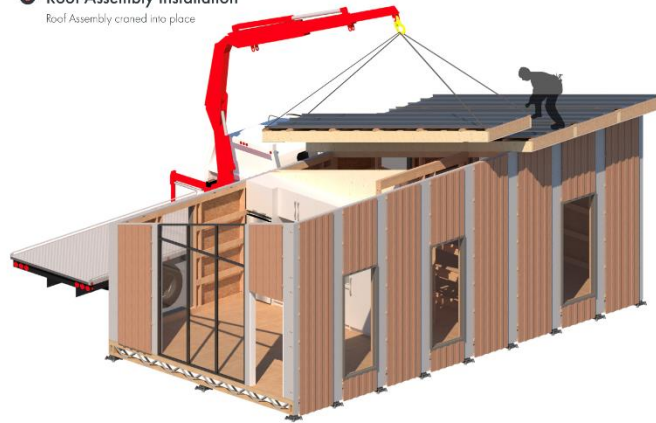


8 Roof Assembly Installation

Roof Assembly craned into place



9 Roof Installation Complete



10 Joint Sealing

M8RX™

Growing Out before Out Growing – thesis by Liam Playle

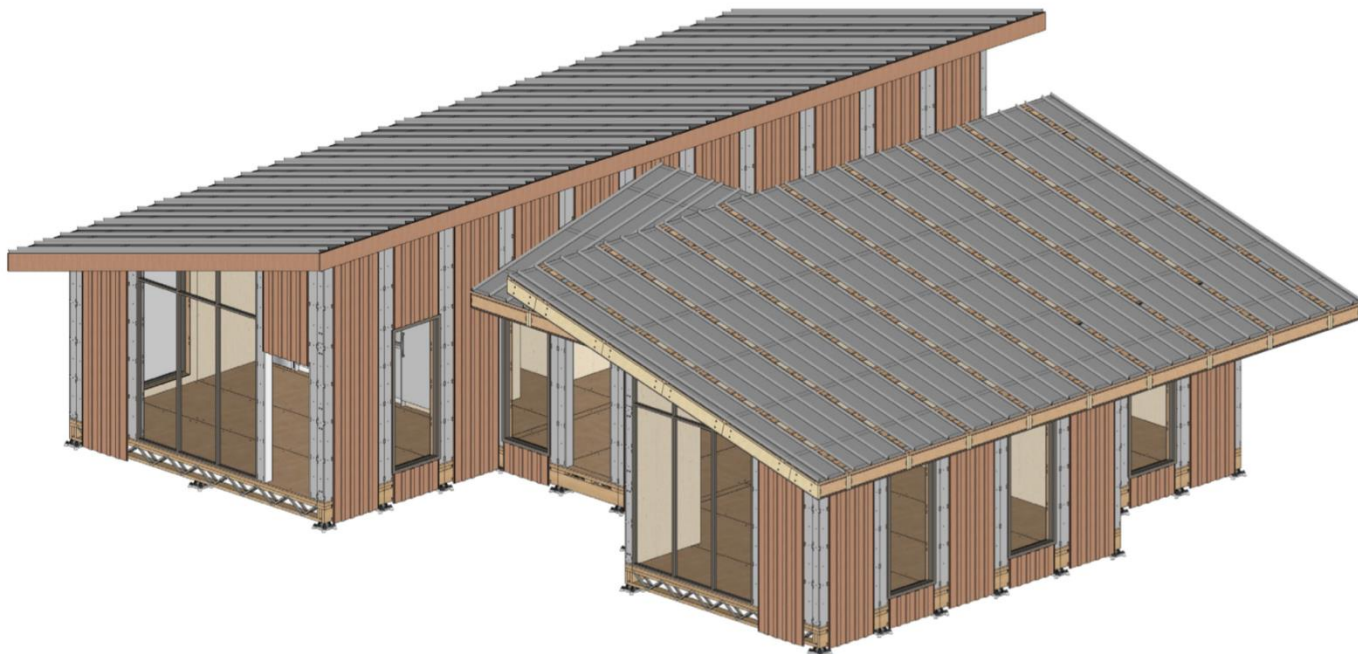
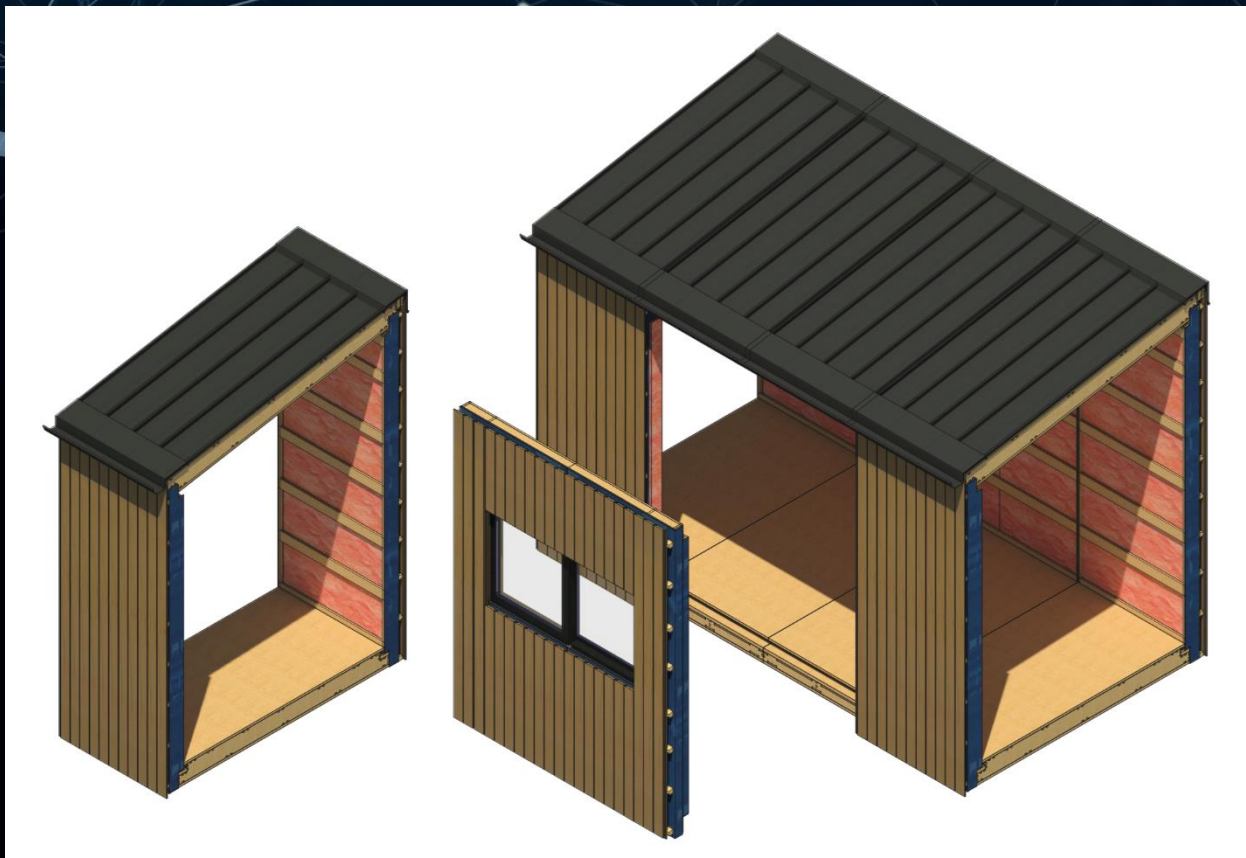


Figure 139: Stage 3 demonstrating lateral expansion

M8RX™

Liam Playle



Flexible Housing

Prefab Futures, by Mitch Holden



LVL planks as a folded sheet

Chris Moller at Mount Pleasant Community Centre

*If one large factory can produce 1 new house each day
= approximately 300 houses per year*

*We would need 33 large factories producing 300 houses per year
To reach 10,000 houses per year*

Or

10 big factories producing 1000 houses each a year

To do that, each factory needs a contract for at least 10-20 years

Prefabrication – Offsite Construction

Housing Innovations



Prefabrication – Offsite Construction

Two major players in the Prefab industry

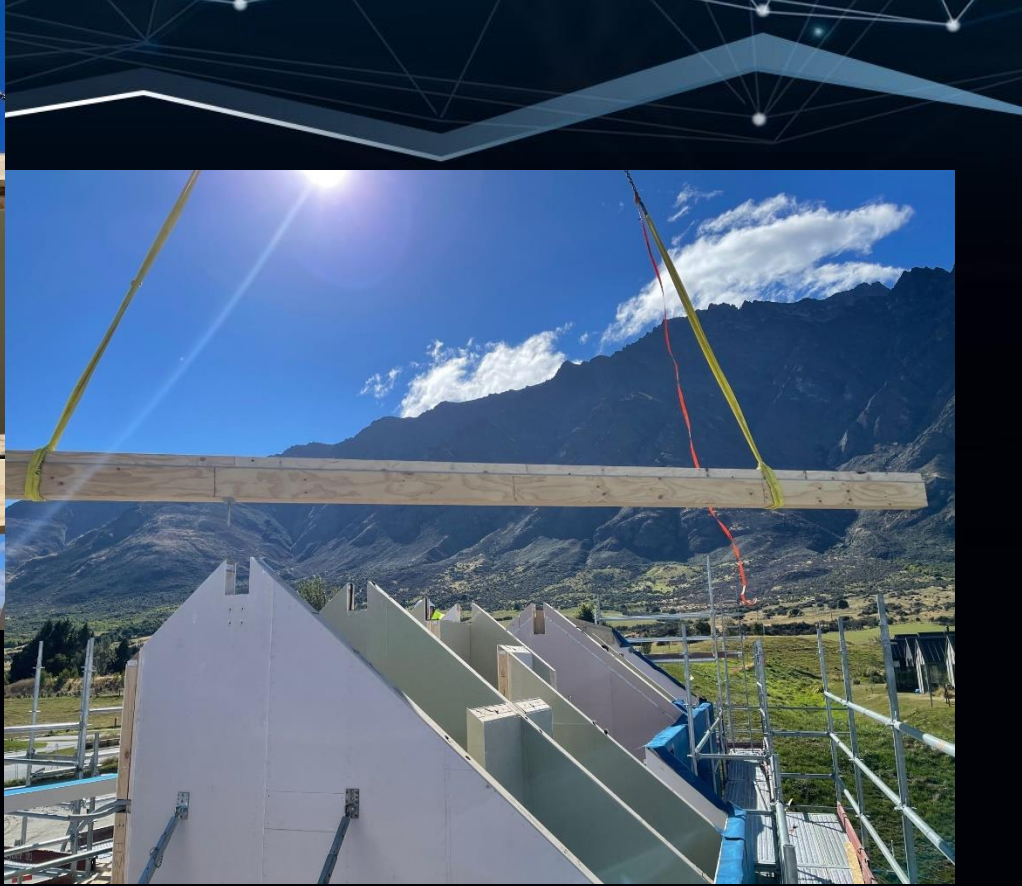


Hector Egger HolzBau

New Prefabricated building factory, Cromwell, NZ – ex Switzerland



Building structure erected in 4 days,
with windows in the next day: Fast



Hector Egger HolzBau

New Prefabricated building factory, Cromwell, NZ – ex Switzerland



Housing that Grows

Low Cost starter homes: architect: Alejandro Aravena in Chile



Housing that has grown

Home owners can extend in their own time - Alejandro Aravena in Chile



Choose your SNUG Home

Twelve smart + sustainable secondary housing options for your backyard

snughome.nz

SNUG competition organized by PrefabNZ

Flippin'
good
homes



FLIP Homes

www.fliphomes.nz



FLIP Homes

www.fliphomes.nz



Fits anywhere

No site too tricky



Backyard approved

Mow it or grow it



Low maintenance

Weekends free



Above code

A better product



Seismically robust

No worries



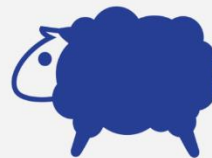
Lifetime design

Grows with you



Flexible orientation

For more sun



Well insulated

Warmer home



Custom interiors

Designed for you



Architect designed

It's all in the details



Light touch

On the earth



Prefab options

Quicker build times

- Design better
- Customise quicker
- Design cleverer
- Low cost land
- Design Medium Density Housing

- Build better
- Build quicker
- Build off site
- Build more intensively
- Build quality

Solving the Housing Challenge

Housing Innovations

Kia ora, thanks for attending!

Speaker's Science Forum

Aotearoa New Zealand

Questions welcome.



When to Prefab? site location

	Urban	Suburban	Rural	Remote
Traditional timber frame house	Multiple visits easy, but many traffic issues	Multiple visits easy	Long commutes	Pain in the butt
One-off volumetric Prefab	Minimise time on site	Minimise time on site	Better solution	Great solution if terrain permits it
Multiple wall panel Prefab	Assemble on site	Assemble on site	Assemble on site	Better solution if terrain is rough
Modules / Pods	Why not ?	Why not ?	Definite advantages	Absolute no-brainer

When to Prefab? benefits, cost, duration

	One off house	Several houses all the same	Numerous houses based on one system
Traditional timber frame house	One builder, one labourer, one ute	Use Prefab	Prefab mandatory
One-off Prefab	No real advantage	Real advantages	Real advantages
Multiple Prefab	Real advantages	Perfect for Prefab	Perfect for Prefab
Mass customisation	Absolute necessity	Choose one system and built variants	Totally

Pros & Cons of each **Material / Product**

Issue	SIPS	Concrete	CLT	Timber frame
Mass / density	Low mass	High mass	Medium mass	Low mass
Acoustics	Low-medium	Very effective	Moderate effective	Low effective
Thermal insulation	Highly effective	Needs added insulation	Needs added insulation	Needs added insulation
Ease of Assembly	Simple	Heavy crane needed	Light crane needed	Varies: simple plus fiddly
Sustainability	Foam insulation	High CO2 input to cement	Mass storage of CO2 within	Homegrown timber
Cost	Slightly higher than standard	Higher	Higher	Standard

Pros & Cons of each Prefab Element

Issue	Components	Panels	Pods	Volumes
Weight	Low	Size Dependent	Medium	Large
Transport	Simple	Simple	Moderate	Significant
Factory requirements	Simple / standard	Table jigs / simple - medium	Multi-trades in-house	All trades in-house
Ease of Assembly	Simple	Crane needed	Larger Crane needed	Very large crane needed
Speed of Assembly	Slow	Quick	Very quick	Super quick
Cost	Standard	Standard	Higher	Higher