BUILDING OUR DIGITAL COMMUNITIES CONFERENCE

2023

Delivering Net Zero BIM Enabled Carbon Assessment

- Embodied Carbon
- BIM enabled Carbon Assessment
- Case Studies
- Automation and AI
- Towards 2030

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How can we reduce carbon emissions in early design?

OPPORTUNITIES

01 Efficient modelling strategies

02 Material Data Management

03 Making informed data driven design decisions

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Climate **Emergency**

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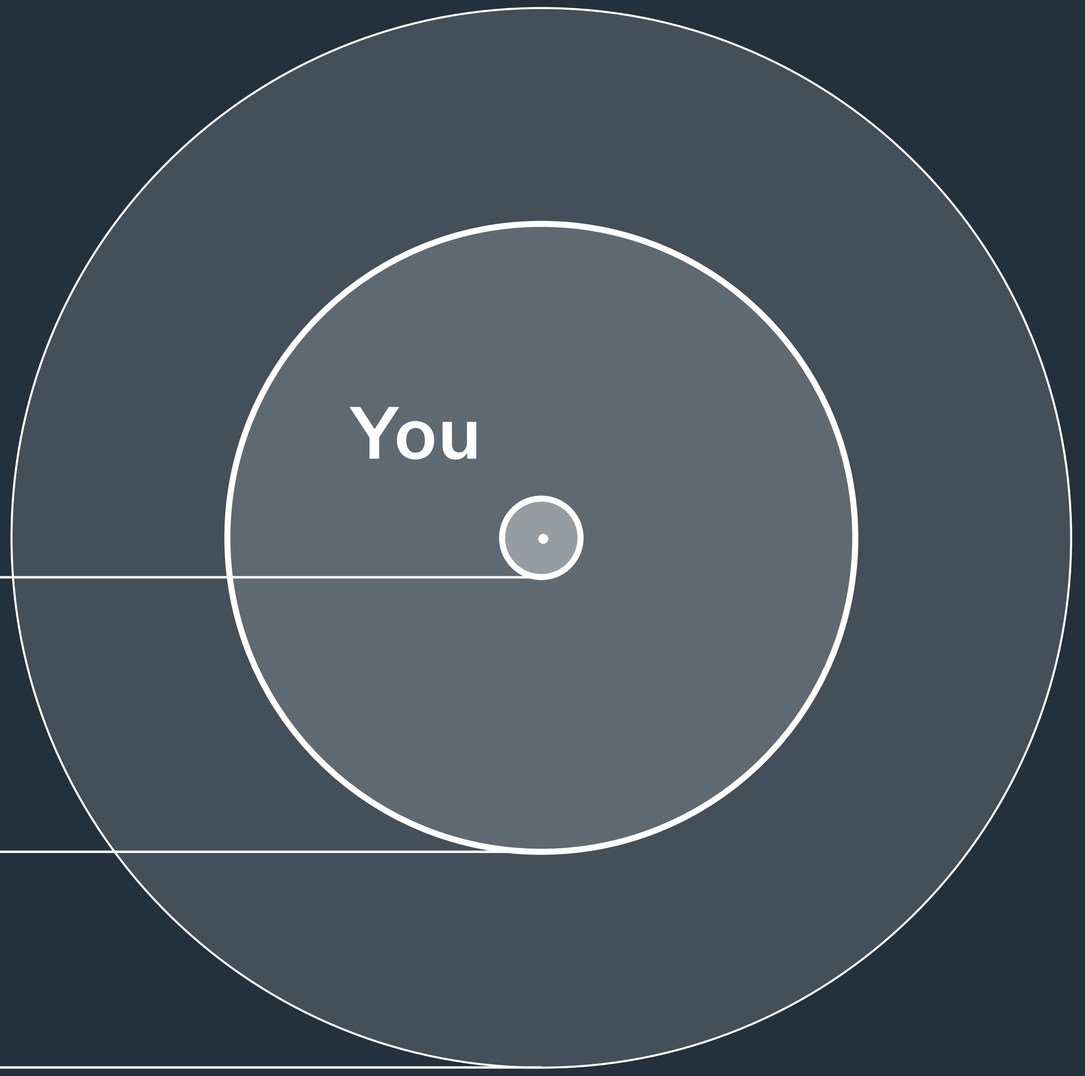
Your Business

Your Work

Your Influence



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TOTAL AVOIDED

1445 tCO_2e-

Upfront excluding Biogenic and Module D of retained structure

avoided* 1445 tCO_2e-

*estimate based on the embodied carbon it would take to replace the retained structure

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Our Goal

By 2030, our goal —with our clients— is that all new projects designed by us will be net-zero carbon in operation, be 50% more energy efficient and have **40% less embodied carbon**.

TOITŪ CARBON ZERO ISO 14064-1 ORGANISATION

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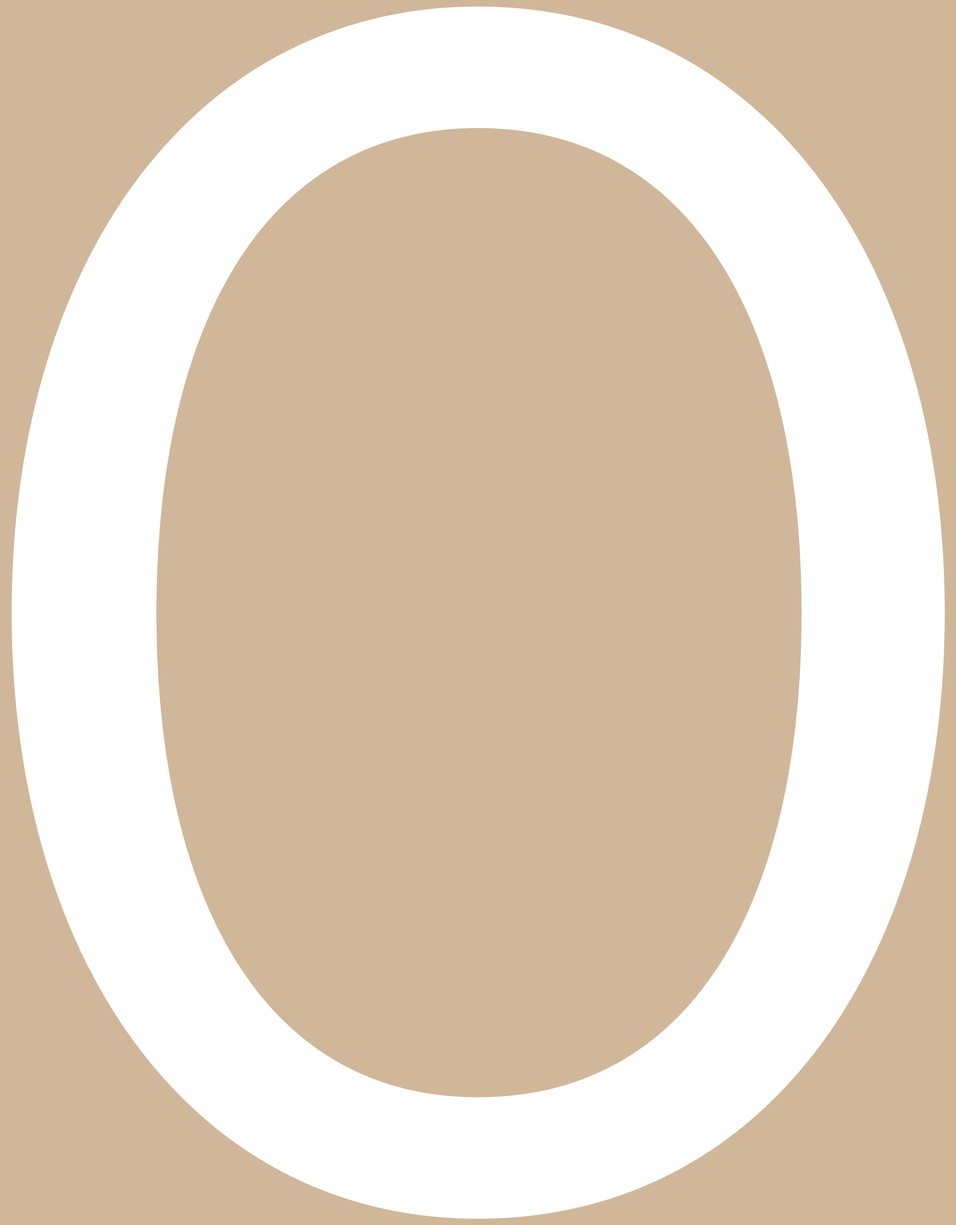

Join us on
the path to
zero

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CARBON 101

Embodied Carbon in Design

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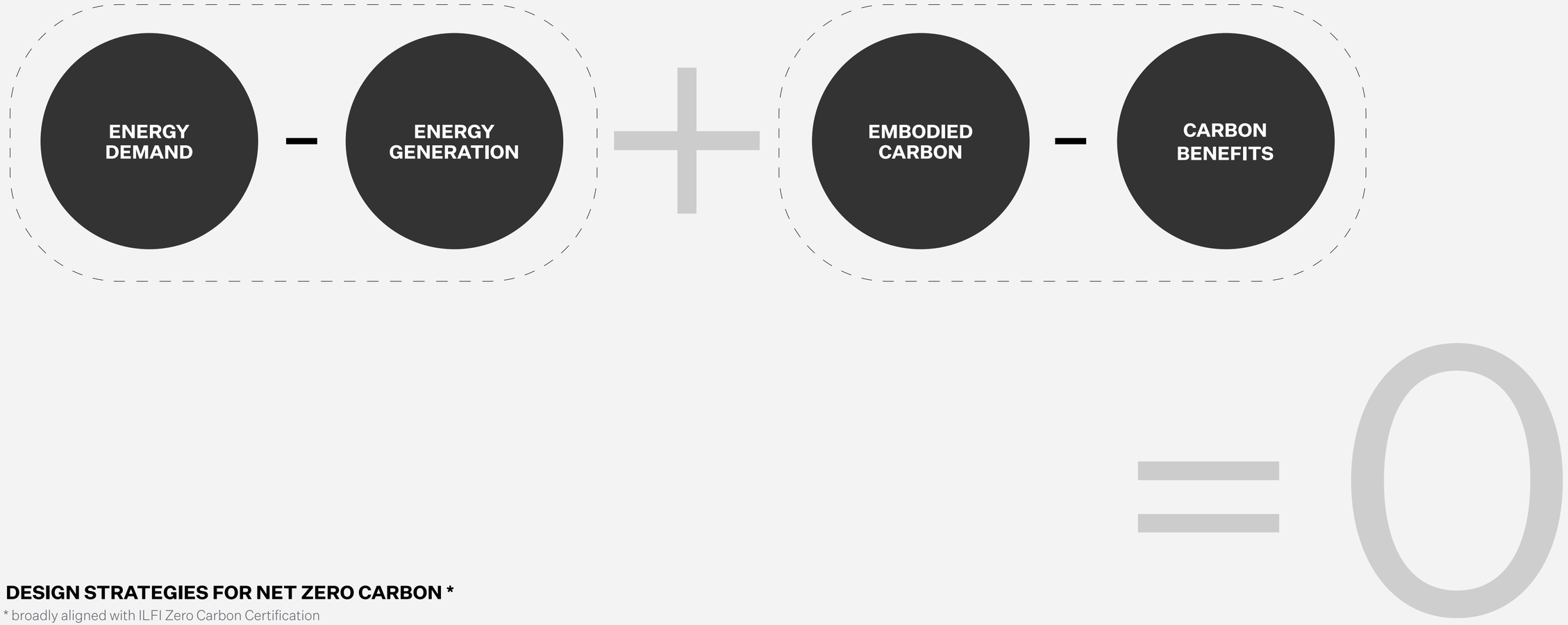
Zero Carbon



DESIGN STRATEGIES FOR NET ZERO CARBON *

* broadly aligned with ILFI Zero Carbon Certification

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‘Carbon’

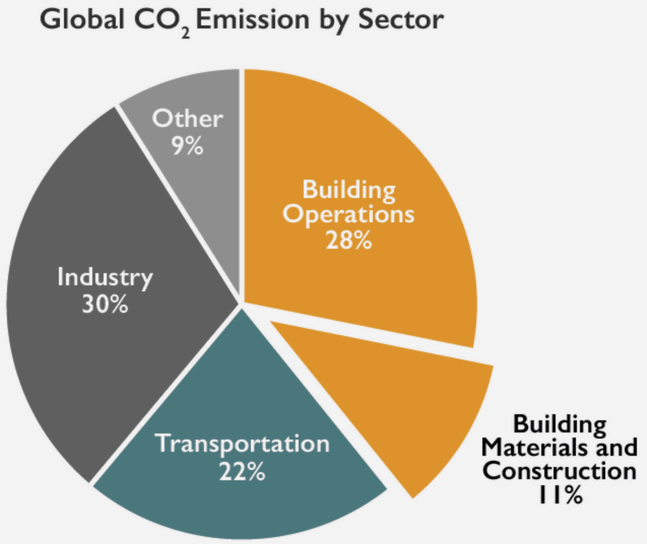
Greenhouse Gas (GHG) are any gas that absorbs heat in the atmosphere such as **Carbon Dioxide (CO_2)** and **Methane (CH_4)**.

The impact of GHGs is **Global Warming Potential (GWP)** which is measured in **Carbon Dioxide equivalent** gas (CO_2e-) measured through a Life Cycle Assessment (LCA).

Impact of Buildings Globally

39%

of global greenhouse gas emissions from buildings



Source: Global Alliance for Buildings and Construction - https://globalabc.org/

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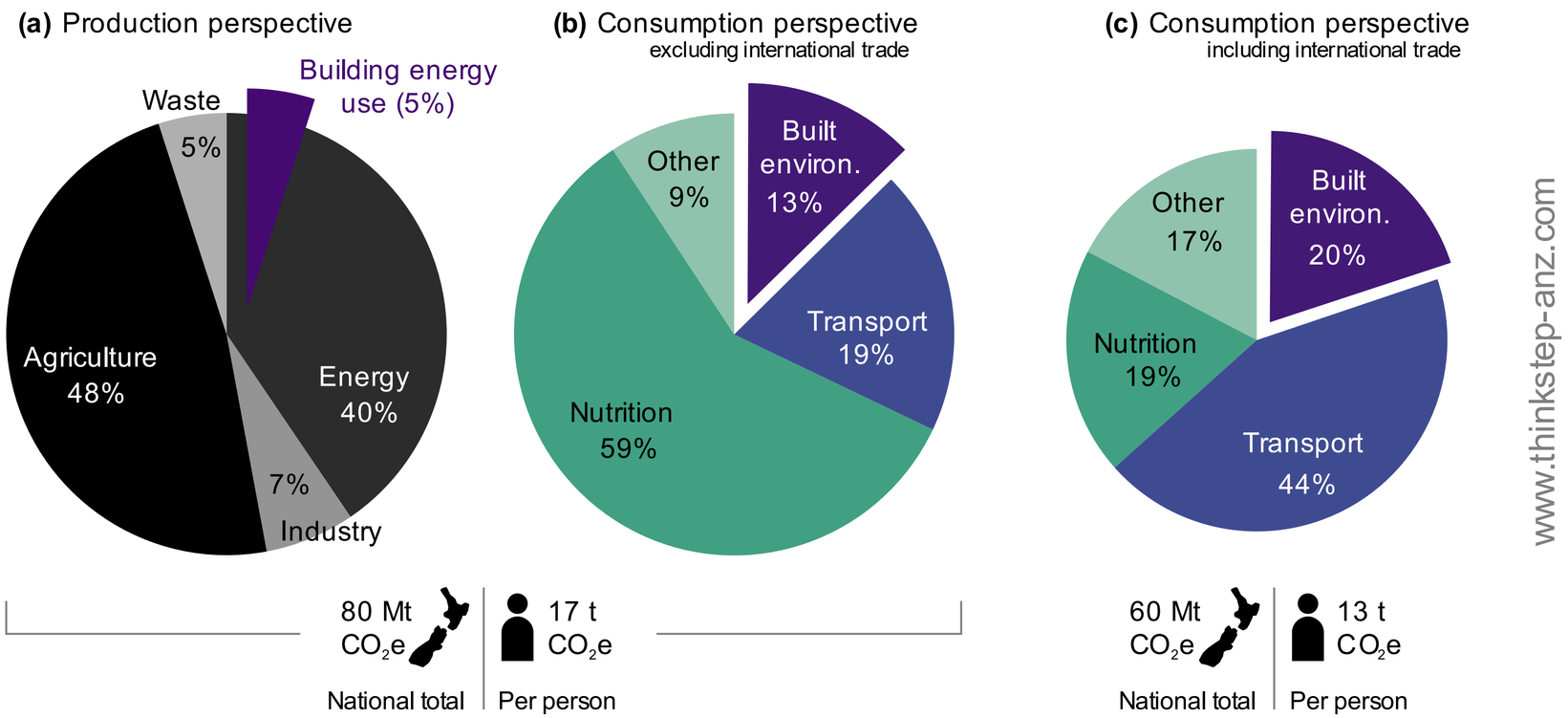
Impact of Buildings in New Zealand



www.thinkstep-anz.com

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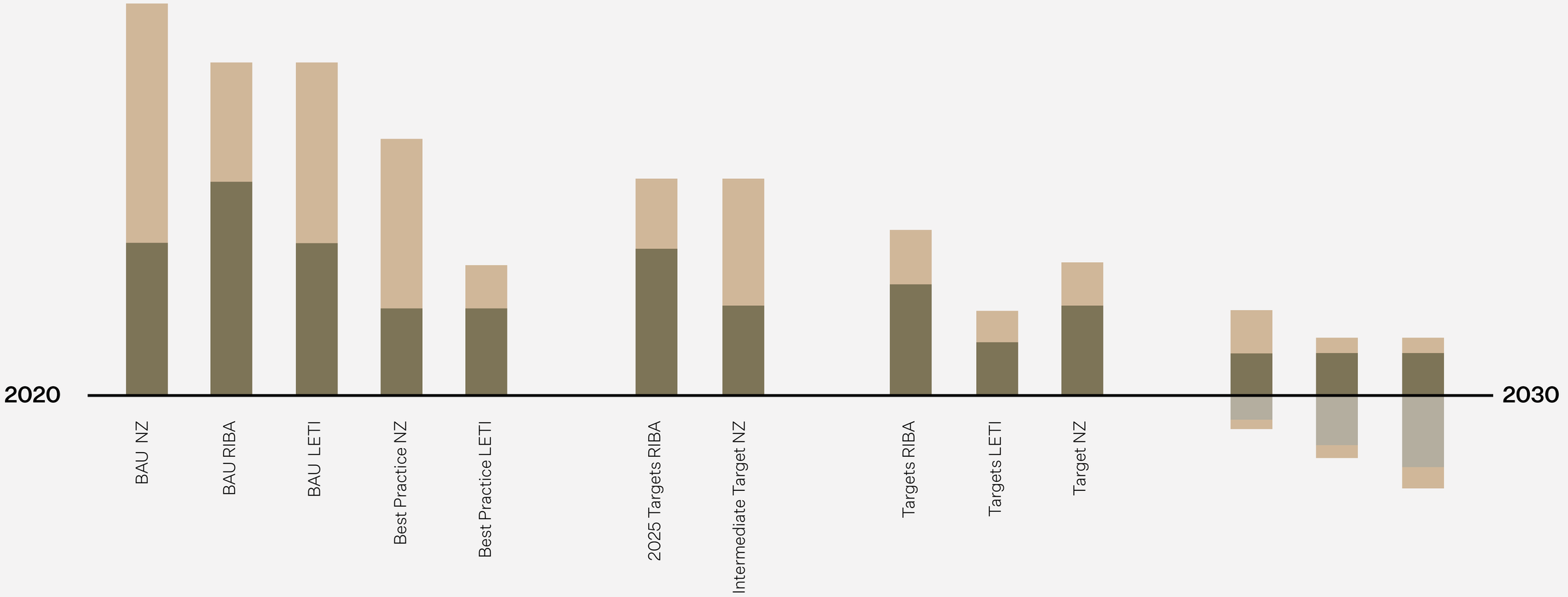
Source: Link to Thinkstep Report- https://www.nzgbc.org.nz/Attachment?Action=Download&Attachment_id=2453

Embodied and Operational Carbon



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CASE STUDY

Flowers Site 6

Scope

LIFE CYCLE SCOPE

WHOLE OF LIFE

UPFRONT | **FUTURE**

Material Production and Construction | Use Stage - (50 Years) | End of Life | Beyond

A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D

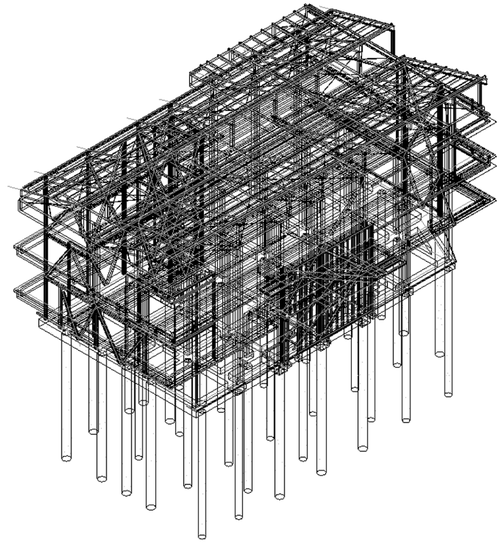
BUILDING ELEMENT SCOPE

STRUCTURE	ENVELOPE	INTERIOR	FURNITURE	SERVICES	CIVIL	LANDSCAPE

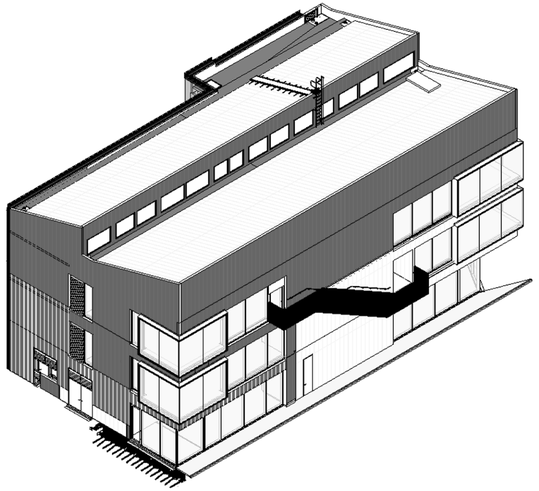
Included In Scope

Excluded in Scope

STRUCTURAL SCOPE



ARCHITECTURAL SCOPE



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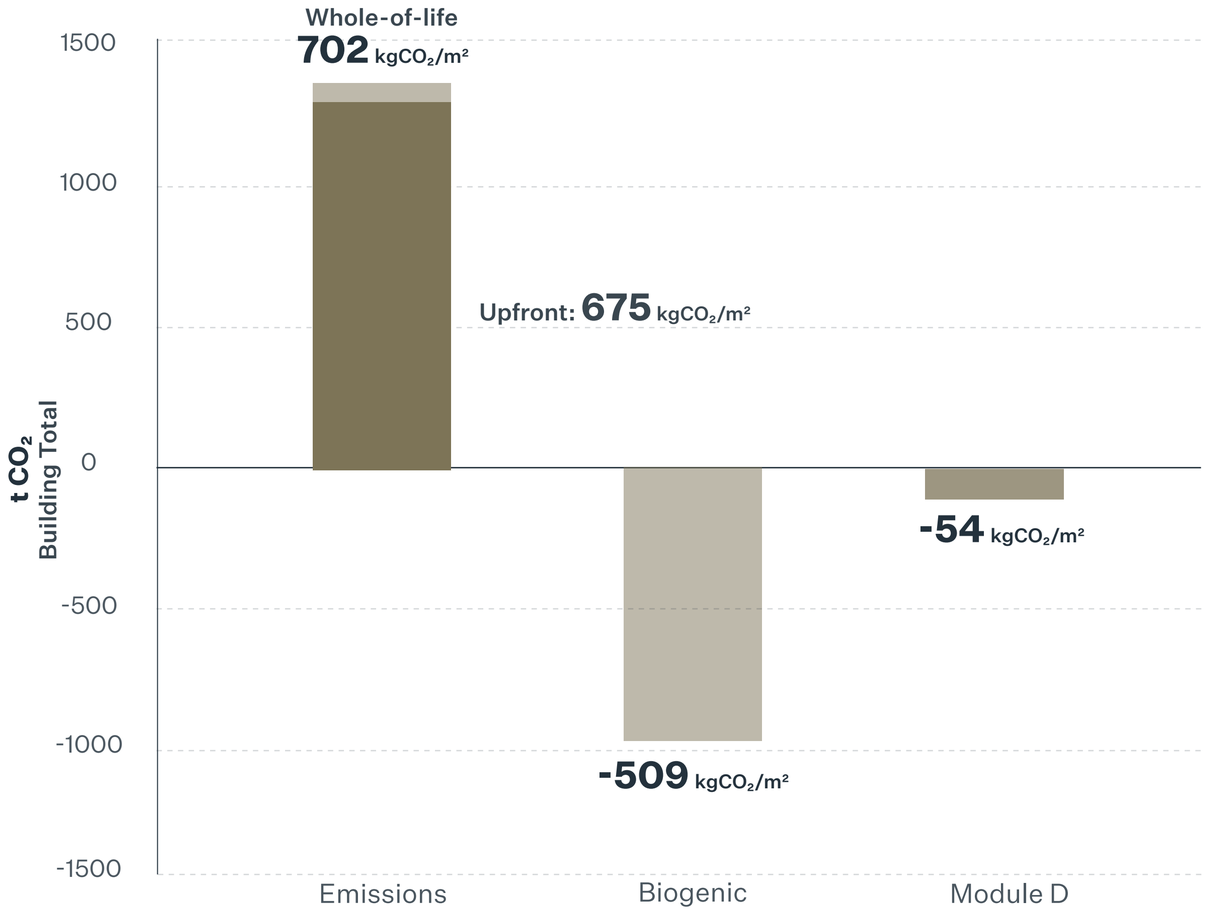
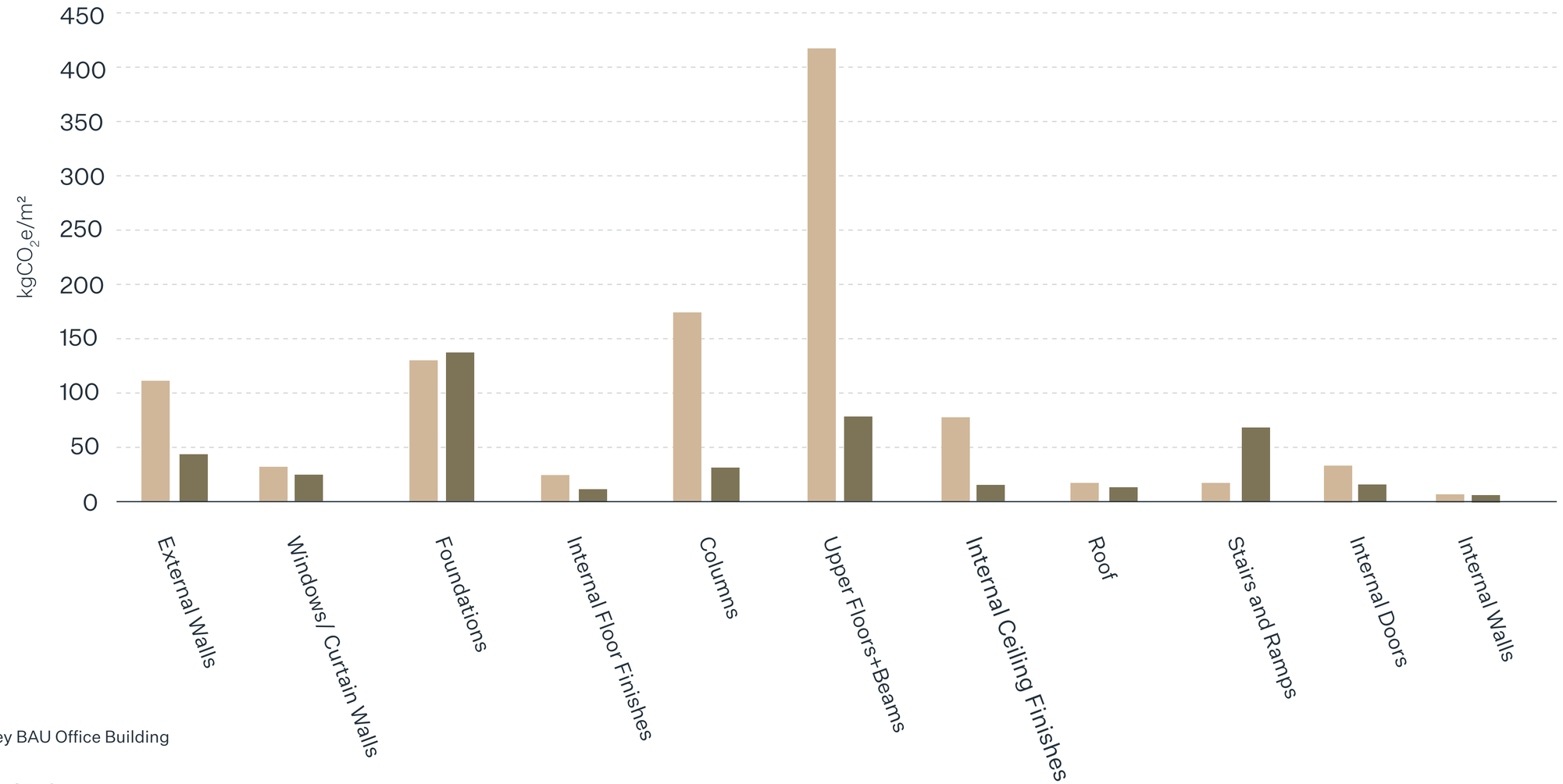
Results



Comparison of Carbon Intensity



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CARBON

BIM enabled carbon assessment

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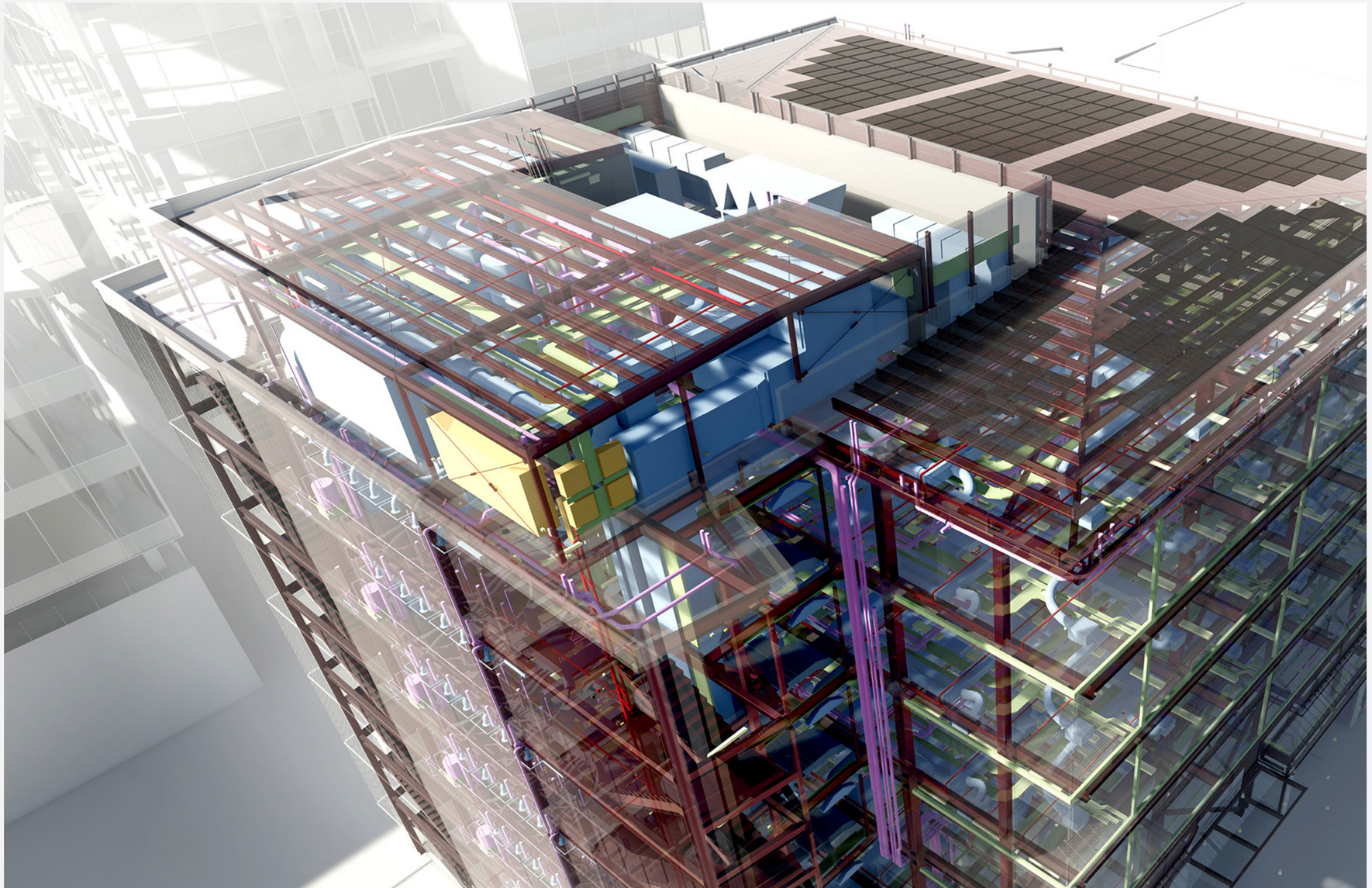
Expectation v Reality

"Expected experience"



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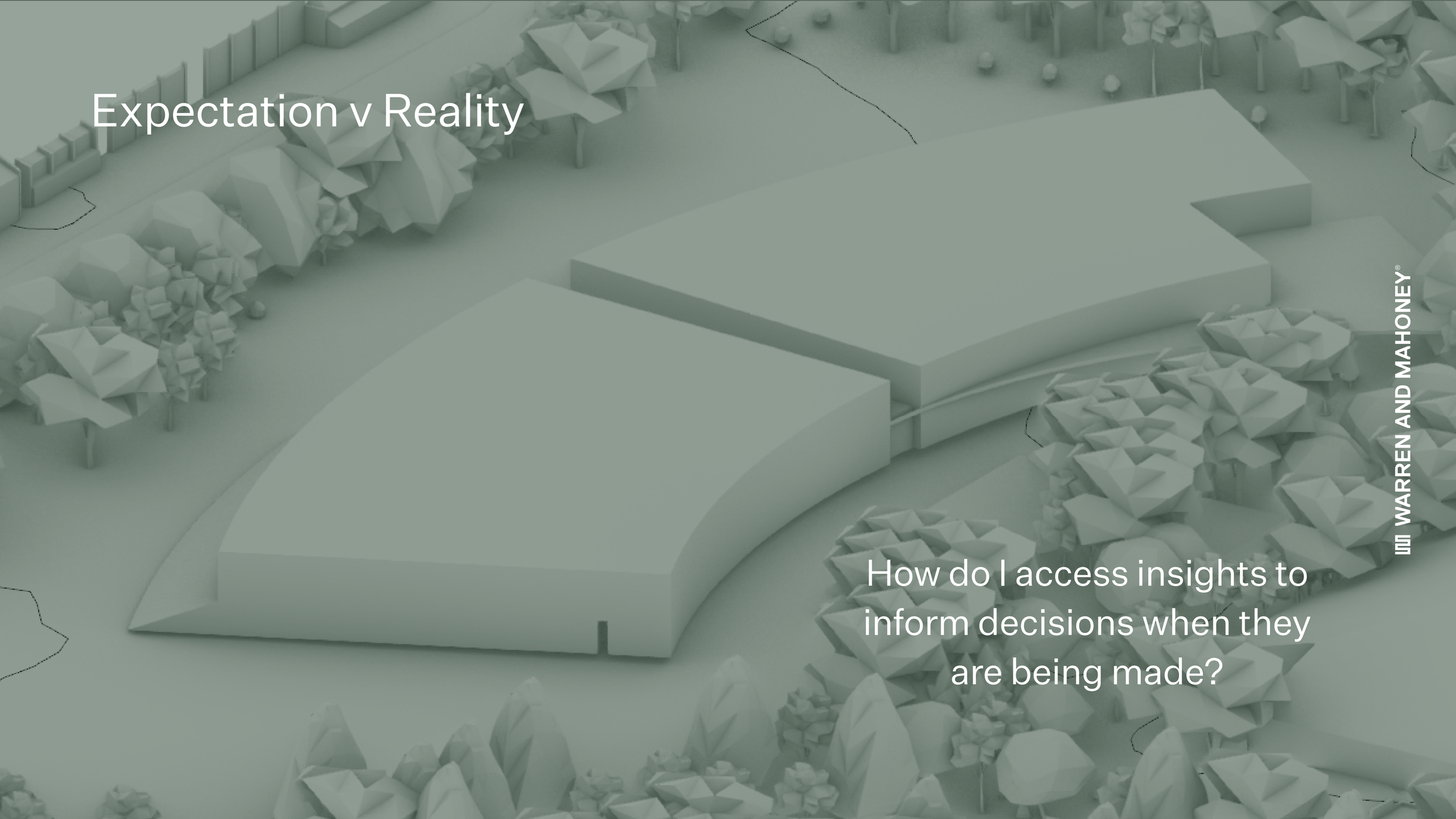
Expectation v Reality



How do I access insights to inform decisions when they are being made?

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Building Information Model

What you measure impacts how you manage your team.

What is the **building element scope** I am looking to measure?

What is the **building's life cycle scope** I am looking to understand?

PRIMARY MATERIAL ASSEMBLIES	Foundation	• Retaining Walls • Footings
	Structure	• Slabs • Framing • Reinforcement
	Enclosure	• Cladding • Insulation • Fenestration • Roofing
INTERIOR MATERIAL ASSEMBLIES	Finishes	• Ceiling • Wall • Floor • Partitions
	Partitions	• Framing • Insulation • Fenestration
OPTIONAL MATERIAL ASSEMBLIES	*Interior Furnishings*	*• Furniture* *• Fixtures* *• Equipment*
	Building Systems	*• Electrical* *• Mechanical* *• Plumbing + Fire Protection*
	Site Work	*• Excavation* *• External Paving*

IFLI Zero Carbon Certification Building Elements

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Building Scope - MBIE methodology

Building System	Mandatory: must be included in the assessment	Voluntary: may be reported independently within the assessment
Ground Work	• Substructure/foundations • Earth retaining structures • Basements	• Vegetation • Hard landscaping • Ancillary buildings • External services, including drainage
Structure	• Ground floor structure • Upper floor(s) structure • Load bearing systems: gravity and lateral structural frames and walls • Roof structure	• Temporary works (form work, scaffold etc.) used during construction that are not reused • Stairs • Lifts and escalators
External Envelope	• Cladding/façade primary elements (weather exposed layer, structural support system) • External wall insulation • Roof covering and insulation • External windows and doors	• Cladding/façade secondary elements (seals, brackets etc.)
Non- structural internal elements	• Non-loadbearing walls • Internal doors • Floor and wall finishes	• Ceilings • Fixtures, fittings and furniture
Building Services	• HVAC4 equipment	• Water, drainage, electrical services • Other building systems such as fire and security systems

MBIE Building Elements

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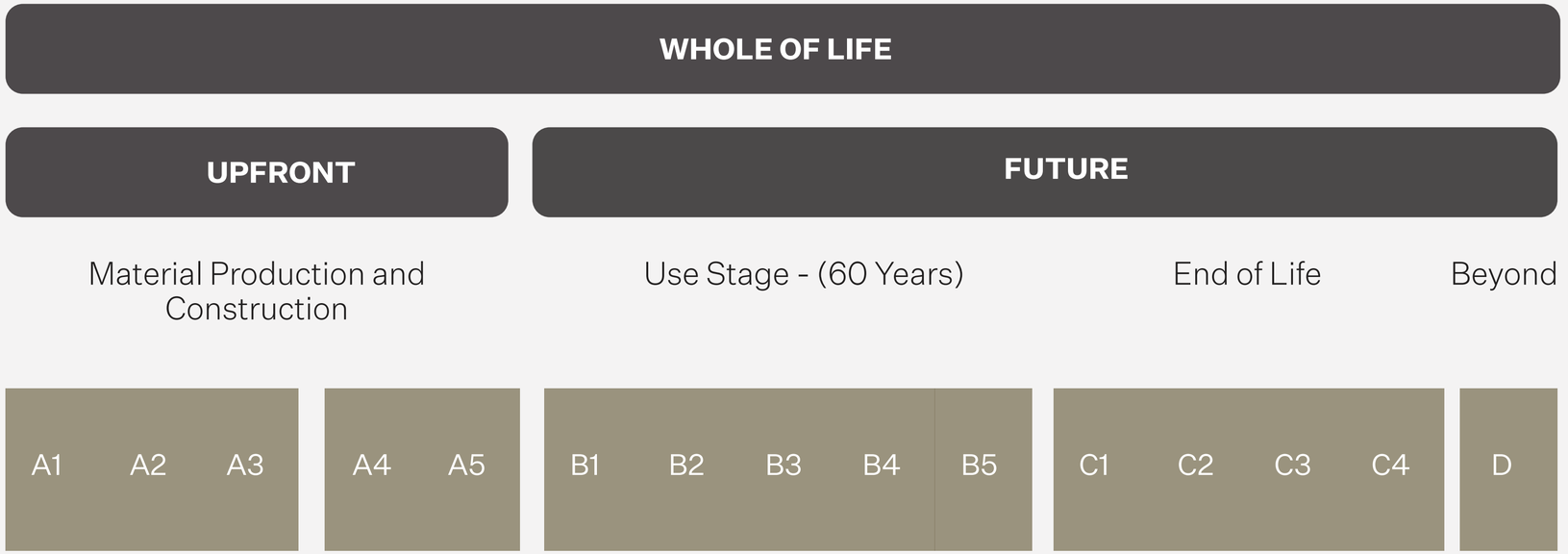
Consistent Lifecycle Scope - LCA terms



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Building **Information** Model

Product Specific Database Examples

EPD® AUSTRALASIA

EPD®
THE INTERNATIONAL EPD® SYSTEM

GLOBAL GREEN TAG

Generic Database Examples

One Click LCA

ecoinvent Centre

CO2NSTRUCT

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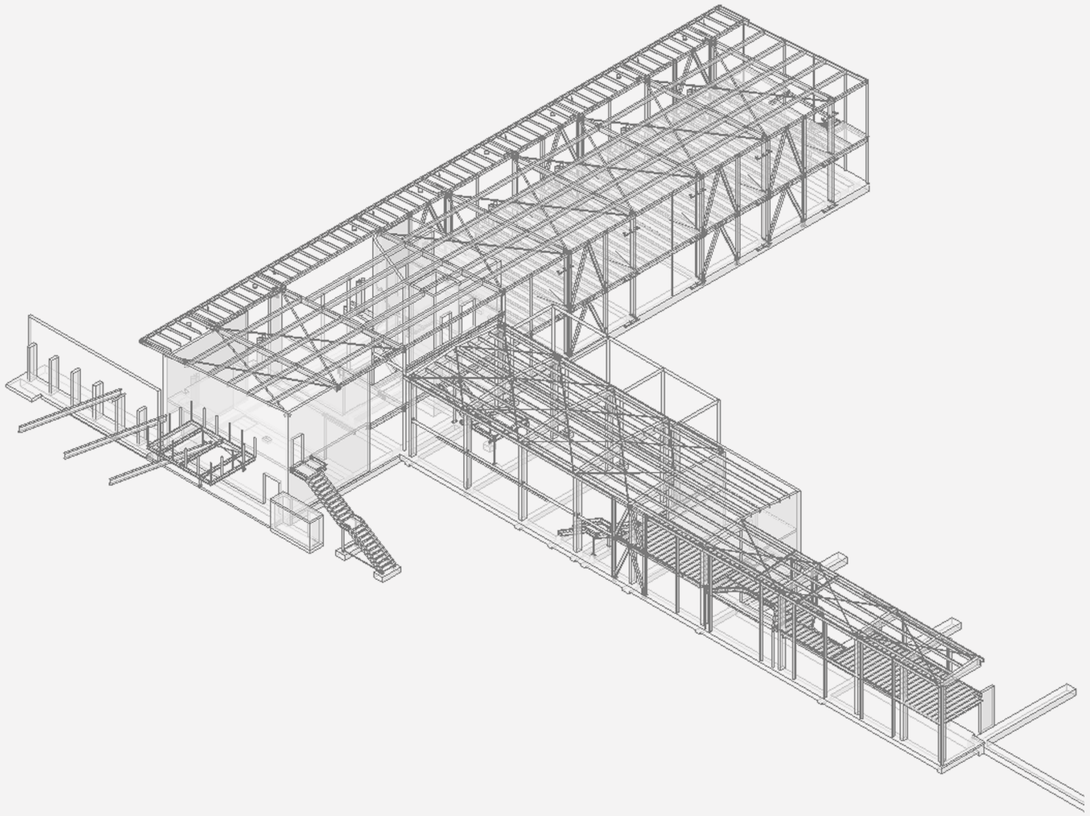
Building Information **Model**



MODELLING STRATEGIES

01 Volume based approach

Model to a level of detail were the volume is a appropriate quantity

02 Area based approach

Using area planes to represent quantities of multiple materials

03 Length based approach

Model lines to represent more detailed elements for example, structure

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Early Design Workflow

1

Simplify

Model efficiently using an area and length based approach

2

Measure

Utilise product specific where possible & input generic data consistently

3

Test

Swap out materials or remodel to identify a reduction pathway

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CASE STUDIES

Head Start on Low Carbon Design

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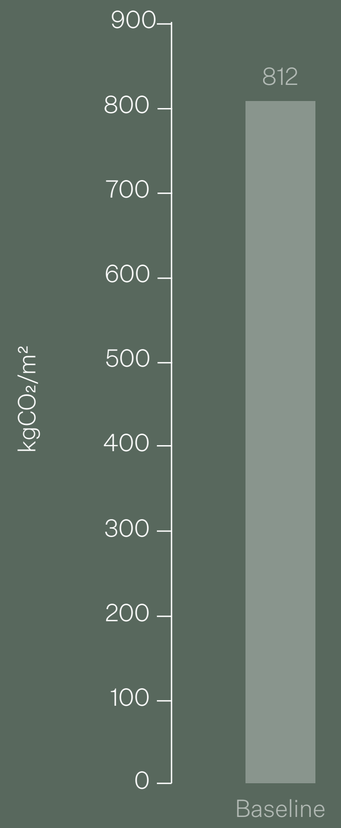
Embodied Carbon in Concept Design

LCA Scope: Whole of life assessment over a 50 year service life
Building Element Scope: Superstructure (beams, columns, ground and upper floors), Envelope (roof,& facade), Interior (carpet, ceilings, stairs). Substructure (foundations) were excluded from the assessment.
Baseline: Was calculated off the same design parameters using business as usual material specifications



Reductions from Design Moves

- 4%
Upper Floors: Change to CLT from concrete

- 23%
Superstructure: -14% Change to LVL,
-2% Efficent Design
-7%Specfiying sustainable LVL

- 5%
Interior: Design out ceilings

1,080 tCO_2
Biogenic carbon in CLT

720 tCO_2
Biogenic carbon in LVL

- 32%
Embodied carbon reduction from business as usual

Embodied Carbon Intensity

197 $kgCO_2/m^2$
Biogenic carbon sequestered upfront

567 $kgCO_2/m^2$
Embodied carbon emissions

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Proposed Design

68% of remaining emissions come from 6 elements

15% Ground floor
14% Glazing
12% Bracing
10% Solid walls
9% Carpet
8% Raised floor

Embodied Carbon in Bulk & Massing

LCA Scope: Whole of life assessment over a 60 year service life
Building Element Scope: Superstructure (beams, columns, ground and upper floors), Envelope (roof,& facade), Substructure (foundations). Interior (carpet, ceilings, stairs) were excluded from the assessment.
Baseline: Latrobe was use as a reference building to make allowances for unknown quantities

1A

707
$kgCO_2/m^2$

5,658 tCO_2
total whole of life emissions

0.185 $kgCO_2$
per visit

1.3 km
per visit

Best Performance

2C

736
$kgCO_2/m^2$

5,888 tCO_2
total whole of life emissions

.191 $kgCO_2$
per visit

1.3 km
per visit

3A

659
$kgCO_2/m^2$

6,193 tCO_2
total whole of life emissions

0.198 $kgCO_2$
per visit

1.4 km
per visit

4A

729
$kgCO_2/m^2$

6,199 tCO_2
total whole of life emissions

0.198 $kgCO_2$
per visit

1.4 km
per visit

2A

676
$kgCO_2/m^2$

6,897 tCO_2
total whole of life emissions

0.214 $kgCO_2$
per visit

1.5 km
per visit

Selected Design

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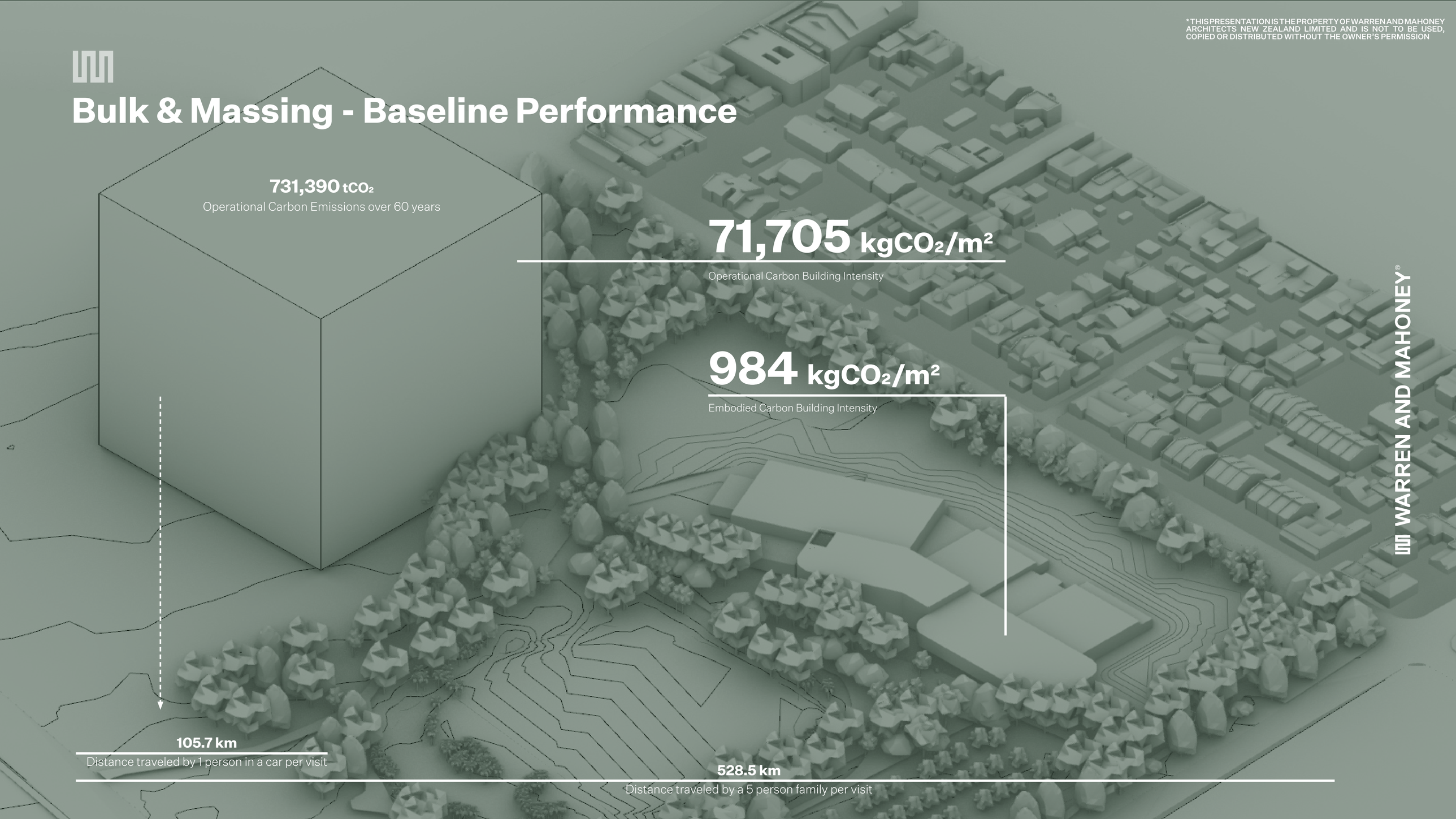
Bulk & Massing - Baseline Performance



731,390 tCO_2
Operational Carbon Emissions over 60 years

71,705 $kgCO_2/m^2$
Operational Carbon Building Intensity

984 $kgCO_2/m^2$
Embodied Carbon Building Intensity

105.7 km
Distance traveled by 1 person in a car per visit

528.5 km
Distance traveled by a 5 person family per visit

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CASE STUDIES

Data Informed Design

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Taita College

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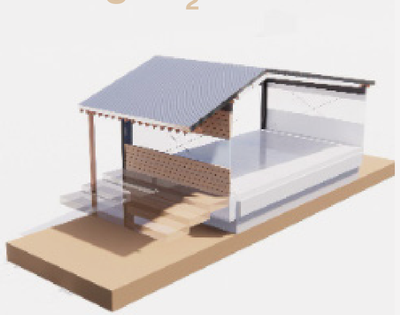
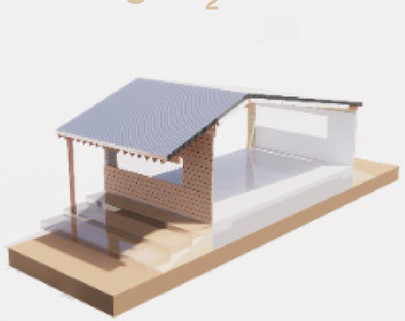
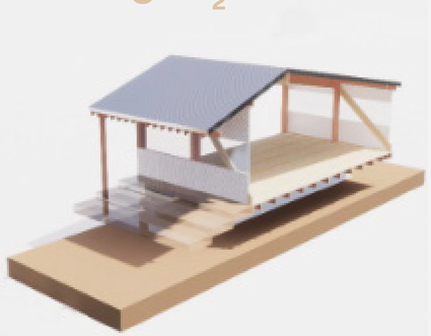
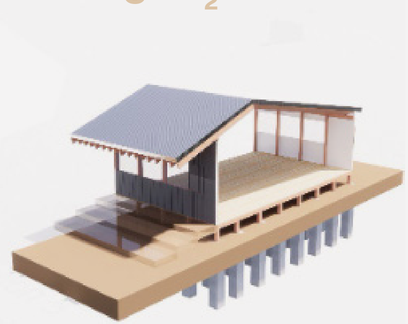
Carbon hotspot identification

	822 $KgCO_2m^2$	838 $KgCO_2m^2$	534 $KgCO_2m^2$	610 $KgCO_2m^2$	524 $KgCO_2m^2$
					
	Design System Option 1 (A1, B1, C1, D1, E1)	**Design System Option 2** (A2, B2, C2, D2, E2)	**Design System Option 3** (A3, B3, C3, D3, E3)	**Design System Option 4** (A4, B4, C4, D4, E4)	**Design System Option 5** (A5, B5, C5, D5, E5)
Foundations	30%	40%	66%	66%	67%
Ground Floor	45%	44%	11%	19%	12%
Load Bearing Structure	14%	1%	2%	6%	8%
Roof Structure	7%	5%	15%	3%	6%
Cladding/Facade	4%	9%	5%	5%	6%

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zero carbon certification

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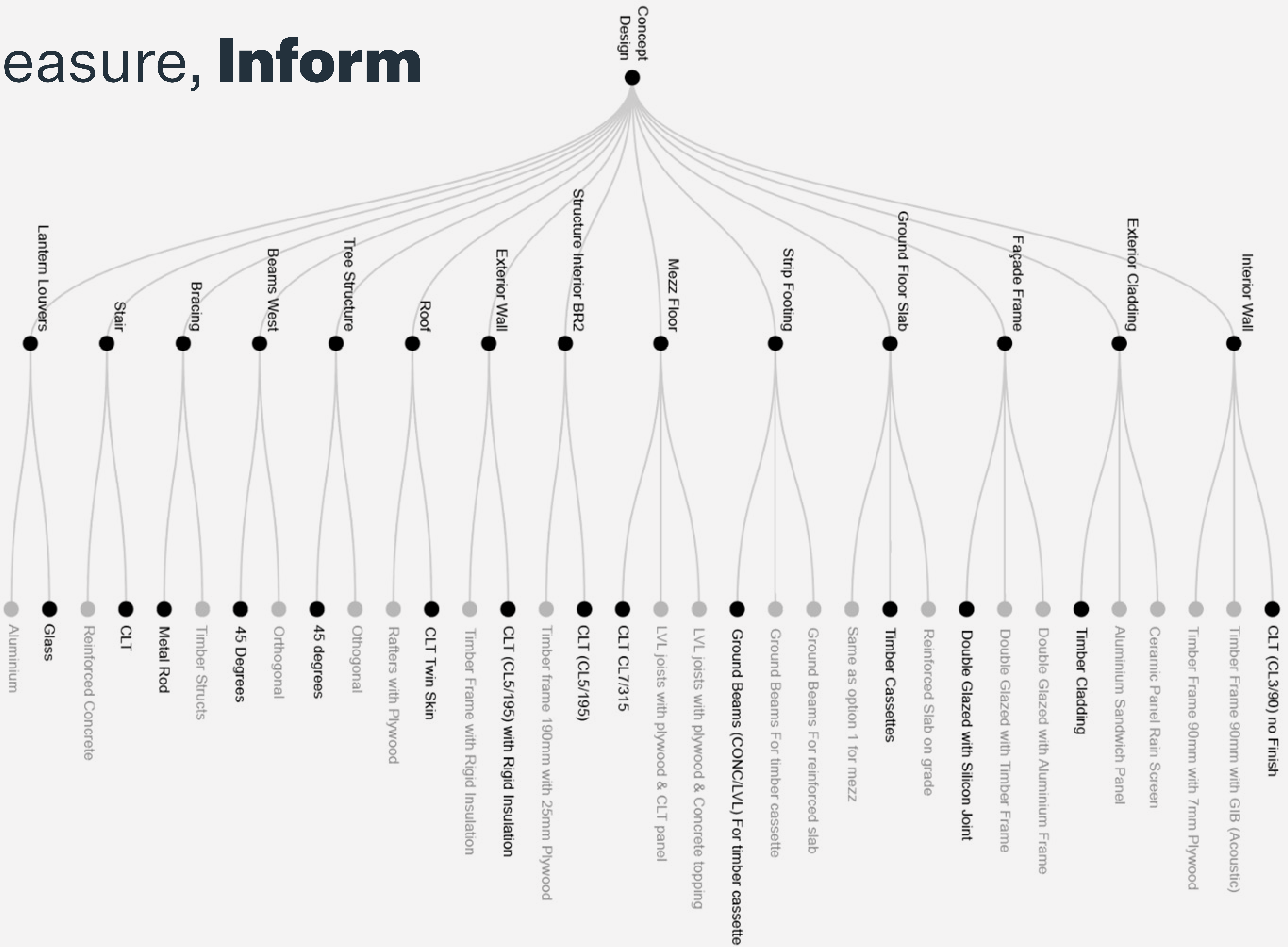
Test, Measure, **Inform**



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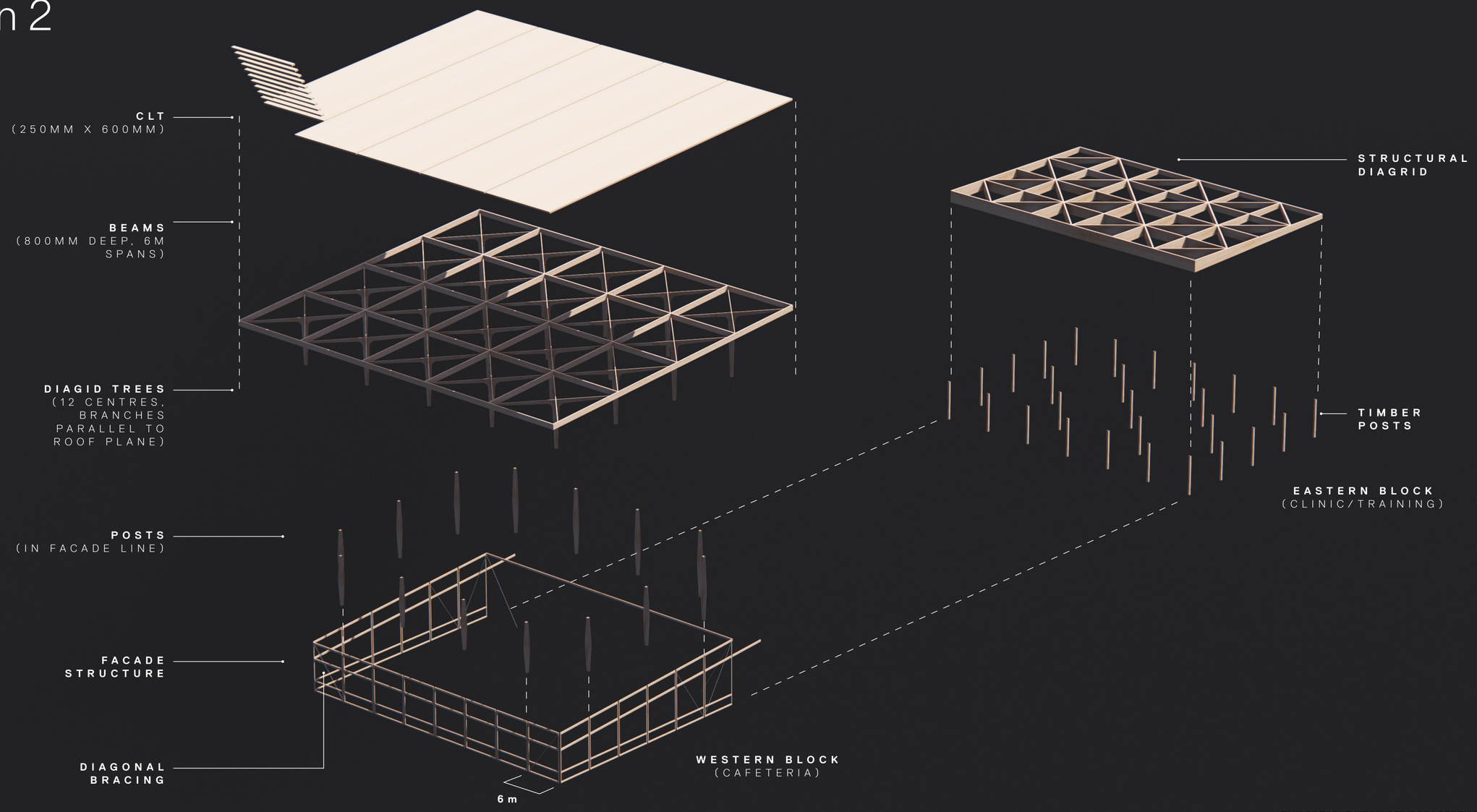
Building Parts

Option 2



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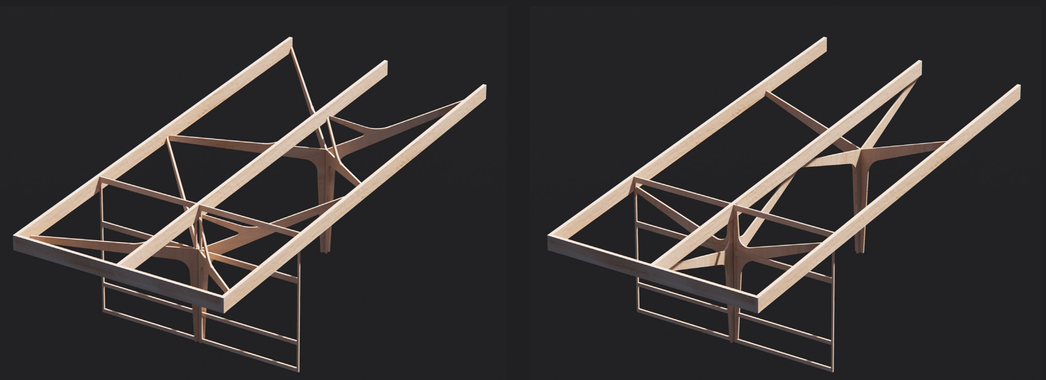
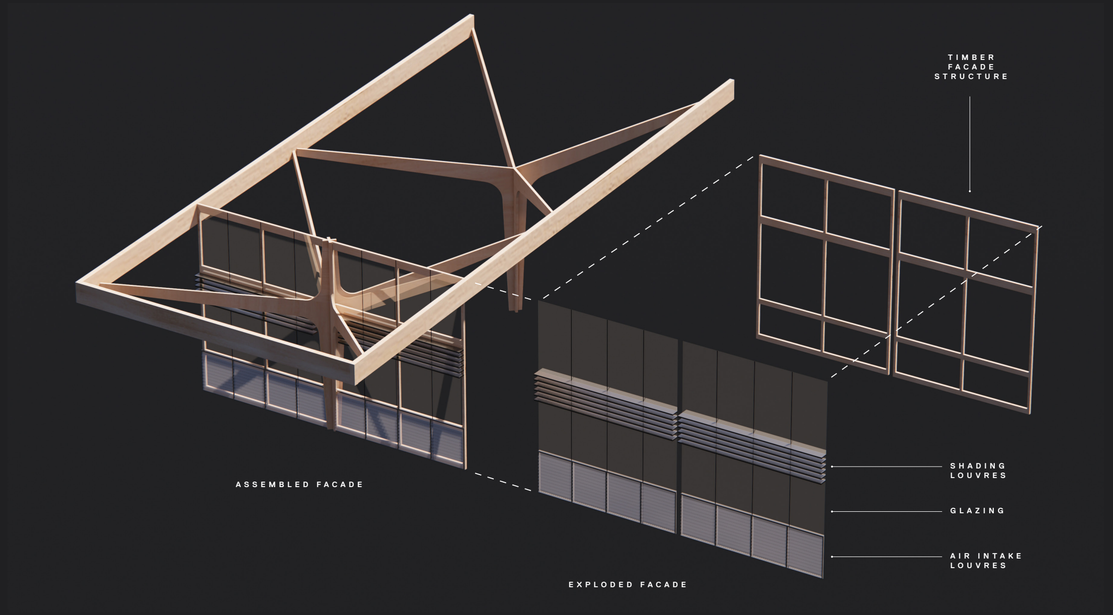
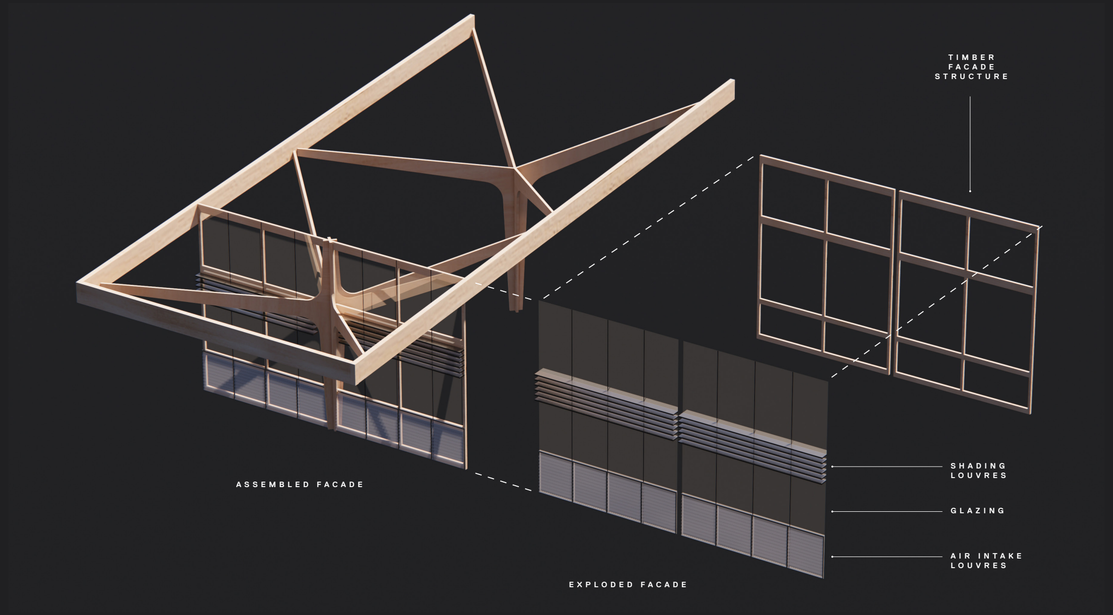
Facades

Flexible and modular construction

The facades and their sub-structure are designed to be modular and flexible with optimised module dimensions. Within it is a framework of apertures that can be filled to respond to the requirements of shading or maximising views and connectivity. The lower portion of the facades accommodate operable louvres to enable natural ventilation at the perimeter whilst the high-level apertures are predominantly glazed to optimise natural day-lighting.







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RESEARCH FILLING GAPS

Facade Study

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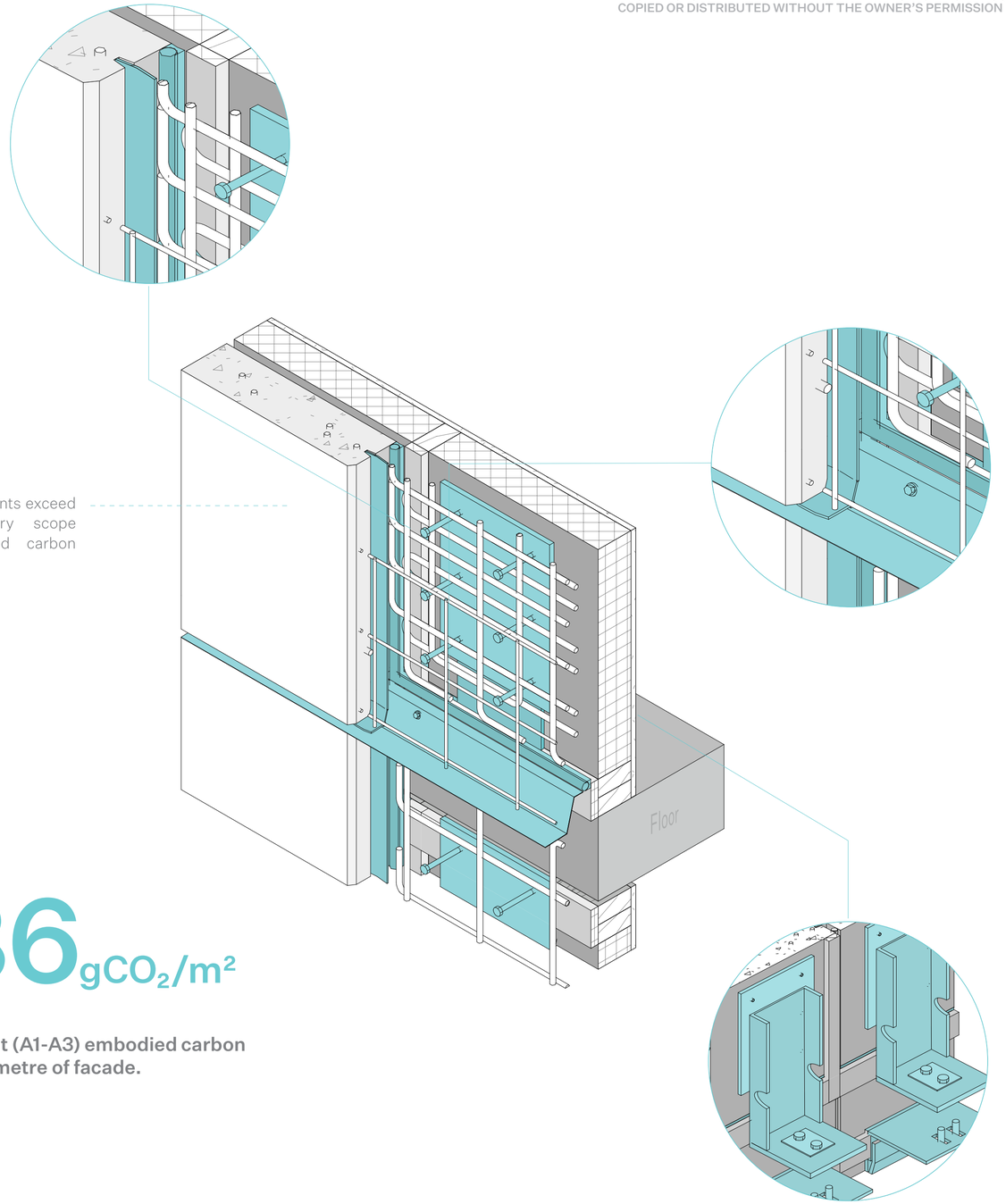
04

Facade Type Four

Precast Concrete Panels



Highlighted elements exceed MBIE's mandatory scope for an embodied carbon assessment.

186 gCO_2/m^2

Total upfront (A1-A3) embodied carbon per square metre of facade.

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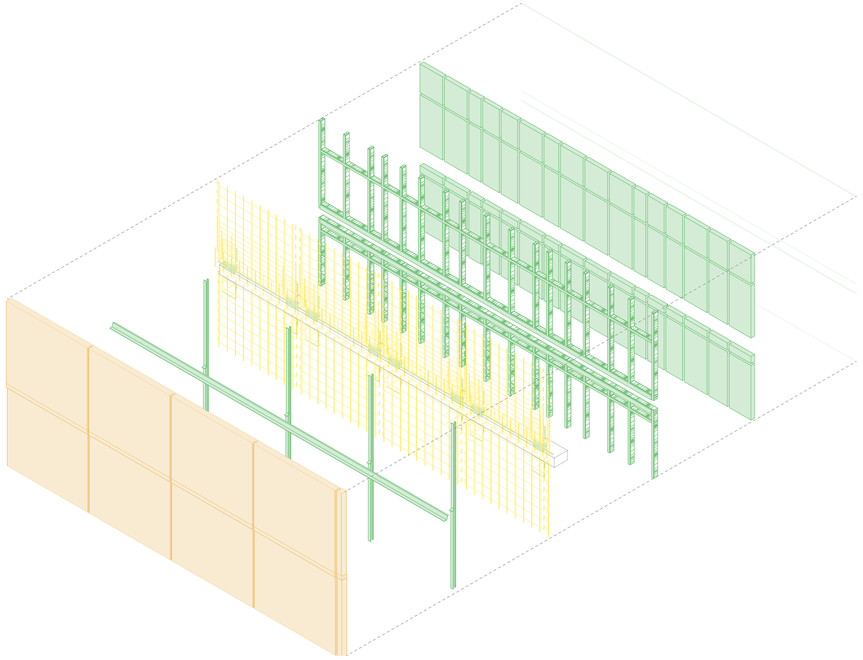
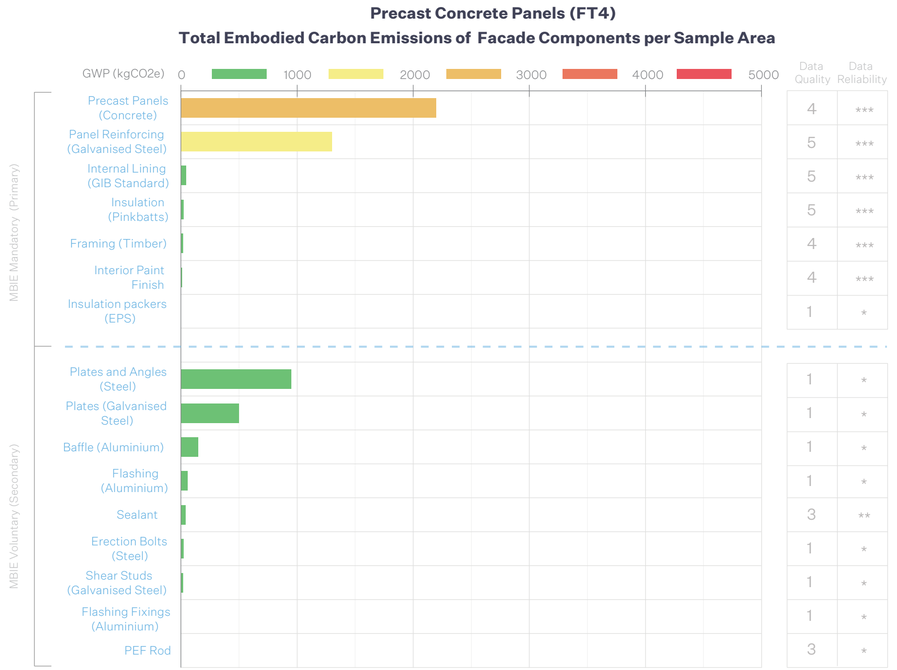
Precast Concrete Panels

Areas of high carbon intensity





4th

Place in carbon intensity within studied facades

186

GWP per square metre ($kgCO_2e/m^2$)

The total sample area of facade ($28.7m^2$) measured at 5343 $kgCO_2e$ of upfront (A1-A3) embodied carbon.

125

MBIE mandatory GWP (kgCO2e)

The 'primary elements' (mandatory MBIE scope) within this facade system accounted for 67% of the total GWP.

61

MBIE voluntary GWP (kgCO2e)

The 'secondary elements' (voluntary MBIE scope) within this facade system accounted for 33% of the total GWP.

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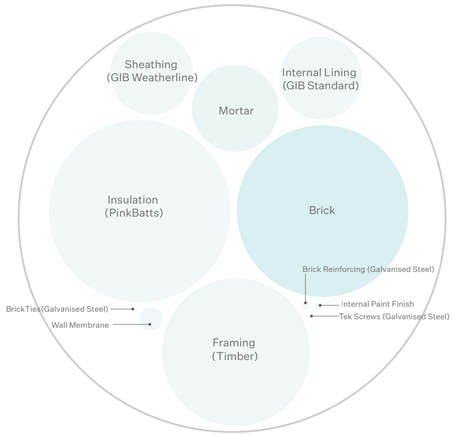
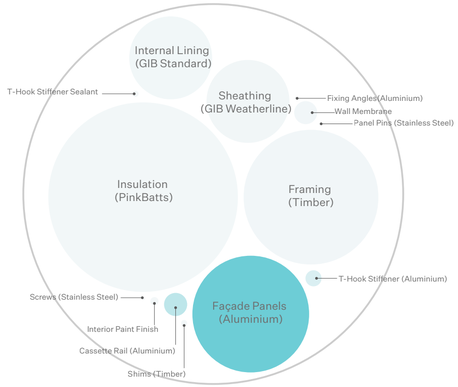
Measure What Matters

Cut-off Criteria

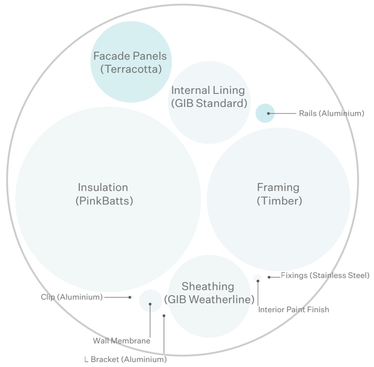
Brick Rainscreen (FT1)



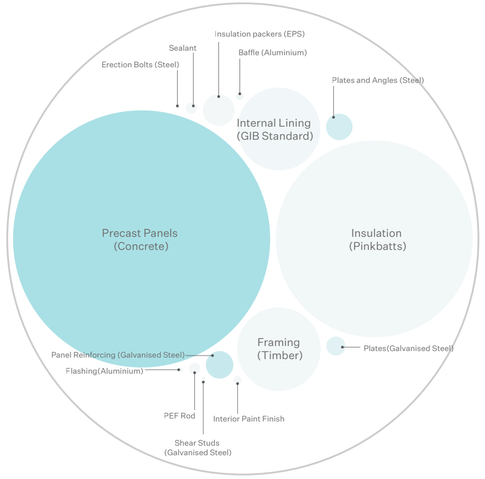
Aluminium Rainscreen (FT2)



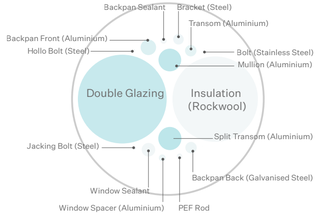
Terracotta Rainscreen (FT3)



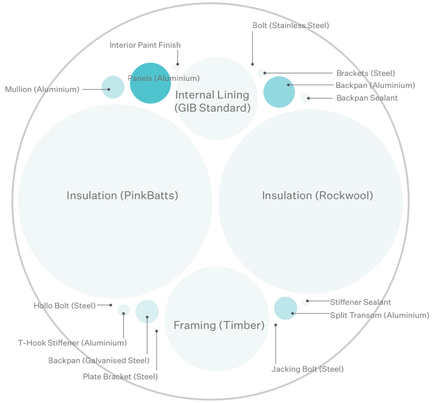
Precast Concrete Panels (FT4)



Glazed Curtainwall (FT5)



Aluminium Curtainwall (FT6)



Components with smaller volumes don't always have a smaller carbon impact.

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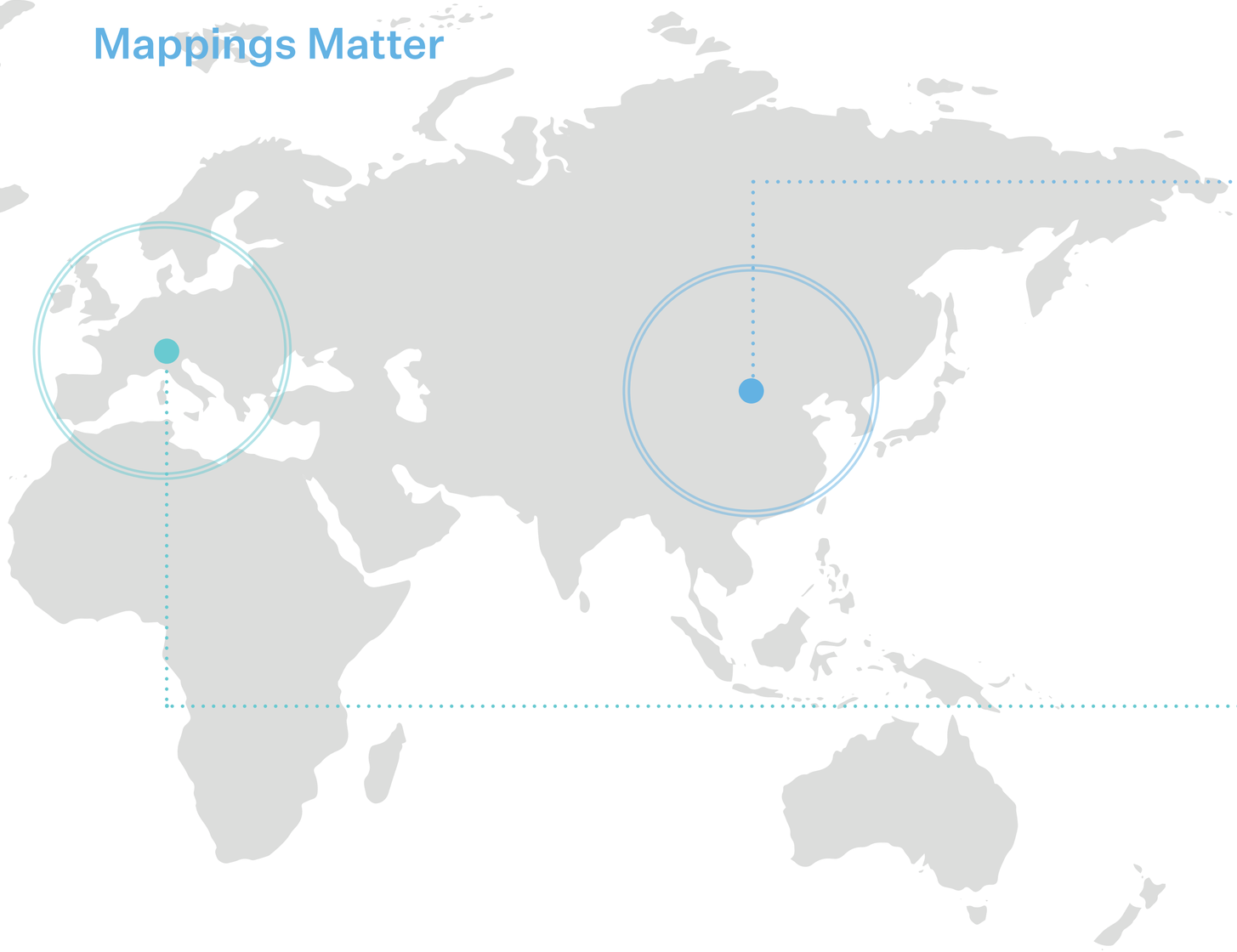
Mappings Matter



Carbon impact of aluminium sourced from two of NZ's common supplier locations

Generic aluminium data from China

29

Upfront Carbon ($kgCO_2e$)

A1-A3 Product Stage	26.00 kg
A4 Transportation	0.02 kg
A5 Construction	2.00 kg

Generic aluminium data from Europe

9

Upfront Carbon ($kgCO_2e$)

A1-A3 Product Stage	8.60 kg
A4 Transportation	0.02 kg
A5 Construction	0.65 kg

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ADVANCED TECHNOLOGY

Automation & AI

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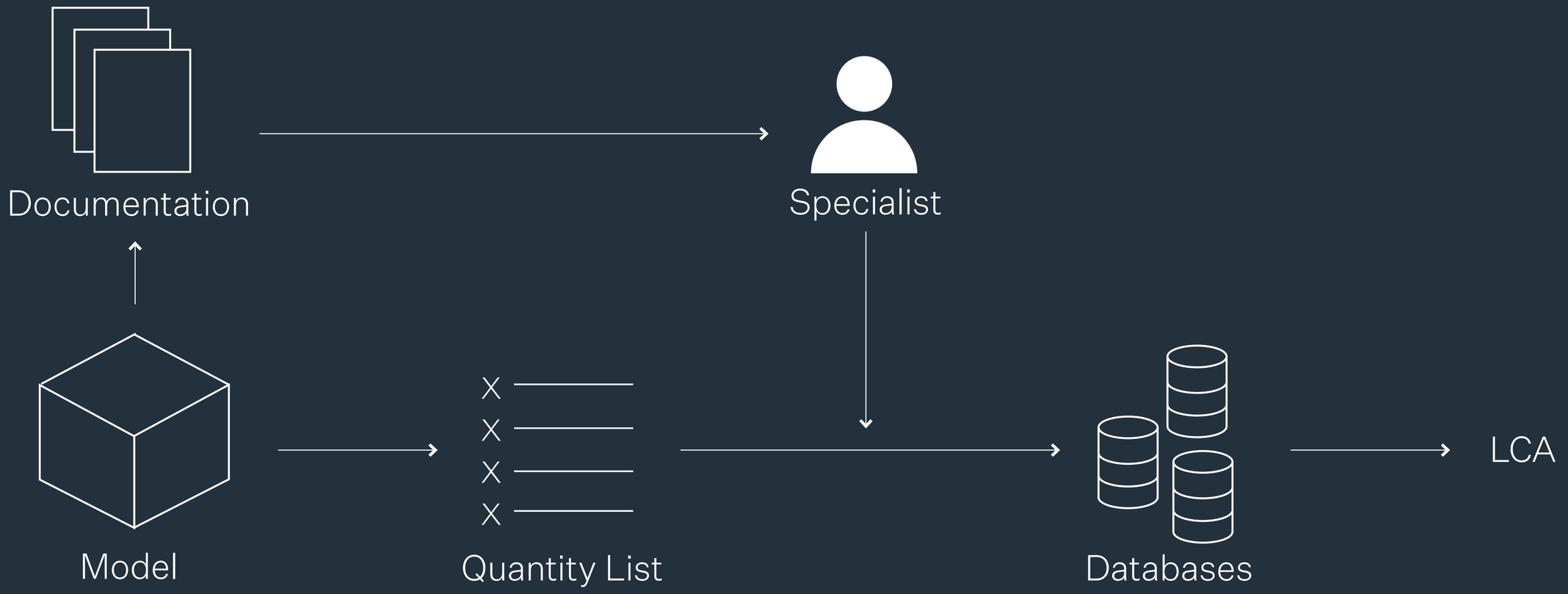
Current LCA Workflow



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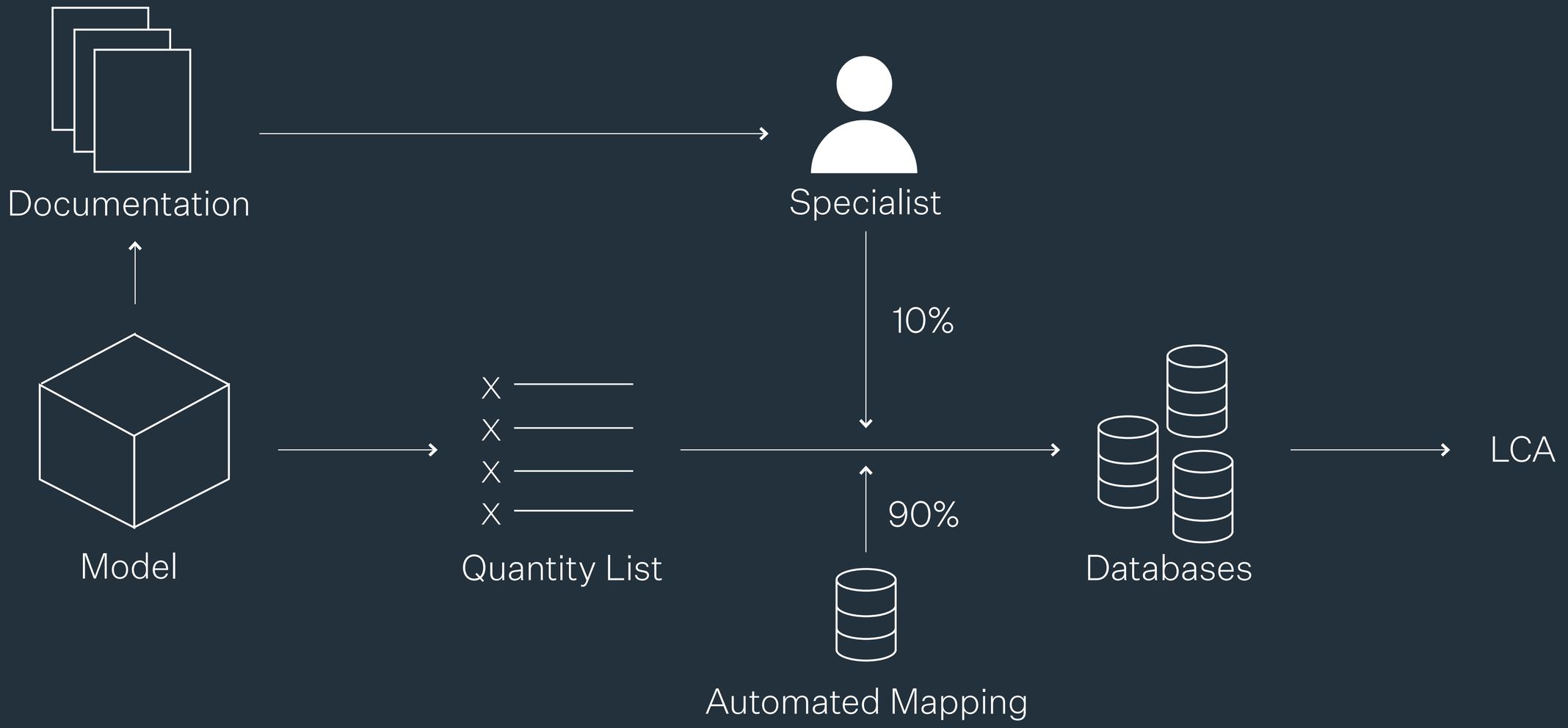
Semi-Automated LCA Workflow



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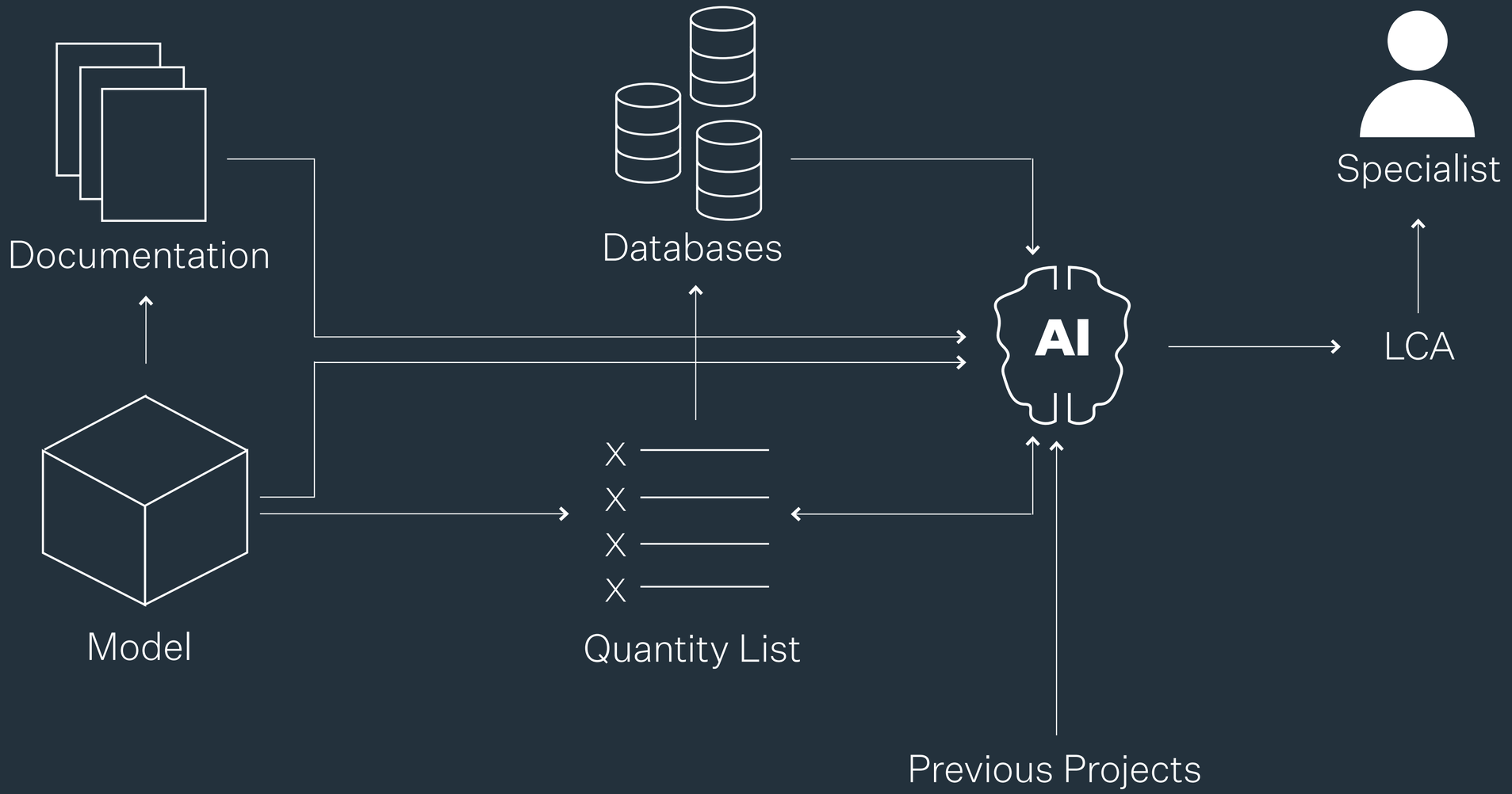
AI Driven LCA Workflow



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Towards 2030

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Embodied Carbon

from	**to**
good vs bad materials	resourcefulness

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Technology

from	**to**
auditing a detailed design	informing an active design

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1,337 tCO_2/s

1,604,400 tCO_2

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