RTA Living House

Carbon Modelling and Analysis

The Lever Room: March 2025

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1.0 Project Overview

This report provides an overview of the carbon modelling and footprint analysis conducted by The Lever Room for the RTA Living House and associated Fisher & Paykel (F&P) products.

The Living House is an affordable building designed by RTA's in-house Design Group to address New Zealand's housing shortage. Constructing lower-carbon buildings are an important part of reducing greenhouse gas emissions to address climate change. Over their entire life cycles, buildings have significant effects on the environment, people and the economy.

The Living House a single storey dwelling with a gross floor area (GFA) of 86m². This carbon analysis follows a 50-year lifecycle assessment, which is the best practice timeframe for evaluating the long-term environmental impact of buildings. The modelling explored **three scenario options** assessing both embodied and operational carbon emissions, where:

- **Embodied energy** refers to the total energy consumed throughout the lifecycle of building materials, encompassing extraction, processing, manufacturing, transportation, construction, maintenance and disposal.
- **Operational energy** pertains to the energy required to operate a building over its lifespan, including heating, cooling, lighting, and appliance usage.

Scenario 1: Building Only

This option focuses solely on the upfront embodied carbon emissions of the physical building itself, without considering any active energy systems or usage profiles.

Scenario 2: Building & Energy Use

In this option, we still evaluate the core building, but we also factor in the energy consumption patterns of the occupants.

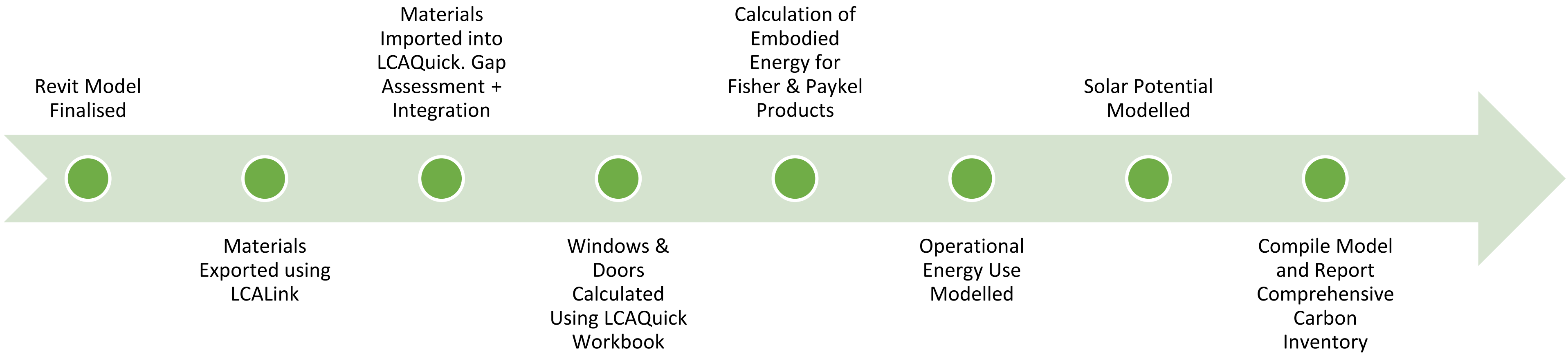
Scenario 3: Building, Solar System, Energy Use & Residual Export

Here, we're examining not just the building and how it uses energy, but also how a solar photovoltaic (PV) system contributes to meeting that energy demand.

2.0 Assessment Methodology

The carbon inventory and modelling for this project was developed through utilisation a Lifecycle Assessment Tool designed for New Zealand's built environment, BRANZ LCAQuick 3.6. The assessment was performed by The Lever Room and populated by extracting material quantities directly from the project's Revit model, ensuring a comprehensive and accurate representation of embodied carbon impacts.

To account for any additional elements not captured in the model, we liaised with the project teams at RTA and Fisher & Paykel Home Solutions team to gather supplementary data. This approach ensured that all material inputs were considered, allowing for a robust assessment of the project's lifecycle emissions.



3.0 Carbon Impact Results

Carbon modelling for The Living House shows a net positive carbon balance of -12,056 kgCO_2e, meaning the CO_2e stored in its materials and reduced through exporting clean energy outweighs its total lifecycle emissions.

The Living House is climate positive and sequests 140 kgCO_2e per m^2.

Carbon modelling was carried out by The Lever Room, an independent organisation, who developed a comprehensive whole-building lifecycle assessment (LCA) model. This assessment encompassed the building, solar system, energy use, and residual export from the Living House.

A "whole of house" or whole-building life cycle assessment examined the impacts associated with all stages of a building's life cycle, including:

- **Material Sourcing and Production:** The extraction, processing, and manufacturing of building materials.
- **Construction:** The activities involved in building the structure.
- **Operation and Maintenance:** The energy consumption, water usage, and other environmental impacts during the building's operational period.
- **End-of-Life:** Demolition, waste disposal, and potential reuse or recycling of materials.

Lifecycle Stage	**kgCO2e**
A1-A3: Product Manufacturing	15,310
A4-A5: Construction	2,348
B2, B4: Maintenance & Replacement	8,492
B6: Operational Energy Use	-
B7: Operational Water Use	7,166
C1-C4: End of life	5,940
D: Potential Environmental Benefits outside the lifecycle e.g. material recycling and reuse	(2,132)
D: Energy Export	*(11,504)*
D: Total - the benefits and loads beyond system boundaries	(13,636)
Biogenic carbon	(37,678)
Total	**(12,056)**

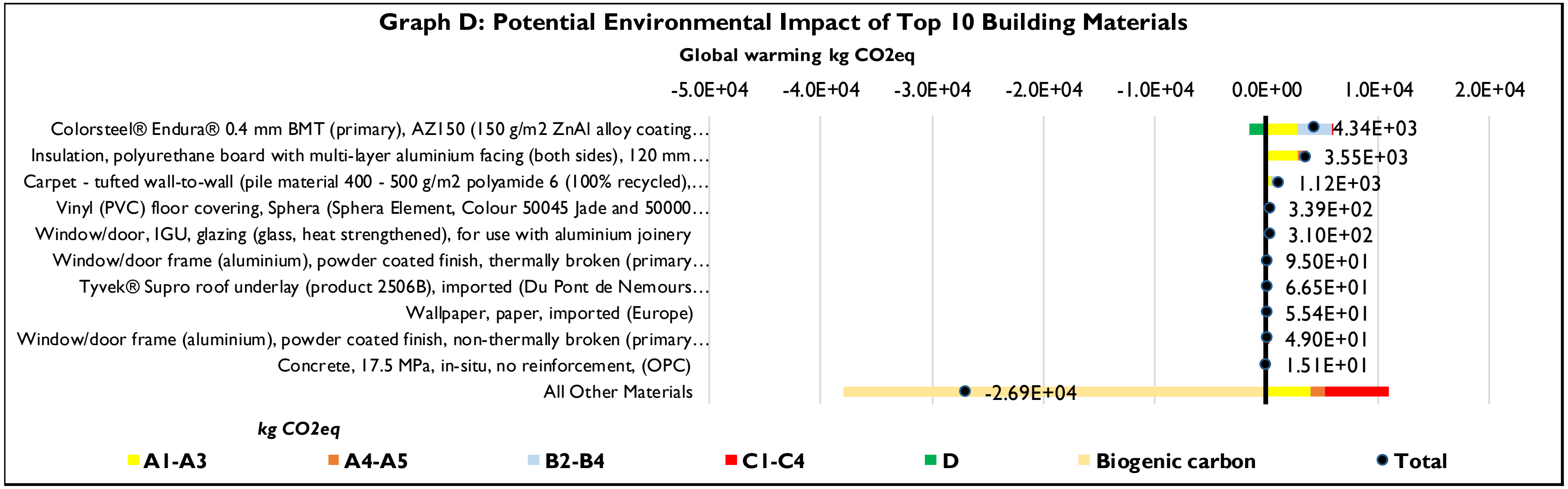
The carbon footprint of the RTA Living House has been assessed across three different scenarios to understand both the embodied and operational emissions over its lifecycle. This analysis provides insight into the carbon impact of material choices, energy consumption, and the role of renewable energy in reducing emissions.

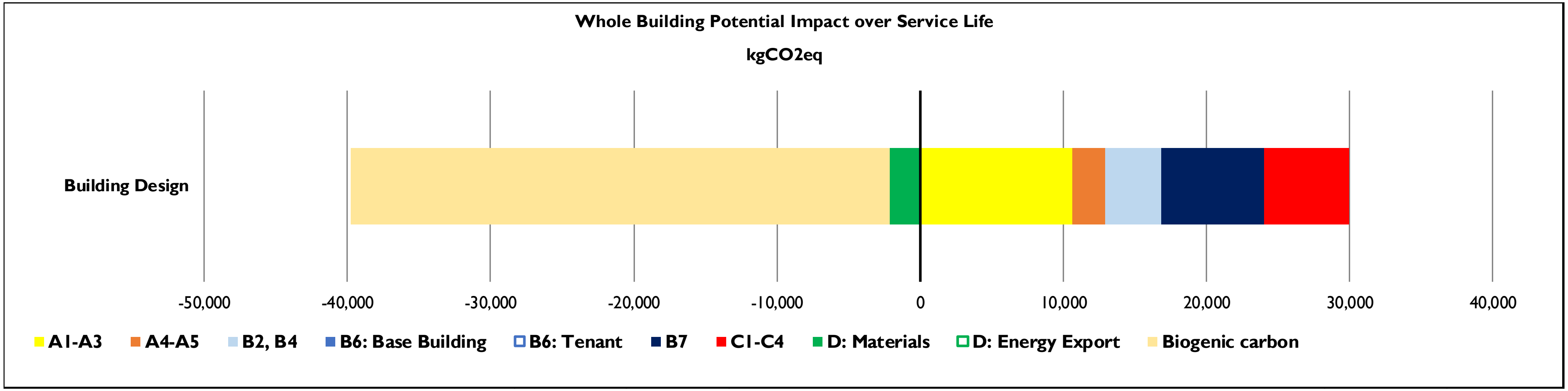
Scenario 1: Building Only Carbon Model

In the first scenario, Building Only, the house achieves a carbon-negative footprint of **-9,841 kgCO_2e.** This negative footprint means that more carbon is stored within the building materials as biogenic carbon than is emitted during construction. The negative emissions number highlights the effectiveness of low-carbon material choices.

The lifecycle impacts of the Top 10 Building Materials are outlined below. Key components of the house included in the assessment include but aren't limited to:

- Foundation and Pilings
- Walls
- Insulation
- Roofing
- Windows
- Doors



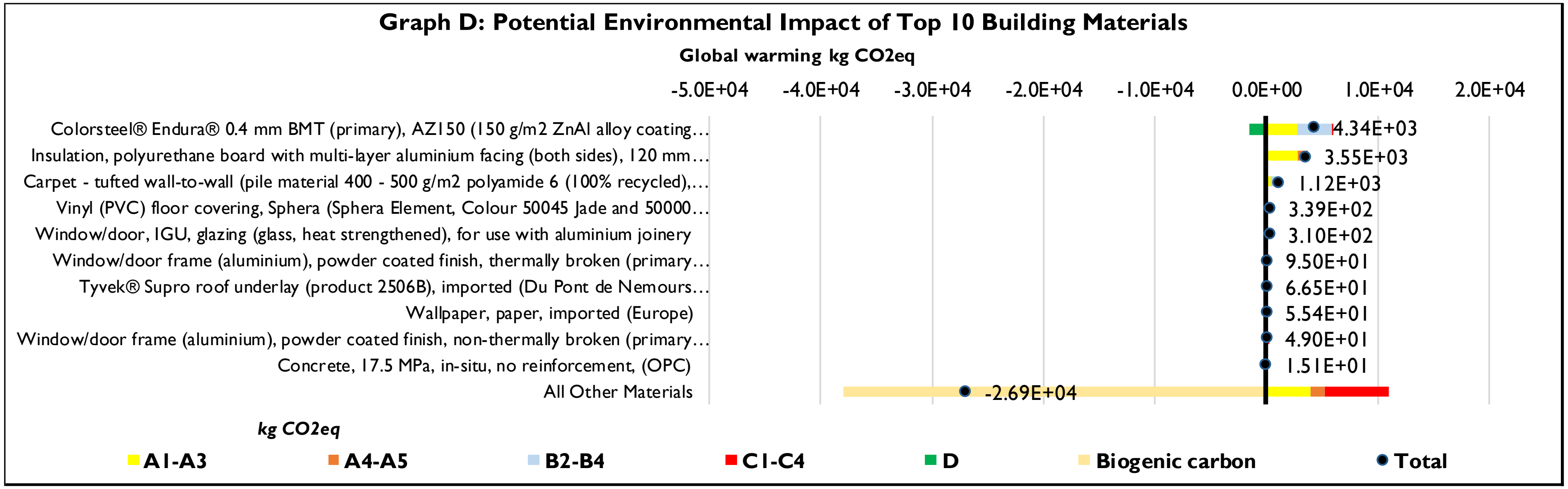


Scenario 2: Building and Energy Use Carbon Model

In the Scenario 2 Carbon Model, operational energy use has been calculated across the Fisher & Paykel product suite, which means the footprint shifts. In the second scenario, Building and Energy Use, total emissions have been assessed rise to **14,209 kgCO_2e**. This increase is entirely due to energy consumption over the building's lifespan, demonstrating the significant impact of operational emissions.

In addition to energy consumption from Fisher & Paykel products, components of the house included in the assessment include:

- Foundation and Pilings
- Walls
- Insulation
- Roofing
- Windows
- Doors

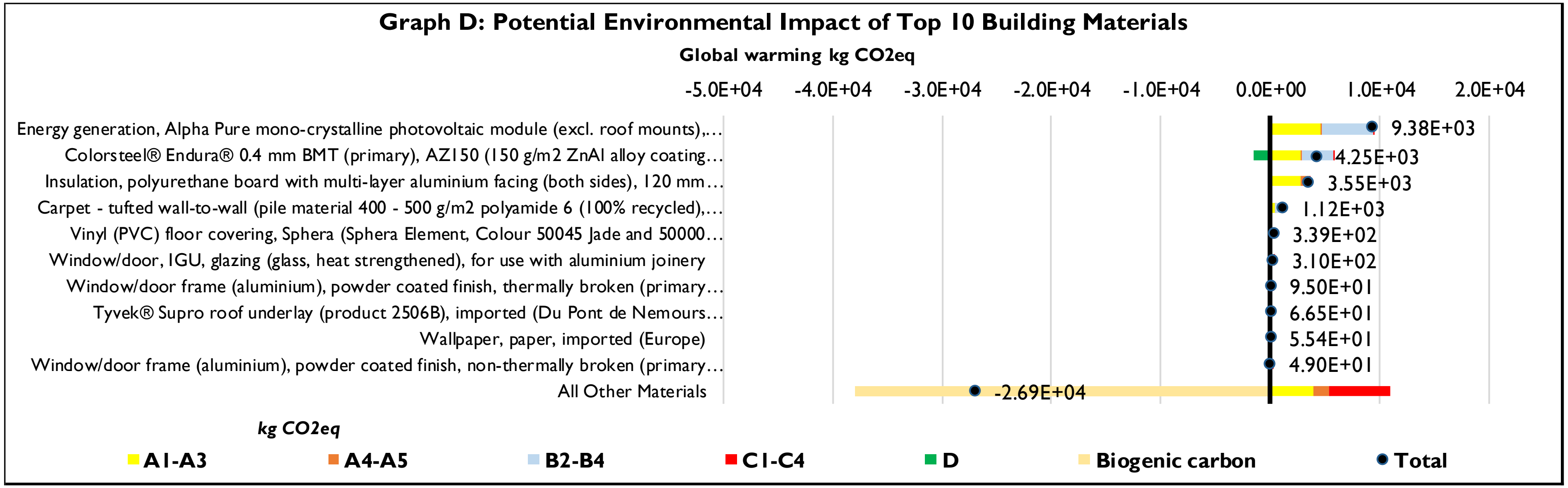


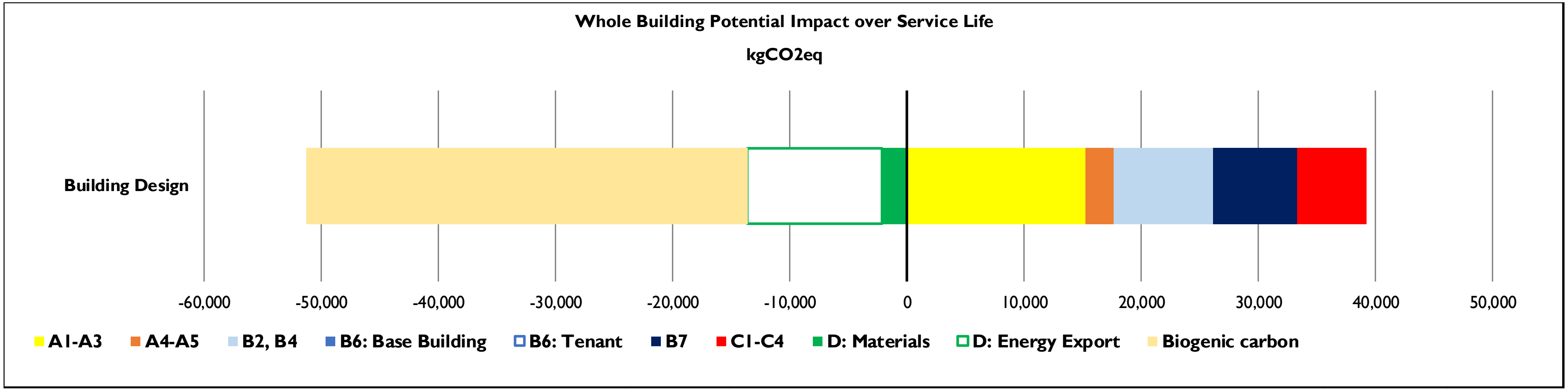
Scenario 3: Building, Solar System, Energy Use and Residual Solar Export

The third scenario—Building, Solar System, Energy Use, and Residual Export—results in a net positive carbon balance of -**12,056 kgCO_2e,** meaning the CO_2e the building stores in its materials, and saves through exports of clean energy to the grid, is more than it emits across its lifecycle. Although the solar system has its own embodied carbon from manufacturing, installation, and eventual replacement after 30 years, the combined benefits of material sequestration and renewable energy generation more than offset these impacts, making the building carbon positive overall.

Key components of the house included in the assessment once again include:

- Foundation and Pilings
- Walls
- Insulation
- Roofing
- Windows
- Doors
- REC Solar Panels


Graph D: Potential Environmental Impact of Top 10 Building Materials
Global warming kg CO2eq
-5.0E+04
-4.0E+04
-3.0E+04
-2.0E+04
-1.0E+04
0.0E+00
1.0E+04
2.0E+04
Energy generation, Alpha Pure mono-crystalline photovoltaic module (excl. roof mounts),…
Colorsteel® Endura® 0.4 mm BMT (primary), AZ150 (150 g/m2 ZnAl alloy coating…
Insulation, polyurethane board with multi-layer aluminium facing (both sides), 120 mm…
Carpet - tufted wall-to-wall (pile material 400 - 500 g/m2 polyamide 6 (100% recycled),…
Vinyl (PVC) floor covering, Sphera (Sphera Element, Colour 50045 Jade and 50000…
Window/door, IGU, glazing (glass, heat strengthened), for use with aluminium joinery
Window/door frame (aluminium), powder coated finish, thermally broken (primary…
Tyvek® Supro roof underlay (product 2506B), imported (Du Pont de Nemours…
Wallpaper, paper, imported (Europe)
Window/door frame (aluminium), powder coated finish, non-thermally broken (primary…
All Other Materials
9.38E+03
4.25E+03
3.55E+03
1.12E+03
3.39E+02
3.10E+02
9.50E+01
6.65E+01
5.54E+01
4.90E+01
-2.69E+04
kg CO2eq
A1-A3
A4-A5
B2-B4
C1-C4
D
Biogenic carbon
Total


Whole Building Potential Impact over Service Life
kgCO2eq
Building Design
-60,000
-50,000
-40,000
-30,000
-20,000
-10,000
0
10,000
20,000
30,000
40,000
50,000
A1-A3
A4-A5
B2, B4
B6: Base Building
B6: Tenant
B7
C1-C4
D: Materials
D: Energy Export
Biogenic carbon

3.1 Lifecycle Stage Analysis

The following table presents the results for each scenario in detail:

Lifecycle Stage	**kgCO2e**		
	BO*	**B&E***	**BE & Solar***
A1-A3: Product Manufacturing	10,670	10,670	15,310
A4-A5: Construction	2,306	2,306	2,348
B2, B4: Maintenance & Replacement	3,893	3,893	8,492
B6: Operational Energy Use	-	24,050	-
B7: Operational Water Use	7,166	7,166	7,166
C1-C4: End of life	5,934	5,934	5,940
D: Potential Environmental Benefits outside the lifecycle e.g. material recycling and reuse	(2,132)	(2,132)	(2,132)
D: Energy Export	-	-	*(11,504)*
D: Total - the benefits and loads beyond system boundaries	(2,048)	(2,048)	(13,636)
Biogenic carbon	(37,678)	(37,678)	(37,678)
Total	**(9,841)**	**14,209**	**(12,056)**

*BO = Building Only, B&E = Building and Energy Use, BE & Solar = Building, Solar System, Energy Use and Residual Export

A1-A3: Product Manufacturing – Emissions from raw material extraction, transportation, and manufacturing of building materials.

A4-A5: Construction – Emissions from transporting materials to the site and the construction process itself.

B2, B4: Maintenance & Replacement – Carbon impact from ongoing maintenance and periodic replacement of building components.

B6: Operational Energy Use – Emissions generated from energy consumption during the building's use phase.

B7: Operational Water Use – Emissions related to water consumption, including treatment and distribution.

C1-C4: End of Life – Emissions from demolition, waste processing, disposal, and associated transportation.

D: Potential Environmental Benefits outside the Lifecycle – Includes benefits from material recycling and reuse, reducing the need for virgin materials.

D: Energy Export – Surplus energy generated (e.g., from solar panels) that is exported back to the grid, offsetting other emissions.

D: Total - Benefits and Loads Beyond System Boundaries – The net impact of all environmental benefits and burdens occurring outside the building lifecycle.

Biogenic Carbon: Carbon stored in biomass materials (e.g., timber), which can act as a temporary carbon sink depending on end-of-life treatment.

4.0 Fisher & Paykel Products

The embodied emissions of appliances have also been modelled, including key household items such as the dishwasher, cooktop, rangehood, and oven, along with systems like the heat pump water heater, air conditioning unit, solar PV Inverter, and the solar panels.

Where possible, actual carbon data for specific models has been utilised. In cases where exact data was unavailable, proxies based on similar products have been calculated to ensure a realistic assessment.

Embodied Carbon assessment results are detailed on the right.

The method assumes:

- A lifetime of 20 years for F & P appliances. To correctly calculate the lifetime emissions attributable of the Living House we have included these 3 times, Year 0, Year 20 and Year 40.
- A lifetime of 30 years for the F & P supplied solar panel. Provision for replacement has been made as part of this carbon model assessment.

F & P Product Inventory	Embodied (Single Product) kgCO2e	Embodied (Building Life) kgCO2e
Dishwasher	750	2251
Cooktop	139	417
Rangehood	36	108
Oven	450	1351
Heat Pump Water Heater[1]	101	303
Aircon- Heat Pump[2]	41	123
Solar Panel[3]	4,690	9380[4]
Solar PV Inverter	1,307	3921
Total	**4,797**	**14,391**

[1] Embodied emission proxy calculations were undertaken by The Lever Room and based on the primary materials used in each appliance.
[2] Embodied emission proxy calculations were undertaken by The Lever Room and based on the primary materials used in each appliance.
[3] Embodied emissions of supplied solar panel This figure includes emissions from initial production, installation, and replacement at the end of its usable life (assumed at 30 years). Solar Panel emissions verified by The Lever Room through BRANZ LCAQuick3.6.
[4] Full replacement across the building life already included in modelled and reported in Scenario 3.

5.0 Material Analysis & Concluding Insights

Across all three scenarios, steel roofing was a major contributor to the building's carbon footprint, accounting for 4,248 kgCO_2e. This was followed by polyurethane insulation at 3,548 kgCO_2e and carpets at 1,120 kgCO_2e. These materials add significantly to the embodied carbon due to their manufacturing processes and material composition.

In contrast, Cross-Laminated Timber (CLT), the primary structural material, provided a substantial carbon benefit, sequestering -25,095 kgCO_2e through stored biogenic carbon. This underscores the role of timber in reducing the overall impact of the building's embodied emissions.

For scenarios that included solar panels, the solar system became the single largest contributor to embodied carbon, with a footprint of 9.38 tCO_2e. This figure includes emissions from initial production, installation, and replacement at the end of its usable life (assumed at 30 years). While solar energy reduces operational emissions, its high embodied carbon highlights the trade-offs in balancing renewable energy benefits with material impacts.

The insights above outline a transparent and evidence-based narrative for the Living House.

In summary:

- The project results in a net positive carbon balance of **-12,056 kgCO_2e,** meaning the CO_2e the building stores in its materials, and saves through exports of clean energy, is more than it emits across its lifecycle.
- The Living House stores more carbon than it emits and sequests 140 kgCO_2e per m2.
- Carbon modelling has been independently undertaken by project partners The Lever Room.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