BUILDING PERFORMANCE

Embodied Carbon Assessment Report Summary

Building Name: Hardy Street Apartments

Building information

- **Typology** – New medium density housing/townhouse development
- **Area assessed** – 1817m² gross floor area (GFA)
- **Number of storeys** – Three
- **Seismic risk zone** – Medium
- **Year of completion** – Unknown

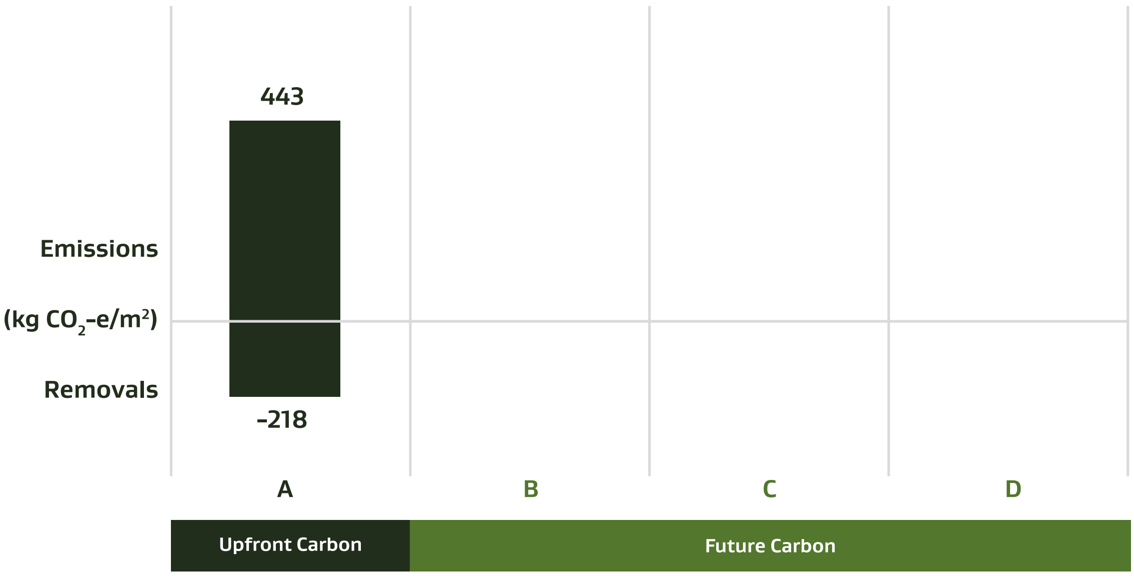
Assessment information

- **Date assessed** – November 2022
- **Purpose** – Client request
- **Design stage** – Detailed design
- **Assessor and role** – Resilienz, carbon assessor
- **Life cycle duration** – Unknown
- **Material quantity data source** – Architect's and contractor's drawings, contract and site visit records
- **Emission factor data source** – BRANZ datasets, cross-laminated timber (CLT), environmental product declarations (EPDs) and others noted separately
- **Tool used** – Clearcut®
- **Building element scope** – Ground work, structure, external envelope, some non-structural elements, building services

Life Cycle Stages Assesssed

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

Embodied Carbon by Life Cycle Stage



MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Te Kāwanatanga o Aotearoa
New Zealand Government

Assessment Summary

This assessment is of eight, three-storey, medium density, housing units. For the purposes of the assessment, the building is split into three sections: unit one (which is larger than the others), units 2-8 (almost identical), and the end structural wall.

This assessment only covers the upfront embodied carbon (modules A1-A3) of the building as required by the terms of reference. These upfront emissions can be generally quantified with the greatest certainty. Although a whole-of-life perspective is important when considering embodied carbon emissions, the scenarios assumed for the use and end-of-life phases (modules B-D) may not occur as expected. Design decisions that reduce upfront emissions have the greatest influence on reducing the immediate climate impact of the building.

Assessment Highlights

The assessment graphically shows the embodied carbon contributions of each building element (page 10). These outputs allow designers to see which building elements have the largest carbon impact in their design and how best they could reduce it.

Details of emissions data sources for specific products that merit additional explanation are also provided (page 14). This allows greater transparency for product data that does do not strictly conform to a standard format.

As this development is comprised of multiple units that are almost identical, they offer a potential time saving in determining the material quantities. The repetitive aspect of medium density housing is a good example of where efficiencies can be gained, although detailing and construction complexities can counteract this.

CARBON ASSESSMENT FOR APARTMENTS AT 317 HARDY ST., NELSON   2022 11 16

Version: V.4.1 2023 11 30 Format adjustment.

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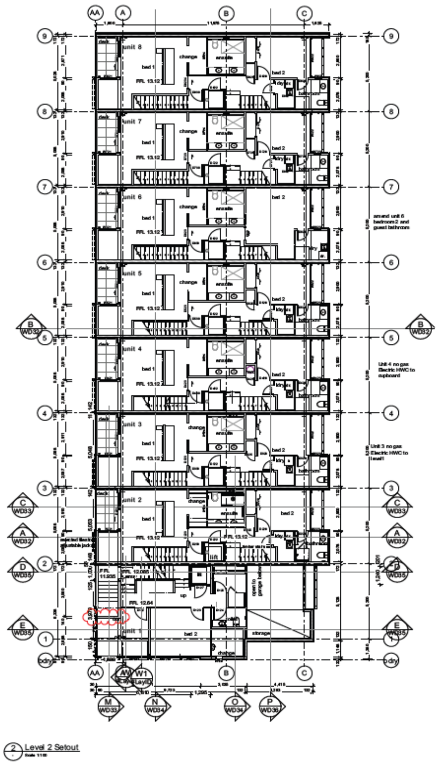
INTRODUCTION AND SUMMARY

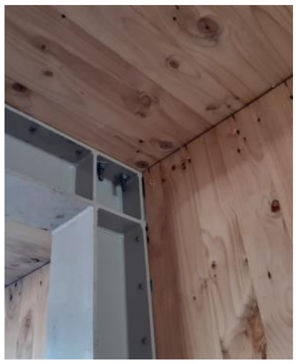
The building comprises eight 3-storey apartments, with one end apartment of individual design (Unit 1) and seven other virtually identical units (Units 2-8). The basic structure is concrete foundations, ground floor slabs and low-level precast concrete walls, with extensive CLT walls and floors above, and stabilised in one direction by substantial steel frames. A range of timber framed internal fit-out and external walls includes quite a complex range of materials and finishes.



This assessment focusses on Modules A1-A3 in the LCA Assessment Framework (i.e., from points of material origin to leaving the manufacturer's/merchants' gates), and on key elements in the as-consented version of the project documents (except including the subsequently revised roof deck construction).

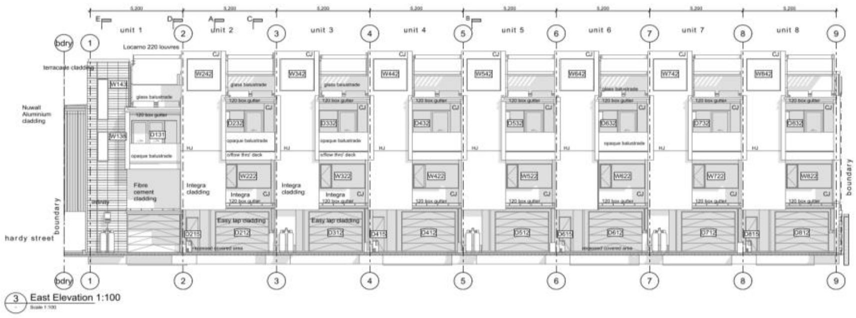
Alternative indicative studies have been carried out to a) evaluate the effect carbon removals due to using all sustainably sourced timber (note the Red Stag CLT panels are always from sustainably managed forests) and b) evaluate the impact on carbon if the CLT and structural steelwork were replaced by concrete components. The latter, especially, entails substantial assumptions and approximations, and is based on guide information from AMK engineers.

In summary, the total CO_2e (Carbon Dioxide Equivalent) of the building has been assessed as 470.2 tCO_2e, or approximately 58.8 tCO_2e average per dwelling. This is itemised in Figure 1 below and, in other formats, in Appendices 1 and 2, and includes a 5% contingency allowance.



These carbon quantities reduce to approximately 396 tCO_2e total and 49 tCO_2/dwelling if all timber-based products are measured as from sustainably managed forests, and rise to some 1,410 tCO_2e total and 176 tCO_2/dwelling for construction based predominantly on concrete panels and frames in lieu of CLT walls and floors and steel frames. Details of these alternatives are included in Appendices 3 and 4.

Please note that real caution must be exercised in comparing these figures with other figures used in the sector on account of the many variables. The explanations that follow will help bring more clarity to at least some of those, but caution will still be needed, especially in areas of comparison.



SUMMARY OF A1-A3 CO2e FOR BUILDING ONLY AT 317 HARDY ST, NELSON			
ITEM	kg CO2e	UNITS	TOTAL kg CO2e
OPTION 1 Typical repetitive Unit 2-8	58,587	7	410,108
OPTION 2 Unit 1	54,656	1	54,656
OPTION 3 Wall construction on Grid Line 9	5,389	1	5,389
TOTAL C02e FOR BUILDING			**470,153**
Unit 1 with 50% Wall on GL 9*			57,351
Typical repetitive Unit 2-8 with 7% of wall on GL 9*			58,972
Average CO2e per dwelling			58,769
Average CO2e per occupant assuming 2.5 people/unit			23,508
Average kgCO2e/m2 **			262
* The approach to measuring includes no party walls with Unit 1 and one internal party wall to each of units 2-8. Allocating 50% of the end wall (on GL 9) to Unit 1 and 7.14% to each other unit is a notional apportionment to actual units of the total CO2e impact of the wall on GL9.			
** Although CO2e/m2 is quite a common metric, Clearcut does not encourage its use as it focuses on relative carbon reduction when the focus should be on absloute reduction.			

Fig. 1 Tabulated summary of CO2e content of consented building.

TERMS OF REFERENCE

The core terms of reference are essentially item 1.5 in Figure 2 below, together with its relevant footnote. However, several aspects merit comment as itemised further below.

1.5. Provide Carbon reporting for the project, by the time of the first site tour. *

1.6. Provide Cost breakdown by Structure, Foundations, P&G, and incorporating the estimated impact of time savings and related market delay risk ** from constructing in mass timber, as well as a QS estimate of the same data of a traditional material structure and foundations.

1.7. Source only New Zealand-made Cross Laminated Timber and/or other engineered wood products at the suppliers' New Zealand market competitive rates, and use wood treated against decay.

1.8. CLT is used for at least all floors and stairs, except on ground level or where a steel or concrete podium is used.

1.9. Commencing construction on site starts before 30 April 2023.

1.10. Ensuring the site has been selected, the zoning does not exclude the intended use, and project funding is available.

The foregoing items are collectively known as the Criteria.

**Report to comply with ANZSMM (Australia New Zealand Standard Method of Measurement) and include modules A1, A2, and A3 of the Life Cycle Analysis (LCA) Framework proposed by MBIE. Refer to the document "Whole of Life Embodied Carbon Assessment: Technical Methodology" February 2022"*

*** MRW can provide a template to access.*

Fig. 2. Specified terms of reference for carbon (and other) reporting as supplied.

1. ANZSMM has been followed in broad terms but is not always suited to carbon assessment in this manner, and the methodology is only partially aligned with that approach.
2. While MBIE's "*Whole of Life Embodied Carbon Assessment Methodology*" has been used as general guidance, that approach is itself still an evolving protocol. Additionally, its "whole of life" scope goes well beyond the A1-A3 modules stipulated for this assessment in the footnote. As such there are various places where our approach has departed from that in the MBIE document.
3. Additionally, the MBIE methodology proposes a data hierarchy that does not find a ready place for information such as that from Nu-Wall. We have commented specifically on aspects of this in Appendix 5.
4. The protocol for accounting for biogenic carbon is to identify it as a separate potential "carbon removal", while including the non-sustainable carbon from timber in the main calculation. While this approach has been adopted in regard to most sawn and engineered wood products, the CLT data in Red Stag's product EPD makes no provision for a non-sustainable option, and as such the CLT elements are always shown as a carbon removal.[1]
5. We note that the Ministry of Education ("MinEdu") has adopted a useful interim interpretation of the MBIE methodology, and we have in part been guided by that (such as for example using a "placeholder allowance" for general building services).
6. Principal exclusions are internal fit-out (but stairs are included), and external finishes not forming part of the consented exterior (e.g., green wall, deck surfacing above the waterproofing, and rooftop louvre systems). Barriers have been included.

THE BUILDING

General description

The building consists of eight 3-storey vertical apartment units, with Units 2 to 8 identical, and Unit 1 to an individual design.

[1] This departs from how the original report was presented to better align with the MBIE methodology explanation.

The main structure is concrete foundations and some ground floor walls, with CLT walls and floors above. These are laterally restrained in one direction by concrete and CLT panels and in the other by steel frames running the full length and height of the building.

Infill walls are light weight timber framed, and floors are mostly acoustic floors above CLT panels.

Building metadata as supplied by KRA.

Table 1 Building Metadata

Location	317 Hardy St, Nelson, Post Code 7010		
Climate Zone	Zone 3 (H1 2019)		
Durability Zone	Zone C		
Wind Zone	Medium		
Seismic Zone	Zone 2		
Soil type	Shallow		
Floor areas	UNIT 1	Net floor area	Gross floor area
	Level 1	60.9	68.4
	Level 2	75.3	83.7
	Level 3	77.8	86.0
	Level 4	8.3 (Stair tower only)	10.6
	TOTAL	222.3 m2	248.7 m2
	UNIT 2 also units 3-8	Net floor area	Gross floor area
	Level 1	67.1	69.8
	Level 2	67.7	72.6
	Level 3	68.0	68.0
	Level 4	11.5 (Stair tower only)	13.6
	TOTAL	214.3 m2	224.0 m2

External cladding is mostly Rockcote Integra panel, with Nu-Wall aluminium cladding to the north (end) wall and Nu-Wall and Terracade panels to Unit 1 at the south end.

The small roofs to the stair towers are in Colorsteel on timber framing. The upper roof is mostly formed with Conqueror insulating panels framed off CLT panels to form falls, and with a waterproofing TPO membrane. Most terraces are either overlaid with artificial turf, or have tiles on jack systems.

GENERAL COMMENTS

A dynamic and emerging field

Although there is considerable global experience and background information in the field of carbon assessment of buildings, it is relatively young in New Zealand and methodologies are in the process of being firmed up and adopted.

Thus, for example, the referenced MBIE Methodology describes itself as “MBIE’s thinking to date”, the A1-A3 scope required for this study is different to the “Whole of life” approach proposed by the MBIE document, and the ANZSMM method of measurement needs adaptation to meet the needs of carbon assessment.

Clarification: “Carbon”, “Carbon dioxide”, “CO2e” and “Decarbonise”.

Aspects of this terminology can be confusing, and this brief explainer is to help defuse that.

“Carbon dioxide,” or CO_2: This is a major and long-lived greenhouse gas, the product of much combustion (notably including from fossil fuels), and its properties are used as a benchmark in terms of the global warming impact of different greenhouse gases. (See “CO_2e” below).

“Carbon”: An element forming, with oxygen, the gas carbon dioxide, “carbon” is used rather loosely in global warming terms, and is often used to refer to carbon dioxide. A notable exception is in aspects of the discussion of carbon storage in timber products.

“CO_2e”: Several other gases are also greenhouse gases, and contribute to global warming, with widely varying levels of impact compared with CO_2. In order to be able to compare and combine these impacts, another greenhouse gas may be expressed in terms of “Carbon dioxide equivalent,” or CO_2e. This is the main term used in this assessment, and thus refers to the combined global warming effect of all of the greenhouse gases associated with the construction of the building.

“Decarbonise”: this refers to measures that reduce the impact of carbon dioxide, or carbon dioxide equivalents, through either reducing the quantum of emissions (e.g., through minimising high-emissions products like steel and concrete), or through removing greenhouse gases from the atmosphere – notably through forestry and the storage of carbon in the timber.

Carbon budgets and targets.

In line with the emergent methodologies, the way of benchmarking acceptable carbon footprints of buildings is also under development. Hence, for example, while there is a tendency to lean towards assessing carbon as tCO_2e/m^2 of floor area, this is recognised by many active in the field (such as BRANZ and the Ministry of Education) as a deficient metric in that it fails to promote the most basic strategy of carbon reduction of reducing building size.

BRANZ in particular have carried out internationally acclaimed studies in this area, with the conclusion that our typical whole-of-life embodied and operational carbon per dwelling needs to fall well below a 35 tCO_2e average to be compatible with our Paris commitments for a 1.5° C global warming limit.

Accordingly, our summary information provides carbon figures in a range of formats.

Carbon removals.

Similarly, the allowance for carbon removals (in this case stored in timber as biogenic carbon) is only recognised where there is assurance that the related timber products are sourced from sustainably managed forests. In that context, all Red Stag CLT panels automatically qualify, but the specification does not call up sustainably sourced framing, plywood, and the like, and as such their potential carbon removals are only recognised in the alternative study.

Other areas of carbon removal (concrete carbonation and Module D - end-of-life provisions for building components) are less certain and are not accounted for in this assessment.

Note: In line with the MBIE methodology recommendation, biogenic carbon quantities have been separated from the main carbon assessment, and while this approach has only been adopted for general timber products in the alternative study, the EPD for Red Stag CLT only provides data for sustainably sourced timber and as and associated removals are always included. The scale of related carbon removals can be gauged from floor and wall structures in the itemised table in Appendix 2.

With regard to the biogenic carbon impact of the CLT products, we have assessed the absolute effective values (see table 2 below, excluding contingency) by combining Red Stag EPD data for biogenic and for fossil carbon, the latter on its own being taken as equivalent to timber *not* sourced from sustainably managed forests.

It is worth noting that, had such *unsustainable* timber been used in the CLT panels, the resultant CO2e for the whole building would have almost doubled, from some 472 tCO2e to 928 tCO2e.

Please note that slight differences between the absolute figures in Table 2 below and those in Figure 4 are due to the values in figure 4 also accounting for other materials associated with the construction of the elements in question.

ABSOLUTE BIOGENIC CARBON VALUES FOR CLT PANELS (kgCO2e)			
LOCATION	**Section 1 Single Unit 2-8**	**Section 2 Unit 1**	**Section 3 Wall on GL 9**
Floor panels	-25,000	-23,960	0
Wall panels	-11,472	-12,309	-12,430
Deck panels	-3,217	-	-
Total biogenic carbon/section	-39,689	-36,269	-12,430
TOTAL biogenic carbon for CLT panels (kgCO2e)			-326,522
Indicative TOTAL if unsustainable timber used (kgCO2e)			132,261
Theoretical overall CO2e reduction (kgCO2e)			458,783

Table 2 Absolute carbon values for CLT panels

METHODOLOGY

Carbon modelling tool

Carbon assessment has been based on V1.1 of the Clearcut® carbon and cost estimating tool developed by Resilienz Ltd. Quantities are based on Clearcut's own computations and carbon data is sourced from EPDs where relevant, and otherwise generally from BRANZ databases, with some from Resilienz's own in-house knowledge base.

Documentation Supplied

Extensive documentation was supplied by KRA, including drawings by KRA, engineers AMK, shop drawings for CLT and precast concrete panels. (See Appendix 5 for comments). AMK also supplied broad information for concrete frames, floors and precast panels as a basis for carbon assessment.

Site visit

The site was visited when the CLT panels, main steel structure and some timber wall framing were in place, and structural steel at level 4 (roof deck level) was being prepared for erection.

Basic methodology

The assessment is based around the repetition of a typical unit in the form of one party wall plus all of the construction up to the next party wall. This applies to units 2 to 8, but does not capture the end wall construction on grid line 9, which is measured separately. Unit 1 is a different design and has been assessed in its own right (but note it excludes the party wall, which is included with Unit 2 as one of the repetitive units).

These assessments are reflected in the accompanying charts, colour coded as explained with Fig. 1.

Data supplied by the contractor:

Contractor has supplied useful information in terms of total quantities of in-situ concrete, reinforcing and tonnage of structural steel. In lieu of onerous calculations these have been apportioned equally between the eight different units.

The contractor has also described their ground works in terms of general excavation to 1200 mm below ground floor level and then hardfill up to the underside of the floor (before excavating for foundations). The assessment has been based on this approach over the building footprint.

Building services:

We have adopted a variation of the Ministry of Education's approach to services by calculating a "placeholder" general allowance plus specific allowances for major unusual items (lifts and PV system in this case). In the case of 317 Hardy St., we have used 45 kg CO2e/m2, being approximately 50% of the MinEdu's placeholder value of 91 $kgCO_2e/m^2$.

The lifts and the PV system are based on the nearest applicable BRANZ figures.

Assessment boundaries

As mentioned above, this assessment is confined to the building itself and excludes various items of fit-out (such as decks above the weatherskin, roof level louvres, and the green wall). However, consent requirements such as deck barriers are included.

No allowance has been made for demolition or for site preparation other than the abovementioned overall excavation and fill.

Calculations of wastage for carbon assessment are different to those normally adopted for construction practices (reflecting that wastage potentially occurs at all stages of the procurement process and not just on the construction site). This alternative wastage is included in the carbon factors used and is calculated with net materials rather than with construction waste also added.

Aggregation and substitution

In some cases, due to complexity or uncertainty, certain products called up separately, or not indicated, may have been estimated in conjunction with another similar product. Examples include certain insulating products; waterproofing membranes; cavity batten systems; acoustic and fire sealants; and resilient separators between CLT and steelwork.

Concrete panel comparison

The carbon assessment for an option with all-concrete to wall and floor panels, and also in lieu of the steel frames, is based on AMK's 2019 09 05 mark up of KRA's drawing SP16. Please note that the only adjustment made for potential changes to acoustic and fire rating treatments are for removal of the acoustic floors, which are understood to be purely the result of the CLT construction.

Contingency

Clearcut is based on good practice being to reflect project contingency allowances in carbon content as well as in cost. In these estimates a 5% contingency has been adopted, to reflect both the relative complexity of the detailing of the project and areas of carbon uncertainty (such as outlined in Appendix 5). While reasonable overall, this is potentially high for some key materials (CLT, steel and concrete) which have more precisely known quantities at this stage of the project.

CONCLUSION

As the units involved have floor areas of the order of 225m2 and 250m2, and A1-A3 carbon footprints of approaching 60 tCO2e they are – like conventionally built current dwellings, and in spite of the extensive use of CLT – greatly in excess of even the 2020 budget derived by BRANZ (35 tCO2e for whole of life embodied and operational carbon, which likely equates to well under 10 tCO2e for A1-A3 for selected components only). Please note BRANZ now consider the 35 tCO2e target needs to be revised down substantially due to recent levels of carbon-intensive construction.

The situation would improve slightly in the event that all timber products were sustainably sourced.

However, of particular note is the dramatic reduction in carbon footprint as a result of the change from precast concrete to CLT, saving emissions in excess of 100 tCO2e/dwelling, even with the addition of a relatively carbon-intensive acoustic flooring system in Units 2-8.

SELECTED REFERENCES

MBIE, 2022: *Whole-of-Life Embodied Carbon Assessment: Technical Methodology*
BRANZ, 2020: *A carbon budget for New Zealand Houses*
BRANZ, online: *https://www.branz.co.nz/environment-zero-carbon-research/framework/branz-co2nstruct/*
Ministry of education, September 2022 Version 1.0: *Whole-of-Life Embodied Carbon Assessments: Life Cycle Assessment Guidance for New Build Projects at Schools*

APPENDIX 1 GRAPHICAL CARBON COMPARISON FOR DIFFERENT SECTIONS

Comparative elemental graphic of one typical unit 2-8 (Section 1), Unit 1 (Section 2), and End Wall on Grid Line 9 (Section 3).

Please note that the relative negative carbon values for the three sections under "Structure, floors, walls, roofs", while at first seeming strange (as Sections 1 and 2, the units have much more CLT than Section 3. the end wall), is due to this category also accounting for other materials – and notably the apportionment of structural steelwork to the units but not to the end wall. (Figure 4 below shows the carbon addition due to structural steel virtually negating the carbon removals due to the CLT on the floors.)

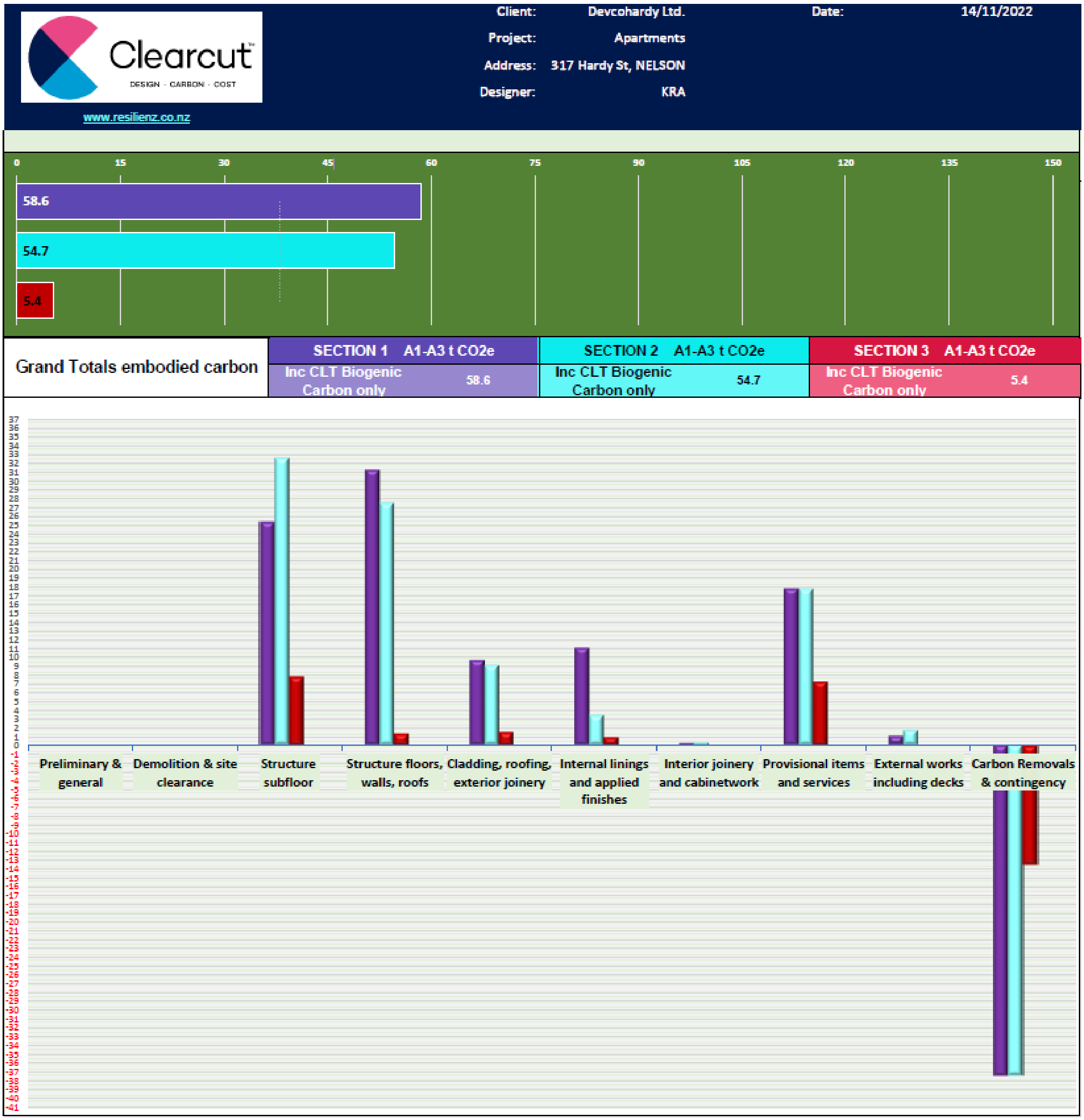


Fig. 3. Graphical comparison with no allowance for biogenic carbon in timber products other than CLT

APPENDIX 2 ITEMISATION FOR UNIT 1, TYPICAL UNIT 2, AND GL9 WALL

This comparative itemised tabulation itemises the elements of one typical unit 2-8 (Section 1), Unit 1 (Section 2), and the End Wall on Grid Line 9 (Section 3). See Fig. 1. for explanation of how to combine these.

Clearcut DESIGN · CARBON · COST www.resilienz.co.nz	APARTMENTS AT 317 HARDY ST., NELSON	TYPICAL UNIT 2-8	UNIT 1	WALL - GRID 9
Trade Description	Trade category	SECTION 1 A1-A3 t CO2e	SECTION 2 A1-A3 t CO2e	SECTION 3 A1-A3 t CO2e
Preliminary & general	Preliminary and general	0.0	0.0	0.0
		0.0	0.0	0.0
Demolition & site clearance	Demolition and site clearance	0.0	0.0	0.0
		0.0	0.0	0.0
Structure subfloor	Excavation and hardfill	1.0	1.0	0.0
	Reinforcing steel	7.1	12.3	4.0
	Concrete, formwork and vapour barrier	17.2	19.3	3.8
	Concrete Blockwork	0.0	0.0	0.0
	Carpentry sections	0.0	0.0	0.0
	Sub floor framing	0.0	0.0	0.0
		25.3	32.5	7.8
Structure floors, walls, roofs	Floor framing & flooring	5.4	2.6	0.0
	Wall framing	2.0	2.3	1.4
	Posts & beams	0.0	0.0	0.0
	Roof framing	2.8	1.5	0.0
	Structural steel	21.1	21.1	0.0
	Strawbale, SIPS and mudbrick	0.0	0.0	0.0
		31.2	27.5	1.4
Cladding, roofing, exterior joinery	External claddings & trim	5.3	1.8	1.5
	Spouting, guttering and downpipes	0.0	0.0	0.0
	Roofng (including membranes & rooflights)	0.3	0.2	0.0
	Brickwork	0.0	0.0	0.0
	Solid plastering (exterior, cement based and synthetic)	0.0	0.0	0.0
	Joinery, exterior windows and doors	4.0	7.0	0.0
	Painting external (new & altered work only)	0.1	0.0	0.0
		9.6	9.0	1.5
nternal linings and applied finishes	Internal linings & trim	3.4	0.8	0.6
	Gibraltar board (not stopping)	3.4	1.3	0.3
	Gibraltar board stopping	0.2	0.1	0.0
	Painting internal (new & altered work only)	0.0	0.0	0.0
	Resilient/soft furnishings (carpet, vinyl, drapes)	3.2	0.4	0.0
	Ceramic tiling (internal floors and walls)	0.7	0.7	0.0
		11.0	3.4	1.0
Interior joinery and cabinetwork	Iinternal glazing (mirrors, shower screens etc.)	0.0	0.0	0.0
	Staircases and balustrading (internal only)	0.0	0.0	0.0
	Internal doors and frames (including glazing)	0.2	0.3	0.0
	Cabinetwork	0.0	0.0	0.0
		0.2	0.3	0.0
Provisional items and services	Heating appliances and mechanical services	17.7	17.7	0.0
	Plumbing (including tank water supply)	0.0	0.0	0.0
	Electrical (including any related work to other trades)	0.0	0.0	7.2
	Drainage (sewer & stormwater)	0.0	0.0	0.0
	Special large or provisional items	0.0	0.0	0.0
		17.7	17.7	7.2
External works including decks	Other framing (decks, pergolas etc)	0.2	0.0	0.0
	Metalwork (screens, balustrading)	0.8	1.7	0.0
	Resilient deck surfacing (vinyl, fibreglass etc.)	0.0	0.0	0.0
	Ceramic tiling to decks (Note paths, patios in external works)	0.0	0.0	0.0
	Site works	0.0	0.0	0.0
		1.0	1.7	0.0
	Sub Total	96.0	92.1	18.9
Carbon Removals	Biogenic carbon removal	-40.3	-40.1	-13.7
	Carbonation of concrete carbon removal	0.0	0.0	0.0
	Credit module D - end of life savings carbon removal	0.0	0.0	0.0
	Carbon removals Sub Total	-40.3	-40.1	-13.7
	Add carbon contingency equivalent	2.8	2.6	0.3
Carbon Removals & contingency	Sub Total carbon removals and contingency	-37.5	-37.5	-13.5
TOTALS	Grand Total	58.6	54.7	5.4
		TYPICAL UNIT 2-8	UNIT 1	WALL - GRID 9
	A1-A3 tonnes CO2e/m2	0.262	0.240	N/A

Fig. 4 Itemised comparison

APPENDIX 3: SUMMARIES OF BIOGENIC CARBON AND CONCRETE COMPARISONS

SUMMARY OF A1-A3 CO2e FOR BUILDING ONLY AT 317 HARDY ST, NELSON			
ITEM with allowance for all biogenic carbon	kg CO2e	UNITS	TOTAL kg CO2e
SECTION 1 Typical repetitive Unit 2-8	49,713	7	347,989
SECTION 2 Unit 1	43,203	1	43,203
SECTION 3 Wall construction on Grid Line 9	5,205	1	5,205
TOTAL C02e FOR BUILDING			**396,397**
Unit 1 with 50% Wall on GL 9*			45,805
Typical repetitive Unit 2-8 with 7% of wall on GL 9*			50,084
Average CO2e per dwelling			49,550
Average CO2e per occupant assuming 2.5 people/unit			19,820
Average kgCO2e/m2 **			221
* The approach to measuring includes no party walls with Unit 1 and one internal party wall to each of units 2-8. Allocating 50% of the end wall (on GL 9) to Unit 1 and 7.14% to each other unit is a notional apportionment to actual units of the total CO2e impact of the wall on GL9.			
** Although CO2e/m2 is quite a common metric, Clearcut does not encourage its use as it focuses on relative carbon reduction when the focus should be on absloute reduction.			

Fig. 5. Summary of CO2e for building with all carbon removals for biogenic carbon

SUMMARY OF A1-A3 CO2e FOR BUILDING ONLY AT 317 HARDY ST, NELSON			
ITEM with concrete for all CLT and steel frames	kg CO2e	UNITS	TOTAL kg CO2e
SECTION 1 Typical repetitive Unit 2-8	173,893	7	1,217,252
SECTION 2 OPTION 2 Unit 1	159,354	1	159,354
SECTION 3 Wall construction on Grid Line 9	33,413	1	33,413
TOTAL C02e FOR BUILDING			**1,410,019**
Unit 1 with 50% Wall on GL 9*			176,060
Typical repetitive Unit 2-8 with 7% of wall on GL 9*			176,279
Average CO2e per dwelling			176,252
Average CO2e per occupant assuming 2.5 people/unit			70,501
Average kgCO2e/m2 **			786
* The approach to measuring includes no party walls with Unit 1 and one internal party wall to each of units 2-8. Allocating 50% of the end wall (on GL 9) to Unit 1 and 7.14% to each other unit is a notional apportionment to actual units of the total CO2e impact of the wall on GL9.			
** Although CO2e/m2 is quite a common metric, Clearcut does not encourage its use as it focuses on relative carbon reduction when the focus should be on absloute reduction.			

Fig. 6. Summary of CO2e for building with concrete floors walls and frames

APPENDIX 4 GRAPHICAL COMPARISON WITH BIOGENIC CARBON ALLOWED

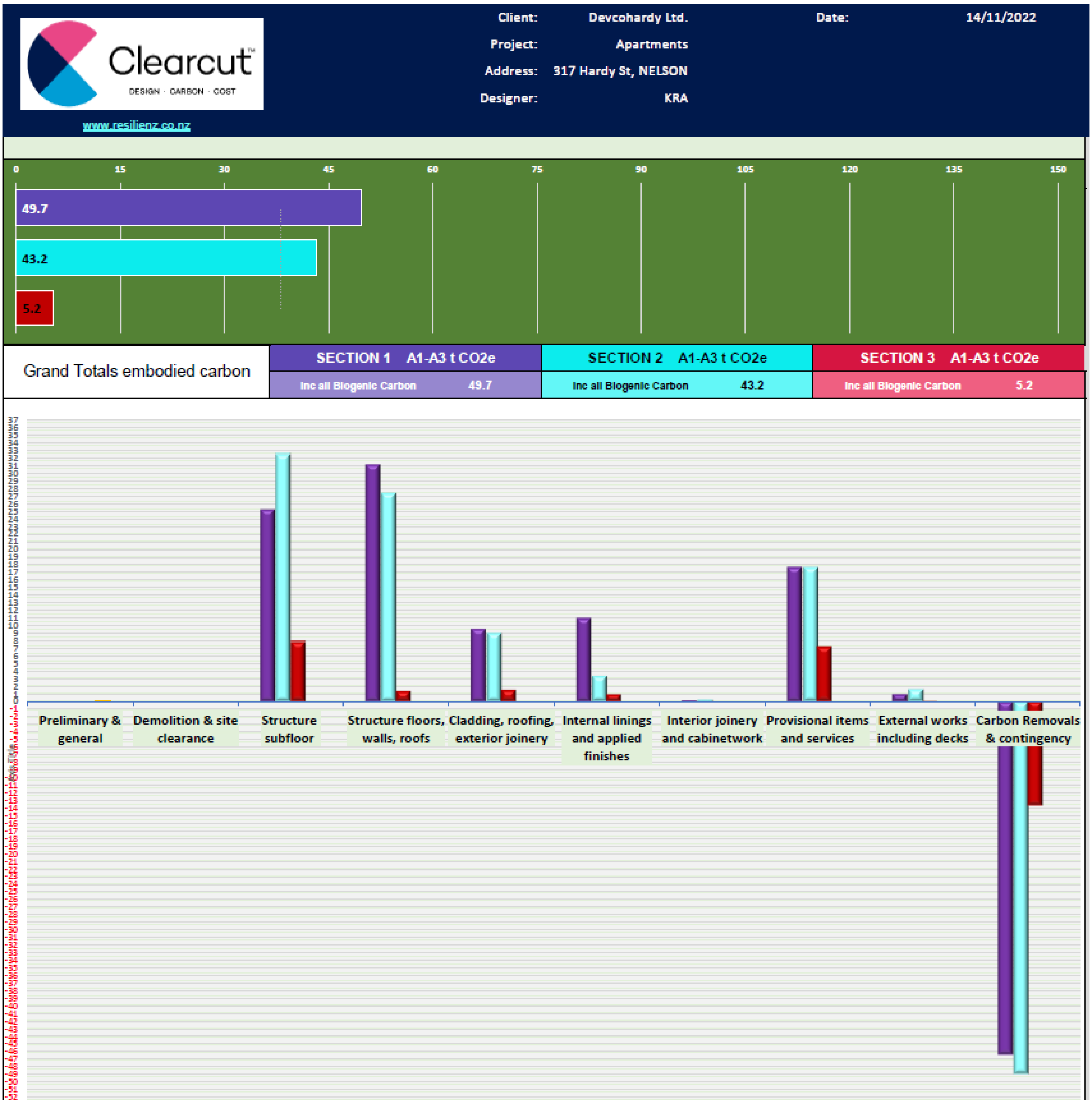


Fig. .7 Graphical comparison with allowance for biogenic carbon

APPENDIX 5 CARBON DATA FOR SPECIFIC PRODUCTS

Red Stag

The EPD supplied for Red Stag is all based on FSC certified timber sources and as such does not include an option for excluding biogenic carbon storage. As a result, the calculations of carbon removals with and without an allowance for biogenic carbon are unchanged with regard to the carbon removals in the CLT panels, which are accounted for the same way both in the main calculation and the alternative one which also shows removals for other timber products.

Nu-Wall

Carbon data supplied by Nu-wall by email ("*Nu-Wall Environmental Statement*" undated, with McKechnie Recycled aluminium "certificate" by Cemars of 1.21 kgCO2e/kg aluminium for "Scope 1 & 2" expired on 30/10/2020) has been taken at face value for A1-A3 CO2e for the raw aluminium ex Taranaki. Allowance has been made for extrusion (0.1 kgCO2e/kg as Hydro Extrusion Nentzing data, 0.1 kgCO2e/kg notional transport to Nu-Wall, and 0.3 kgCO2e/kg for powder coating BRANZ differential between "*Aluminium, primary (powder coated finish, one side 0.08 mm), flat sheet, 0.7mm BM*T" and "*Aluminium, primary (no finish), profile sheet metal, 0.7 BMT*". This yields a total A1-A3 for powder coated Nu-Wall product ex yard at Nu-Wall of 1.26 kgCO2e/kg.

James Hardie

The EPD supplied for James Hardie appears to be exclusively based on Australian data and makes no reference to the New Zealand situation. Given the unknown and potentially large differences in certain aspects of the relevant figures (e.g., transportation and primary energy), BRANZ-sourced data has been used in lieu.

Colorsteel

The value used for Colorsteel is as for the 0.4 mm Maxx product. We note there is only a 2% approximate reduction for Endura, and the areas of product involved are relatively small.

Lift

We were unable to locate relevant carbon data for the specified lift, and so in line with MinEdu recommendations we have selected from the BRANZ CO2NSTRUCT tool and have used the lowest relevant value (even though that is to service more floors than is the case on this project, but for which the BRANZ CO2e content for a lower-rise lift would have been higher).

Terracade

We were unable to locate relevant carbon data and have taken the tile material area density given in the supplied technical manual (6^{th} edition) of 25 kg/m2 and applied it to BRANZ kgCO2e/kg data for ceramic tiles. Fixings etc. have been based on inferred product averages using profile data supplied.