NZGBC
TE KAUNIHERA HANGANGA TAUTAIAO

NZGBC Embodied Carbon Methodology

nzgbc.org.nz

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This document is updated regularly. It can be found at www.nzgbc.org.nz/.

Change Log

Release	Date	Description of changes
v1.0	01/05/2023	Initial version following consultation
v2.0	11/12/2024	Revised version, broadening scope beyond Green Star

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1 INTRODUCTION

1.1 Overview

This document provides a calculation method for embodied carbon and default assumptions for use in New Zealand buildings. Its primary aim is to create greater consistency in the measurement of embodied carbon throughout Aotearoa New Zealand.

The *NZGBC Embodied Carbon Methodology* (the *Methodology*):

- Provides a calculation method for both the start of the building's life cycle (i.e., Upfront Carbon) and the whole of a building's life cycle (i.e., Whole-of-Life Embodied Carbon).
- Provides data that is specific to New Zealand.
- Is primarily aimed at large buildings, such as offices, retail, warehouses, industrial, civic buildings and apartments. While it is not aimed at NZS 3604-scale buildings, such as detached residential houses and townhouses, many elements of this Methodology can still be applied to smaller buildings.
- Aligns with and supports MBIE's Climate Change work programme.
- Aligns with international standards for measurement of embodied carbon emissions, providing small refinements for the New Zealand market where relevant.
- Is the basis for embodied carbon calculations performed under NZGBC's rating tools, including Green Star and Homestar.
- Is open for use by any other organisation or software tool provider.

This document does *not* provide:

- Guidance for environmental indicators other than carbon.
- Guidance for operational energy use or operational water use.
- A how-to guide. For a practical application of this Methodology, please see NZGBC's *Green Star Embodied Carbon Calculator* and *Green Star Embodied Carbon Calculator Guide*.

This document will likely change over time to reflect user feedback and to continue to align with MBIE's Climate Change work programme as it evolves.

1.2 Support and Endorsement

NZGBC is committed to working with the Property and Construction sector to build consensus around the way in which Embodied Carbon is calculated in Aotearoa New Zealand. In support of this we have received the following statement from MBIE:

> *MBIE Building System Performance welcomes the release of the NZGBC Embodied Carbon Methodology. This methodology builds on MBIE's Whole-of-life Embodied Carbon Assessment: Technical Methodology, published in 2022, further supporting consistency in the assessment of embodied carbon in Aotearoa New Zealand. A common approach to assessing embodied carbon of buildings is vital for improving the robustness and credibility of assessment results, so they can be used to inform decisions at all stages of the construction process. MBIE is pleased to support sector-led initiatives that work towards reducing emissions from the building and construction sector in Aotearoa New Zealand.*

The following organizations have also endorsed this methodology. This section will be further updated with support and endorsement from other organisations as and when we received them.

engineering new zealand te ao rangahau

Te Kāhui Whaihanga New Zealand Institute of Architects

1.3 Background

NZGBC consulted with industry in 2021 on the potential need for an embodied carbon methodology and calculator tool for non-residential buildings. Approximately 30 organisations were involved in the consultation, including building product manufacturers, architects, quantity surveyors, engineering firms, construction firms, non-governmental organisations and central government.

An advisory group was established in 2022 and met throughout that year to develop a draft methodology and calculator tool. The advisory group was made up of representatives from Beca, Hawkins, Jasmax, Mott MacDonald, Naylor Love, RDT Pacific, and Warren and Mahoney. This process was facilitated by thinkstep-anz on behalf of NZGBC.

An open consultation on draft documents and an early calculator was held in November 2022. Over 30 responses were received.

NZGBC published the following in May 2023, after addressing the consultation feedback:

- Green Star Embodied Carbon Methodology
- Green Star Embodied Carbon Calculator Guide
- Green Star Embodied Carbon Calculator (based in Microsoft Excel)

This document replaces the *Green Star Embodied Carbon Methodology*, broadening its scope to all buildings in New Zealand. All requirements specific to Green Star have been moved to the *Green Star Embodied Carbon Calculator Guide*. The *Calculator Guide* and *Calculator* implement this *Methodology* and are freely available for anyone to use.

1.4 Design Principles

The consultation in 2021 established the following requirements for the final methodology and associated carbon calculator:

1. Be standards-compliant, specifically:
    a. Follow the modular structure of EN 15978, EN 15804 and ISO 21930.
    b. Follow ISO 14067 for carbon footprinting.
2. Be usable right through the design process, from early concept to practical completion.
3. Lead to consistent and comparable results, by:
    a. Defining which building elements are in scope, and which are out of scope.
    b. Defining the unit for normalisation so that buildings can be compared.
    c. Providing clear calculation methods.
    d. Providing default assumptions.
    e. Providing default data choices, particularly where specific data is not available.
4. Be open and transparent, actively encouraging other organisations and tool providers to contribute to further development of this *Methodology* with the hope of achieving greater standardisation of embodied carbon calculations throughout Aotearoa New Zealand.
5. Be easy to use while still maintaining high completeness for building elements in scope.
6. Draw on public data – sourced from BRANZ, Environmental Product Declarations (EPDs) and Masterspec (once their database is available) – rather than commercial LCI/LCA databases.
7. Align with MBIE's Climate Change work programme, providing additional detail to MBIE's *Whole-of-Life Embodied Carbon Assessment: Technical Methodology* (MBIE, 2022).

8. Encourage suppliers to provide specific data. This is achieved by using conservative emission factors where supplier-specific emission factors are unavailable.

1.5 Reference Standards

This methodology:

- Is based on European standards for building life cycle assessment, EN 15978:2011 (CEN, 2011) and prEN 15978-1:2021 (CEN, 2021), and the international standard for product carbon footprinting, ISO 14067:2018 (ISO 2018). It contains additional guidance specific to upfront carbon and whole-of-life embodied carbon assessments.
- Incorporates content first published by MBIE in the *Whole-of-Life Embodied Carbon Assessment: Technical Methodology* (MBIE, 2022).
- Aims to align with RICS *Whole Life Carbon Assessment (WLCA) for the Built Environment (2nd Edition)* (RICS, 2024). New Zealand-specific deviations from RICS' WLCA Standard are noted in section 8.2.

1.6 Structure of this Document

Within this document, the words 'shall' and 'must' define mandatory items, while the words 'can' and 'may' define optional items.

This document is structured as follows:

2 DEFINITIONS

2.1 Building-related Terms

Warm Shell: The whole substructure, superstructure and building envelope. For commercial buildings: finishes and services are applied to common areas; tenancies are delivered with ceilings, floor coverings and lighting systems, and ducts from air supply and return risers; electrical and hydraulic services are installed above the ceiling from the riser throughout the tenancy areas. For all other buildings: services, floor coverings, wall coverings and ceiling coverings are included throughout.

External Works: This includes external carparks, driveways, hard landscaping and external walls. It also includes land use change across the whole site on which the building is located. It excludes other forms of infrastructure (e.g., water and wastewater infrastructure) and soft landscaping.

Building Material: A single material used in a building. Examples include concrete, steel and timber.

Building Product: Either a single Building Material or an assembly of Building Materials designed to be used in a building. An example is an electrical cable, which consists of one or more cores – itself a material that conducts electricity (copper or aluminium) encased in a material that insulates electricity (e.g., PVC or XLPE) – and then enclosed within a protective jacket (e.g., PVC, XLPE or polyurethane).

Building Element: An assembly of Building Products that together constitute an important part of a building. Building Elements may be functional (e.g., a roof, wall, floor or foundation), aesthetic (e.g., a decorative façade) or designed for occupant comfort (e.g., acoustic wall/ceiling lining). Building products may be assembled into a building element either on the building site (on-site fabrication) or at a separate facility (off-site fabrication).

2.2 Area Measurements

Gross Floor Area (GFA): The total floor area inside the building envelope, measured to the outside face of external load-bearing walls. The definition of the New Zealand Institute of Quantity Surveyors (NZIQS, 2018, p. 1) is applied, as quoted below:

> *The gross floor area is measured over all the external walls of the building, over partitions, columns, internal structural or party walls, stair wells, lift wells, ducts, enclosed roof top structures and basement service areas. All exposed areas such as balconies, terraces, open floor areas and the like are excluded.*
>
> *Generally, projections beyond the outer face of the external walls of a building such as projecting columns, floor slabs, beams, sunshades and the like shall be excluded from the calculation of gross floor areas.*
>
> *Where the outer face of the external walls of a building are not regular vertical surfaces, the overall measurements shall be taken at floor levels and a note made of the vertical profile of the wall line.*
>
> *Where mezzanine floors occur within a structure the gross floor area of this mezzanine shall be added to all other complete floor areas and become a constituent part of the gross area.*

Rentable Area: The total floor area under the control of the tenant, including space which may be unusable. Rentable Area is generally measured to the internal face of perimeter walls and windows. It includes unusable floor area (e.g., columns and internal partition walls) and amenities (kitchens, toilets, lift lobbies, etc.), so long as these areas are under the tenant's direct control. All common areas are excluded from this measure, as are the thicknesses of external walls and intertenancy walls. For a full definition, please see the *Guide for the Measurement of Rentable Areas* (PCNZ & PI, 2023).

Net Lettable Area (NLA): See Rentable Area.

Gross Internal Area (GIA): The total floor area inside the building envelope, measured to the inside face of external walls.

External Works Area (EWA): The total surface area of external works captured within the scope of the assessment. It includes areas on the site covered by pavements, hardstands, covered walkways and hard landscaping. It excludes all areas that are not covered by hard surfaces (e.g., grassed areas and gardens), the surface area occupied by the building itself, and all areas that are not within the site boundary. Only new construction should be captured in the measured area. The area occupied by existing hard landscaping on the site should not be included.

2.3 Stages of a Building's Life Cycle

European standards (EN 15978:2011, prEN 15978-1:2021 and EN 15804+A2:2019) and international standards (ISO 21931-1:2022 and ISO 21930:2017) divide the life cycle of a building into modules, as shown in Figure 1. Only those modules relevant to Whole-of-Life Embodied Carbon are shown.

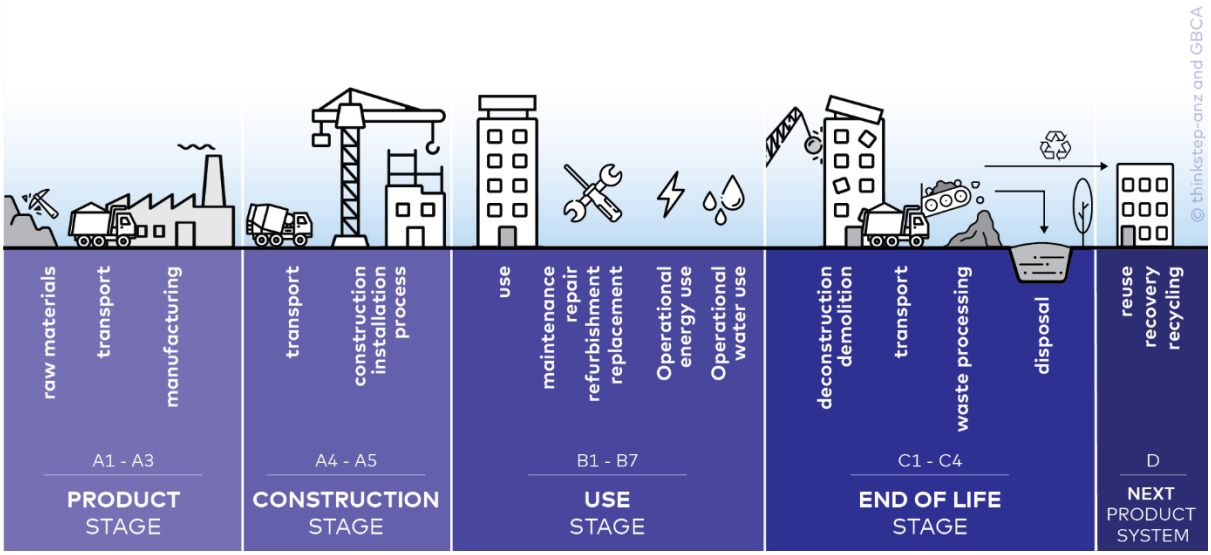

Figure 1: Stages of a building's life cycle (as per EN 15978)

Stage A: The production of materials (modules A1-A3), transport of materials to the construction site (module A4) and construction of the building (module A5).

Stage B: Building maintenance and renovation (modules B1-B5), operational energy use (module B6) and operational water use (module B7). Newer standards introduce optional module B8 for building-related activities by users not covered in modules B6 or B7, e.g., transportation of people to work.

Stage C: The end of a building's life, including demolition (module C1), transport of waste materials off-site for processing (module C2), waste material processing for recycling (module C3) and disposal of those materials that cannot be recycled (module C4).

Module D: Benefits and loads beyond the building's life cycle. More specifically, Module D includes credits for avoided production of primary materials or avoided generation of energy. Module D can also include exported utilities from the building, which is defined as Module D2 by newer standards.

2.4 Carbon-related Terms

Carbon Emissions: Emissions of greenhouse gas(es) to the atmosphere. Examples include combustion of fossil fuels and greenhouse gases released from chemical reactions.

Carbon Footprint. The sum of carbon emissions and carbon removals over a full or partial product life cycle. Equivalent to GWP-total (see below).

Carbon Removals: Removals of greenhouse gas(es) from the atmosphere. Examples include removal of CO_2 from the air by plants during photosynthesis and by cement-containing materials during carbonation.

Carbon Storage: The storage of carbon captured from the atmosphere for a period of time, resulting in the temporary reduction in the concentration of greenhouse gases in the atmosphere.

Emission Factor: The Carbon Footprint of a product related to a declared unit, e.g., cubic metres.

2.5 Types of Carbon Footprint

Upfront Carbon: Carbon emissions caused by the production of materials, transport of materials to the construction site and construction of the building(s), prior to the building(s) being occupied (modules A1-A5). Only gross emissions are declared, excluding removals (see GWP-stored).

Use Stage Embodied Carbon: Carbon emissions associated with materials and processes needed to maintain the building during use such as for maintenance, repair or refurbishments (modules B1-B5).

Operational Carbon: The carbon emissions associated with energy used to operate the building (module B6) and operational water use (module B7).

End-of-Life Carbon: The carbon emissions associated with deconstruction/demolition, transport from site, waste processing and disposal phases of a building's life cycle which occur after its use (modules C1-C4).

Whole-of-Life Embodied Carbon: Carbon emissions associated with materials and construction processes throughout the whole lifecycle of a building, excluding operational energy use and operational water use (modules B6 and B7, respectively). This includes Upfront Carbon, Use Stage Embodied Carbon, and End-of-Life Carbon, but not Operational Carbon. Module D (benefits and loads beyond the system boundary) is excluded from the main calculation and must be reported separately.

2.6 Calculation of Carbon Footprint

Global Warming Potential (GWP): The heat absorbed by greenhouse gases in the atmosphere, measured as carbon dioxide equivalent. Carbon dioxide equivalent (CO_2e) is calculated using the Intergovernmental Panel on Climate Change's (IPCC's) Global Warming Potential indicator, typically using a 100-year time horizon (GWP100), with the latest version being from the IPCC's Sixth Assessment Report (AR6).

GWP-fossil (GWP-f or GWPF): Net of:

- Carbon emissions from non-biogenic sources, e.g., combustion of fossil fuels and emissions from chemical processes (reported as a positive number), and
- Carbon removals from non-biogenic sources, e.g., through carbonation of cement (a negative number).

GWP-biogenic (GWP-b or GWPB): Net of:

- Carbon emissions from degradation of biomass via incineration, landfill, composting, or an accounting adjustment (reported as a positive number), and
- Carbon removals through formation of biomass during photosynthesis (a negative number).

GWP-luluc (GWP-l, GWPL, GWP-LULUC or GWPLULUC): Carbon emissions and removals from Land Use and Land Use Change (LULUC) describes changes in carbon stocks, such as soil carbon. EN 15804+A2:2019 does not allow negative numbers (e.g., net sequestration of carbon in the soil) and instead requires these to be set to zero.

GWP-stored (GWP-s or GWPS): The GWP avoided by removals of CO_2 into biomass (CEN, 2019, section C.2.4). GWP-stored should be a negative number, as it is a removal of CO_2 from the atmosphere. In EPDs following EN 15804+A2, there will be a statement of "Biogenic carbon content in product". To convert this to GWP-stored, multiply by -44/12 to convert stored elemental carbon to equivalent carbon dioxide.

GWP-total: The total carbon footprint is calculated differently for Upfront Carbon and Whole-of-Life Embodied Carbon. For Upfront Carbon, GWP-stored must be excluded and declared separately following ISO 14067 because the calculation is a partial carbon footprint. For Whole-of-Life Embodied Carbon, GWP-stored must be included because end-of-life emissions are included, i.e., the system boundary is complete.

- Upfront Carbon = GWP-fossil + GWP-luluc + (GWP-biogenic-GWP-stored).
- Whole-of-Life Embodied Carbon = GWP-fossil + GWP-luluc + GWP-biogenic

Long-term Carbon Storage: Long-term storage of carbon previously removed from the atmosphere into the fabric of the building. Long-term is defined as a forecasted period of at least 50 years. For long-term carbon storage arising from wood sources, the wood is required to be certified by either Forest Stewardship Council (FSC), Programme for the Endorsement of Forest Certification (PEFC), or a PEFC-endorsed system.

2.7 Environmental Impacts of Products

Carbon Footprint of Product (CFP): A method for the quantitative evaluation of the carbon footprint of a product or service system through its life cycle. Standardised by ISO 14067:2018.

Environmental Product Declaration (EPD): Document containing data on the potential environmental impacts of a product or service calculated using LCA following a set of Product Category Rules. An EPD must be independently verified as compliant with ISO 14025:2006 and a relevant PCR and published by an EPD programme operator.

Life Cycle Assessment (LCA): A method for the quantitative evaluation of the potential environmental impacts of a product or service system through its life cycle. Standardised by ISO 14040:2006 and ISO 14044:2006.

Product Category Rules (PCR): A specific set of rules for completing an LCA of a particular product category and publishing an EPD. Only EPDs conducted according to the same PCR are comparable. The two main PCR documents for building products are EN 15804 and ISO 21930.

3 SCOPE

3.1 Building Types

This *Methodology* applies to any type of building. While originally developed for non-residential buildings, it can also now be applied to residential buildings.

3.2 Geographic Scope

This *Methodology* is not country specific; however, all default values and some definitions are specific to Aotearoa New Zealand.

3.3 Life Cycle Stages

The following life cycle modules shall be included for **Upfront Carbon**:

- **Modules A1-A3:** Building product manufacture
- **Module A4:** Transport of building products to site
- **Module A5:** Construction of the building and disposal of construction waste.

The following life cycle modules shall be included for **Whole-of-Life Embodied Carbon**:

- **Modules A1-A5:** Upfront Carbon (as above)
- **Modules B1-B5:** Use stage embodied carbon
- **Modules C1-C4:** End-of-life embodied carbon

For Whole-of-Life Embodied Carbon, **Module D** (benefits and loads beyond the system boundary) must also be calculated and reported separately.

These modules come from EN 15978:2011 (CEN, 2011) and EN 15804:2012+A2:2019 (CEN 2019).

The following modules are excluded from embodied carbon calculations under this *Methodology*, but may be reported separately:

- **Module A0:** Pre-construction activities, such as land acquisition and building design.
- **Modules B6**-**B7:** Operational energy and operational water.

  Note: These modules are excluded because they are not part of embodied carbon, not because they are unimportant.
- **Module B8**: Users' activities not covered in B1-B7. It includes transport of people to and from the building, consumables purchased for the building's occupants (e.g., office paper), and furniture that is not permanently installed.

3.4 Declared Unit

The declared unit for both Upfront Carbon and Whole-of-Life Embodied Carbon is **kg CO_2e/m^2 GFA**, which is kilograms of carbon dioxide equivalent per square metre of Gross Floor Area (GFA).

The project shall declare its GFA and may also report on Upfront Carbon and Whole-of-Life Embodied Carbon at a building-wide level, using either kg CO_2e or tonne CO_2e as the functional unit.

3.5 Building Elements

The building elements included within the carbon footprint shall:

- **Be part of the warm shell.** The warm shell includes the whole substructure, superstructure and building envelope. NZGBC defines warm shell as: “Finishes and services are applied to common areas. Tenancies are delivered with ceilings, floor coverings and lighting systems; and ducts from air supply and return risers, electrical and hydraulic services are installed above the ceiling from the riser throughout the tenancy areas.” (NZGBC, 2022a, p. 7)
- **Be permanent.** This includes all building elements designed to be a permanent part of the building, including permanent walls (whether structural or non-structural) and fire doors. For commercial buildings, it excludes non-permanent walls, doors or kitchenettes installed as part of a tenant fit-out. Temporary installations required during site preparation or construction must be included where they are single use.
- **Fall inside the dripline** of the building(s) under analysis. The dripline is the furthest outward projection of the building, typically the outside edge of the building’s roof. For the sake of clarity, include anything mechanically attached to the external façade or roof of the building if it is intended for that building alone. Include external shading systems, awnings and canopies. Exclude covered walkways between buildings and external patios, both of which are part of external works. Also exclude external sections of slabs/hardstands covered by external awnings/canopies if they are not part of the building’s GFA, putting them with external works.
- **Include ancillary buildings and external systems only if they provide core parts of the building services** required to deliver a warm shell. Examples include external HVAC equipment, water tanks and sprinkler storage tanks.

The following must also be reported, but must be declared separately:

- **External works.** This includes external carparks, driveways, hardstands and other hard landscaping. It includes ancillary buildings, retaining walls, and covered walkways between buildings. It also includes land use change across the whole site (e.g., if a forest is cut down and replaced with a grassed area). It excludes site infrastructure (freshwater, stormwater, sewerage, electrical, etc.), fences (as long as they are non-structural) and all soft landscaping.

The following may also be reported, but must be declared separately:

- **All permanently installed building elements up until the point the building is occupied by the first tenant.** This includes items that may not last the life of the building, such as partition walls, kitchenettes, etc. It excludes non-permanent fittings and furniture.
- **Fittings and furniture.**

A list of building elements that must be included within the carbon footprint is provided in Table 1 at Level 1 of Masterspec’s Co-ordinated Building Information (CBI) classification system. A more detailed list of inclusions and exclusions is included in Appendix A: Detailed Scope of Building Elements (page 36). In cases where it is not clear if a certain building element should be included or excluded from the core carbon footprint calculation, these elements should be included as a conservative approach. Any deviations from this conservative approach must be justified.

Table 1: Building elements in scope of assessment

Masterspec CBI Level 1	Included in scope?
1 General	**No**
2 Site	**Yes**
3 Structure	**Yes**
4 Enclosure	**Yes**
5 Interior	**Partial** (refer to 'Appendix A: Detailed Scope of Building Elements')
6 Finish	**Partial** (more detail may be reported separately)
7 Services	**Yes** (see default values in Table 11 on page 53)
8 External	**No** (but **must be reported separately**)

3.6 System Boundary

The system boundary follows EN 15978:2011 (CEN, 2011) and EN 15804:2012+A2:2019 (CEN 2019).

The following activities are **included**:

- Manufacture of building products.
- Transport of building products, formwork and construction machinery to/from site.
- Land use change (for greenfield sites only).
- On-site construction activities, such as operation of cranes and excavators.
- On-site commissioning activities prior to building occupation, e.g., testing large diesel generator sets (*note:* this is only relevant to a small number of building types).
- The manufacture, transport and disposal of any wasted building products.
- The manufacture and transport of replacement building products and disposal of the old building products they replace during the building's life.
- Demolition and disposal of the building at the end of its useful life.

The following activities are **excluded** from the system boundary:

- Manufacture of machinery and other capital goods (unless these are likely to be material to the results), such as:
    - Manufacture of earthmoving equipment and cranes used for construction.
    - Manufacture of trucks used for transportation.
    - Manufacture of machinery used to manufacture building products.
    - (In all cases, emissions from operating machinery and vehicles must be included.)
- Transport of staff to and from the construction site.
- Electricity used off-site for professional services.

  Note: The exclusions above are aligned with a process-based life cycle assessment approach, e.g., *PCR 2019:14 Construction Products* from the International EPD System (IEPDS 2024, section 4.3.2) as used within EPD Australasia.

The following activities are **excluded** because they relate to operational carbon, not embodied carbon:

- Operational energy and water use.
- Consumables linked to the building's users rather than the building itself.

Please note that all lists above are intended to be illustrative and are not exhaustive.

3.7 **Cut-off Rules**

This *Methodology* follows EN 15978:2011 and EN 15804:2012+A1:2019. These standards require that data which are available must be included in the study. Where there are data gaps, up to 5% of each module (A1-A3, A4-A5, B1-B5, C1-C4 and D) may be excluded, as measured by mass or energy.

In practice this means that smaller items can be excluded from the study, unless there is reason to believe that this 5% threshold would be crossed. These smaller items include but are not limited to:

- Individual screws, nails and other fasteners that are not part of delivered building products.
- Glues, sealants, caulking compounds and filling compounds used in small quantities throughout the building and not part of delivered building products. (Sealants used in membrane roofs applied on-site must be included in the study.)
- Doorknobs, door hinges, fasteners for openable windows, light switches, power sockets and other minor fittings.
- Skirtings, architraves and flashings.

Module B2 (building maintenance, including washing and repainting) can also be excluded, unless there is a reason to believe the 5% threshold would be crossed.

4 CALCULATION METHOD

4.1 Carbon Footprint

All carbon footprint calculations shall be performed using Global Warming Potential over a 100-year time horizon (GWP100) in line with ISO 14067:2018 (ISO, 2018). The most recent characterisation factors from the Intergovernmental Panel on Climate Change (IPCC) should be used where possible. At the time of writing, the IPCC Sixth Assessment Report (AR6) contains the most recent factors (IPCC, 2021). However, GWP100 factors following older assessment reports and following EN 15804 may also be used.

The total carbon footprint – **GWP-total** – is the sum of three constituent parts:

- **GWP-fossil:** Carbon footprint arising from fossil sources.
- **GWP-biogenic:** Carbon footprint arising from biogenic sources.
- **GWP-luluc:** Carbon footprint due to land use and land use change.

The components of GWP above (fossil, biogenic and LULUC) derive from EN 15804+A2. An additional indicator, GWP-stored, is introduced here to report storage of carbon in building products.

GWP-stored is the GWP avoided by removals of CO_2 into biomass from all sources except native forests (CEN, 2019, section C.2.4). GWP-stored should be a negative number, as it is a removal of CO_2 from the atmosphere. In EPDs following EN 15804+A2, there will be a statement of "Biogenic carbon content in product". To convert this to GWP-stored, multiply by -44/12 to convert stored elemental carbon to equivalent carbon dioxide.

Results must be calculated following EN 15804+A2. Secondary results following EN 15804+A1 are also allowed.

4.2 Upfront Carbon

Upfront Carbon shall be calculated as the sum of carbon emissions from (see Figure 2):

- Modules A1-A3: Manufacture of building products used in the building.
- Module A4: Transport of building products to site.
- Module A5: Site preparation works and construction of the building. This includes:
    - Land use change (for greenfield sites only).
    - The use of energy in machinery on-site for site preparation (e.g., site clearing and levelling) and construction (e.g., excavation for the foundation and erection of the building). If a previous building was present on the site, only include the work after the previous building(s) was (were) demolished and the materials for disposal have been put into skips or stockpiles for collection.
    - Production, transport and end-of-life treatment of materials that become construction waste.
    - Commissioning of the building, up to building occupation. This includes the energy used to test building services, e.g., backup diesel generator sets.

Upfront Carbon represents the gross carbon footprint up to practical completion of the building under this *Methodology*. As such, the following must be excluded from the calculation:

- Carbon offsets.
- Stored biogenic carbon. This must be reported separately as GWP-stored (see section 4.2.1).

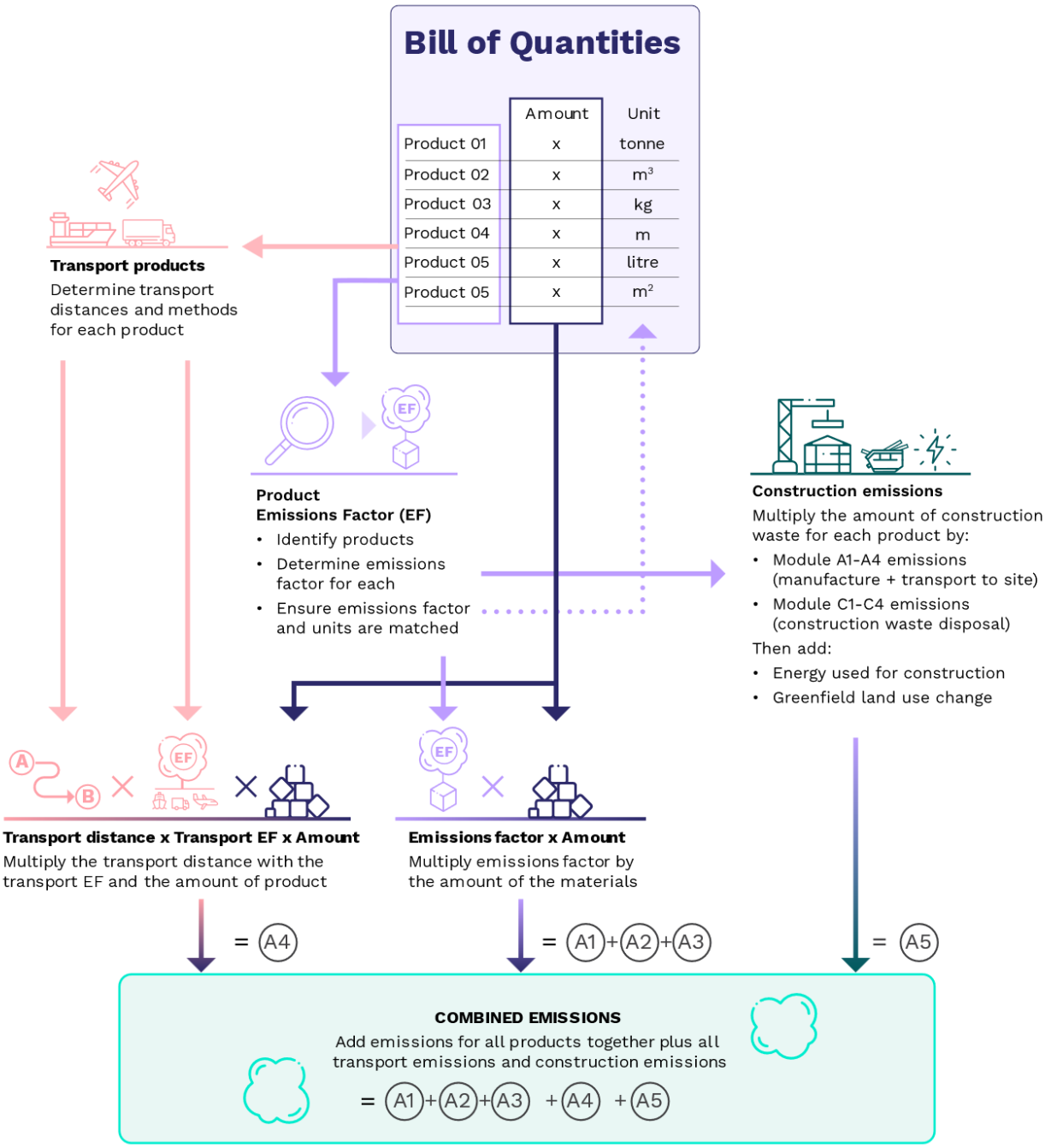

Figure 2: Calculating Upfront Carbon

4.2.1 Removing GWP-stored for Bio-based Products

Depending on the standard followed, GWP-total and GWP-biogenic may either include or exclude GWP-stored for products that contain stored biogenic carbon. This *Methodology* requires GWP-stored to be excluded from Upfront Carbon and reported separately. As such, GWP-stored must be manually removed if it is included.

Standards that require GWP-stored to be included are:

- EPDs produced to EN 15804+A2:2019
- EPDs produced to EN 15804+A1:2013 and EN 16485:2014
- CFPs produced to ISO 14067:2018.

For other EPDs, LCAs and CFPs, GWP-stored needs to be assessed on a case-by-case basis. Where it is not explicitly stated in the study, a large negative carbon footprint (i.e., carbon removal) from cradle-to-gate and a large positive carbon footprint (i.e., carbon emission) at end-of-life normally indicates that GWP-stored is included.

Where GWP-stored is included in GWP-total and GWP-biogenic:

- GWP-total (Upfront Carbon) = GWP-total (as reported) - GWP-stored
- GWP-biogenic (Upfront Carbon) = GWP-biogenic (as reported) - GWP-stored

Where the GWP-stored is unknown, it can be calculated as (1 - water content) * (biogenic carbon content of dry matter) * (-44/12). Commonly, the biogenic carbon content of absolutely dry wood is approximately 50%. Kiln-dried wood and air-dry paper typically have a water content of approximately 10%. As such, the carbon stored in a wood or paper product is typically approximately -1.65 kg CO_2e/kg = (1-0.1)*(0.5)*(-44/12). This value will vary where fossil-derived resins are used in addition to wood (e.g., in engineered wood products) and products with different water content.

4.3 Whole-of-Life Embodied Carbon

Whole-of-Life Embodied Carbon shall be calculated as the sum of carbon emissions from:

- Modules A1-A5: Upfront Carbon, as calculated in section 4.2 but including GWP-stored.
- Module B1: Direct emissions from the building. Module B1 includes:
    - Fugitive emissions from refrigerants[1] and blowing agents in foams.
    - Carbon removals from carbonation of concrete (where this can be shown to be significant).
    - Land use change emissions (for greenfield sites only).
- Module B2: Maintenance of the building. This includes washing, repainting and repointing of mortar. This module can be excluded as below the cut-off rules unless there is a good reason to believe it will be significant to the full life cycle results.
- Module B3: Repair of building products. This module can be excluded as below the cut-off rules unless there is a good reason to believe it will be significant to the full life cycle results.
- Modules B4 and B5: Replacement of building products and renovation of the building. This includes replacement of some or all building elements from the Upfront Carbon assessment. The carbon footprint of the individual building elements (including transport to site) must be

[1] Version 1.0 of this Methodology excluded emissions from refrigerants, arguing that they were an operational emission and therefore not part of Whole-of-Life Embodied Carbon. This approach was chosen to align with prEN 15978-1:2021 section 13, which classifies B1 as “operation related” rather than “material related”, and PAS 2080:2023, which distinguishes “capital carbon” and “operational carbon”. However, other documents and standards often classify module B1 as part of embodied carbon, including MBIE’s *Technical Methodology* (MBIE, 2022) and RICS’ *WLCA Standard* (2nd Ed.) (RICS, 2024). Given that there is not yet consensus on this point, this Methodology includes refrigerant emissions in embodied carbon to align with MBIE but requires separate reporting of module B1 to enable embodied carbon to be recalculated in future if definitions change.

calculated in accordance with EN 15978:2011 and EN 15804:2012+A2:2019. Disposal of the old building elements shall be calculated as for Modules C1 to C4 below.

- Modules C1 to C4: Demolition of the building, transport of building products to waste treatment and the waste treatment process (recycling, landfill, composting or incineration).

Module D (avoided impacts from recovery of building elements) shall not be included in the core Whole-of-Life Embodied Carbon calculation but must instead be reported separately alongside Whole-of-Life Embodied Carbon.

As with Upfront Carbon, carbon offsets must be excluded.

4.4 Buildings Within a Precinct

Where a building shares elements with other buildings as part of a precinct, these shared elements must be apportioned (allocated) to the building under study in a way which reflects their use of these shared elements. Floor area – whether measured as Gross Floor Area (GFA), Rentable Area / Net Lettable Area (NLA), or Gross Internal Area (GIA) – should be used as the default allocation method. Where Heating, Ventilation and Air Conditioning (HVAC) services are to be allocated, the internal volume of buildings supplied by these shared HVAC services may be used instead. Alternative methods may be used but shall be justified in a report accompanying the results.

Example:

- A retail store shares services (HVAC, waste disposal, toilets, car parks) with the wider retail precinct that it is a part of.
- The retail store has total rental floor area of 1,000 m^2. It is part of a retail precinct with 100,000 m^2 of total rentable floor area and 140,000 m^2 total GFA.
- The retail store should be allocated 1% (=1,000/100,000) of the shared services of the precinct. Rentable area is preferred to GFA in this context as otherwise the common areas of the precinct would receive some of the burden of the retail precinct despite these not being let by any tenant.

5 DATA REQUIRED PER LIFE CYCLE MODULE

5.1 Building Products (Modules A1-A3)

Two types of data are needed to complete the carbon footprint:

1. **Building material quantities:** The quantities of materials used in the building itself. (Within carbon footprinting and life cycle assessment, these quantities are often known as the activity data.)
2. **Emissions factors:** The carbon footprint per unit of material, energy or waste.

Building quantities used in the final carbon footprint calculation shall be based on **actual quantities used in the building**, as can be validated from invoices and/or a schedule (such as a Schedule of Quantities / Bill of Quantities) that has been updated during or following construction to reflect the actual quantities and specific materials/products used in the finished building.

Building material quantities for in-progress carbon footprint calculations (including in all design stages) will need to be based on other quantity sources as noted in section 6.2.

For guidance regarding the selection of appropriate data, refer to section 6.

5.2 Transport to Site (Module A4)

The emissions of transporting building products, formwork and machinery to/from site (and any empty return trip) should be calculated by multiplying the total mass from a given location by the corresponding emission factors in Table 12 (page 57). Alternative emission factors from an LCA database may also be used if this is more convenient due to the low environmental relevance of module A4 in most building LCA studies. If multiple modes of transport are used (e.g., truck and ship), both should be calculated and the emissions summed together. Emissions do not need to be calculated product-by-product – what is important is the total tonne-kilometres of transport for each mode of transport.

Example:

- 2,000 kg of scaffolding is moved to the construction site from a warehouse at the start of the project. It remains on-site for the duration of the project, after which it is moved back to the same warehouse. The distance from the warehouse to the site is 30 km. The truck travels across an urban area in both directions.
- GWP-Total = (30 km + 30 km) * (2,000 kg / 1,000 kg/t) * (0.390 kg CO_2e/tkm)
- GWP-Total = 46.8 kg CO_2e

5.3 Construction (Module A5)

Module A5 includes carbon emissions from several sources:

- Land use change (greenfield sites only)
- Construction waste, including manufacture, transport and disposal of the waste
- On-site construction activities
- Commissioning of the building prior to building occupation.

5.3.1 Land Use Change

Land use change is not relevant for brownfield sites because the land use type remains built land (termed ‘settlement’ within national greenhouse gas accounting).

Where construction takes place on a greenfield site, the effect of land use change (GWP-luluc) must be considered. Only the land area that is transformed needs to be included in the calculation. If some of the land on the property remains in its original form, this should not be included.

Only land use change that occurs within the building's dripline (see section 3.5 on page 14) is assigned to the building itself. Other land use change that occurs on the rest of the site shall be attributed to External Works.

The default emission factors in Table 15 (page 60) shall be used wherever project specific data is not available.

5.3.2 Construction Waste

Emissions from construction waste must be included. These emissions include:

- Manufacturing construction products that are wasted on-site (equivalent to Modules A1-A3)
- Transport of these wasted construction products to site (equivalent to Module A4)
- Disposal of these wasted construction products (similar to Modules C2-C4).

Default scrap rates and end-of-life fates per material type are included in Table 20 (page 65). These values shall be used wherever project specific data is not available. Emission factors for end-of-life treatment can be found in Appendix H: Default Emission Factors for Waste Treatment (page 70).

5.3.3 On-site Construction Activities

On-site construction impacts, including site preparation, excavation and erection of the building. Demolition activities are excluded as they are considered part of the previous building's life cycle.

Project teams shall use the following default emission factors unless they have on-site energy use data that covers all stages of the project (land clearing, levelling, excavation, erecting the building, etc.) from all contractors and subcontractors.

- 15 kg CO_2e/m^2 GFA for NZS 3604-scale buildings (detached residential and townhouses).
- 25 kg CO_2e/m^2 GFA for all non-residential buildings and apartment buildings.[2]

If a project team does collect complete on-site energy use data, the relevant emissions factors for the use of energy are shown in Table 19 (page 64).

5.3.4 Commissioning of the Building

Commissioning the building involves testing the core building services.

Commissioning is negligible for most building types and should be excluded in most cases. It can be excluded for buildings that do not have backup generators, large exhaust fans and other forms of energy-intensive equipment that must be tested extensively prior to the building being occupied

[2] RICS (2024) specifies a default emission factor of 40 kg CO_2e/m^2 GIA. The value of 25 kg CO_2e/m^2 GFA comes from RICS original consultation draft for WLCA (2nd Ed.) and was sense-checked with industry in New Zealand prior to launching the original version of this Methodology in 2023. The lower value is considered appropriate in New Zealand due to (i) much smaller basements in high-rise buildings – and therefore much less excavation – than comparable countries, and (ii) New Zealand's relatively renewable electricity mix used in tower cranes and other electrical equipment. The only significant public dataset available for building construction in Australasia comes from Infrastructure Australia (2024) which found values between 16 and 75 kg CO_2e/m^2 GFA (median 32 kg CO_2e/m^2 GFA) across ~30 different building types; however, these values include equipment energy use across the entire site, which can potentially be large for some building types, such as new schools.

Commissioning may be relevant to data centres, hospitals, prisons, large civic buildings and a handful of other building types. These buildings typically have site-wide backup diesel generators and all services must typically be tested extensively in case of a power failure during operation.

Default values:

- 0 kg CO_2e/m^2 GFA for all residential buildings (detached, townhouses and apartments) and most other buildings that don't meet the criteria above (e.g., most offices, retail, industrial, warehouses, aged care and schools).
- 35 kg CO_2e/m^2 (average) and 60 kg CO_2e/m^2 (conservative) for the small number of commercial, industrial and civic buildings that have facility-wide backup diesel generator sets. This data is based on Infrastructure Australia (2024).

Where commissioning occurs after practical completion but before the building is occupied, it should still be accounted for in Module A5 and as part of Upfront Carbon.

5.4 Direct Emissions (Module B1)

Module B1 (direct emissions from the building) includes:

- Leakage of refrigerants from HVAC systems during the building's operational life.
- Any carbon emitted from building components during the life of the building, e.g., release of greenhouse gases from HFC blown insulation.
- Any ongoing changes to soil carbon following land use change.
- Carbonation of concrete during the building's life (as a carbon removal).

For leakage of refrigerants, please use either:

- NZGBC's Refrigerant Impacts Calculator, which calculates refrigerant carbon footprint based on refrigerant type, capacity and leakage rates from ASHRAE (NZGBC, 2022b).
- CIBSE TM65ANZ (CIBSE, 2022).

For land use change, default emission factors are included in Table 16 (page 61). These values shall be used wherever project specific data is not available.

5.5 Maintenance (Module B2)

Module B2 includes:

- Washing the building
- Repainting
- Repointing mortar.

Module B2 can be assumed to be under the cut-off rules and therefore excluded from the study, unless there is a good reason to assume that it should be included.

5.6 Repair (Module B3)

Repair includes:

- Fixing an installed building product or its parts
- Replacement of broken components/parts within a building element
- Preventative action taken to preserve the functional or aesthetic properties of an installed building product or its parts (without replacement).

Module B3 can be assumed to be under the cut-off rules and therefore excluded from the study, unless there is a good reason to assume that it should be included.

5.7 Replacement and Renovation (Modules B4 and B5)

A 50-year building life must be assumed as the base case for all of Whole-of-Life Embodied Carbon calculations. This follows MBIE (2022) and aligns with section 113 of the Building Act 2004. Additional scenarios may be reported to allow comparison of buildings with long-lived elements.

All reasonably foreseeable replacement and renovation over the building's life must be included. All emissions shall be modelled using today's emission factors without discounting. (Given that buildings products will likely decarbonise over time, this means that reported emissions for Module B4 and Module B5 likely represent a worst-case approach and may be overly conservative.)

Module B4 and Module B5 include:

- Manufacture of replacement building products (modelled as per section 5.1).
- Transport of building products to site (modelled as per section 5.2).
- Disposal of the product being removed from the building (modelled as per section 5.3.2).

Modules B4 and B5 may be combined as a single number in reporting, as both modules report similar impacts and it can be difficult to separate the two modules in practice. Focus should be given to replacement of significant items within the building (by mass and/or dollar value). Replacement of smaller items are likely to fall below the cut-off rules, unless these smaller items collectively contribute to a large share of the building's mass over its full life cycle.

Default replacement cycles per building product group (excluding services) are included in Table 21 (page 67). Default emission factors for services are included in Table 11 (page 53). These values shall be used wherever project specific data is not available. Emission factors for end-of-life treatment can be found in Appendix H: Default Emission Factors for Waste Treatment (page 70).

5.8 Building End-of-Life (Modules C1 to C4 and D)

Appendix H: Default Emission Factors for Waste Treatment (page 70) provides emission factors for demolition (Module C1) different end-of-life pathways (recycling, reuse, energy recovery and landfill) for different material types. A summary of how to use the data is included in the appendix itself. Default end-of-life fates per building product group are included in Table 21 (page 67). These emission factors and end-of-life fates shall be used wherever project specific data is not available.

6 SELECTING DATA

6.1 Types of Data Needed

Two types of data are needed to complete a carbon footprint of a building project:

1. **Building quantities:** The quantities of materials used in the building itself. Within carbon footprinting, these quantities are often known as the activity data.
2. **Emissions factors:** The carbon footprint per unit of material, energy or waste. Appendix B: Generic Emission Factors for Product Manufacture and BRANZ's CO_2NSTRUCT Database are the core databases for use in the *NZGBC Embodied Carbon Methodology*. Once available, Masterspec's database will also become a core database.

6.2 Building Quantities

The following preference hierarchy must be applied to select building quantities, as per MBIE's *Technical Methodology* (MBIE, 2022):

- **As-built information:** As-built information is the highest quality level. It applies to information gathered or validated after construction. It must be able to be validated against verifiable documents, such as invoices from building product suppliers and contractors.
- **Schedule information:** A Schedule of Quantities (SoQ), Bill of Quantities (BoQ) or cost plan is a full schedule of material quantities prepared by a costing specialist such as a quantity surveyor or an estimator within a construction firm.
- **BIM take-off:** Data from Building Information Modelling (BIM) is assigned average data quality. BIM can yield both highly accurate and less accurate material quantities depending on how consistently building elements have been coded or shaped throughout the building model at each stage of the project.
- **Estimate:** Any estimate must be specific to the project. The estimate can be made by any relevant building professional and should be informed by calculation of quantities from relevant drawings or sketches of the relevant building design systems/elements under consideration.
- **Benchmark building:** The lowest form of data quality is the use of data from a different building – or set of buildings – and scaled to represent the project (e.g., scaled by m^2).

Post-construction embodied carbon assessments should be based on "as-built information" and "schedule information" to the greatest extent possible. When an SoQ/BoQ from detailed design is used for an as-built embodied carbon assessment, variations to major building elements must be tracked during construction. The "estimate" and "benchmark building" data categories are suitable for early design stages.

6.3 Emission Factors

Table 2 defines a data quality hierarchy for selecting emission factors. This hierarchy must be applied when selecting emission factors for building products used during construction (Modules A1-A3), that are wasted during construction (Module A5) and that are used for maintenance, repair, replacement and refurbishment (Modules B2-B5). Default emission factors for other life cycle stages can be found in the appendices to this document.

The highest quality emission factor available for a given building product must always be used. Where an emission factor at the highest quality level is not available for your chosen building product, continue moving through Table 2 from top to bottom until an emission factor is identified.

The list below provides a step-by-step approach to apply Table 2. This step-by-step approach must be used when selecting emission factors for building products to comply with this *Methodology*. Please start at the top of the list and move down until a suitable emission factor is identified.

- **Product-specific emission factor:** Emission factors that apply to the specific product used in the building shall be used wherever they are available. These emission factors should be:
    - **Product specific**
        - The emission factor must apply to the correct product. The specific product name – or an easily identifiable product range – must be clearly stated.
    - **Producer specific**
        - The emission factor should be specific to the manufacturer who makes the product.
        - Where a sector-wide value is used that includes a variation range, the highest value within the range shall be selected.
    - **Region specific**
        - Where a supplier makes the same product in multiple regions, the data should reflect manufacture in the region where the actual product used is manufactured.
        - If the source of supply is unknown and the supplier declares a range of values, the worst-in-range value shall be used.
    - **Time specific:**
        - The emission factor should ideally be within its declared period of validity.
        - Emission factors with no period of validity, or which are outside their declared period of validity, may still be used unless the manufacturer is known to have moved to a higher carbon process. (Emissions generally fall over time, meaning that older declarations are usually more conservative.)
        - Declarations for products not yet on the market can be used in early stage assessments but should not be used for as-built assessments unless it was clear that the product was available and supplied at the time of construction.
    - **Independently verified**, following any of the following approaches:
        - Environmental Product Declarations (EPDs) following ISO 14025 and either EN 15804 or ISO 21930 and registered with an independent EPD system.
        - Carbon Footprint of Product (CFP) compliant with ISO 14067:2018 or PAS 2050:2011 from approved programmes / certification schemes (refer to the

Green Star Embodied Carbon Calculator Guide). Only product carbon footprints can be accepted, not organisational carbon footprints.

- Life Cycle Assessments (LCAs), following EN 15804 or ISO 21930.

- **Generic value from database:** The list of generic emission factors for key materials in Appendix B: Generic Emission Factors and in the BRANZ CO_2NSTRUCT Database shall be used as the core databases where there is no product-specific emission factor. Once available, Masterspec's emission factor database can also be used as a core database.
- **Generic value from global literature scan:** Where there is no suitable emission factor using either of the previous two approaches, a generic emission factor may be used. The data quality hierarchy in Table 2 shall be applied as follows:

  Working from the top to the bottom of Table 2 (noting that this process will likely start from priority 5, as priority 1-4 emission factors should have already been identified in the steps above):

  - Identify all relevant emission factors using both a local and global scan. A relevant emission factor is one for the same or similar product type used in the building, but may be based on generic data (database or literature) or a different country of manufacture to that actually used.

    This scan should include:

    - All major EPD programmes, e.g., EPD Australasia, International EPD System, BRE, IBU, UL Environment, etc. For Australasian EPDs, check https://epd-australasia.com/ and https://www.globalgreentag.com/epd-program.html. For European EPDs, check https://www.eco-platform.org/epd-data.html.
    - All carbon footprint certification schemes listed in the *Green Star Embodied Carbon Calculator Guide*.
    - Generic data, e.g., AusLCI, ecoinvent, Sphera databases. A good central repository is the Global LCA Data Access (GLAD) network: https://www.globallcadataaccess.org/search.
  - If no suitable emission factors are found, move down a row in the table to the next priority level and start scanning for new emission factors.
  - If one or more suitable emission factor(s) exist, convert them to the same unit (e.g., tonnes) and remove stored biogenic carbon (GWP-stored) from GWP-total as per section 4.2.1.
  - Take the highest GWP-total value and use this as the proxy within the Calculator.
  - If there are many results and some appear to be outliers, use the Interquartile Range (IQR) method to exclude these outliers. To apply the IQR method, calculate the upper and lower quartiles of the dataset. Calculate IQR as (upper quartile) minus (lower quartile). Multiply IQR by 1.5 and add this to the upper quartile, forming an upper fence. All values above this upper fence can be excluded. Take the highest GWP-total of the emission factors remaining and use this as the proxy value within the Calculator.

Table 2: Emission factor data quality hierarchy[1]

Order of Priority	Emission factor data quality / precision	Origin of emission factor / data
1	Excellent (product-specific)	**Verified** EPD[2] or CFP[3] for **specific product** with the **specific country of manufacture** reflecting the product installed in the building.
2	High (product-specific)	**Verified** EPD[2] or CFP[3] for **sector average product** with the **specific country of manufacture** reflecting the product installed in the building.
3	Medium (product-specific)	**Verified** EPD[2] or CFP[3] for **the specific product** (specific or sector average) with a **different country of manufacture** to the product installed in the building.
4	Medium (product-specific)	**Peer reviewed** LCA[4] or CFP[4] for the **specific product** (specific or sector average), **regardless of country of manufacture,** not published by an independent programme operator
5	Medium (proxy product)	**Verified** EPD[2] or CFP[3] for **a similar product** (specific or sector average) to the product installed in the building **regardless of country of manufacture**
6	Medium (proxy product)	**Peer reviewed** LCA[4] or CFP[5] for a **similar product** (specific or sector average), **regardless of country of manufacture,** not published by an independent programme operator
7	Low (generic data)	**Unreviewed** LCA or CFP results for the **specific product** accounting for the **specific country of manufacture** using a mix of primary data from the manufacturer and **generic data from databases**, e.g., from ecoinvent, GaBi or AusLCI.
8	Low (generic data)	**Unreviewed** LCA or CFP results for a **similar product** using a mix of primary data and **generic data from databases**, e.g., from ecoinvent, GaBi or AusLCI, **regardless of country of manufacture**.
9	Low (IO data)	**Input-output LCA** or **hybrid LCA** data, either for New Zealand or for a country that has significant manufacturing capacity for this product type.

[1] Table based on the concept of BRANZ's data quality hierarchy (BRANZ, 2021) and MBIE's *Technical Methodology* (MBIE, 2022) with product-specific data first, followed by proxy data for a similar product, followed by generic data. Adaptations have also been made to allow for a wider pool of data (i.e., also from product carbon footprints and life cycle assessment studies).

[2] Environmental Product Declarations must follow both ISO 14025 and either EN 15804 or ISO 21930. They must be independently verified and published with an EPD programme. Preference should be given to EPDs that are still valid; however, an EPD which has expired can still be used given that environmental performance generally improves over time due to improvements in manufacturing efficiency and grid decarbonisation.

[3] A Carbon Footprint of Product must follow either ISO 14067:2018 (preferred) and/or PAS 2050:2011. The study must be independently verified and registered with a carbon certification programme. Approved certification schemes are listed in the Calculator Guide. These declarations will typically be published as a carbon neutral declaration; however, it is the gross carbon footprint prior to offsetting that is needed for this *Methodology*. Only product carbon footprints, not organisational carbon footprints, may be accepted.

[4] A peer-reviewed Life Cycle Assessment must have been reviewed following ISO 14044. Preference should be given for studies that also follow EN 15804 or ISO 21930.

[5] A peer-reviewed Carbon Footprint of Product must have been reviewed following ISO 14044. Preference should be given for studies that also align with the system boundary of EN 15804 or ISO 21930.

6.4 Minimum Data Quality Required

For building material quantities, the following minimum data quality is required for calculating embodied carbon at practical completion:

- ≥80% as-built information
- ≤5% based on estimates and/or benchmark buildings (or, if no data exists, cut off as per section 3.7)
- The remainder can be based on a BoQ or BIM take-off.

This percentage shall be calculated as the share of material cost covered by the project, excluding non-material costs such as labour, profit margins and taxes. If labour and margins cannot be excluded from some line items, they should be included for all line items. In both cases, only include the costs which are in scope of the assessment. Exclude the cost of land and non-physical items, such as professional services and taxes.

For emission factors, there is no minimum requirement as the process for choosing emission factors is designed to be conservative where there is uncertainty (i.e., to err on the side of overestimating emissions).

7 REPORTING

Table 3 sets out the minimum requirements for reporting embodied carbon following this Methodology. All values must be calculated following EN 15804:2012+A2:2019 (or subsequent revisions) and reported to no more than three significant figures (i.e., only one, two or three significant figures are permissible). All data in Table 3 are examples only. Emissions and removals in Modules A1-A3, A4-A5, B1, B2-B5, C and D must not be summed together. The only summed values that can (and must) be reported are Upfront Carbon and Whole-of-Life Embodied Carbon, which must be calculated following section 4. The Gross Floor Area of the building and the External Works Area (see section 2.2 for definitions) must be reported together with the results table. The format of the table can be altered, but the same data must still be contained in any modified version.

Table 3: Minimum requirements for reporting embodied carbon emissions (with example data)

	Upfront Carbon ($kg\ CO_2e/m^2$)	**Embodied Carbon** ($kg\ CO_2e/m^2$)	A1-A3 ($kg\ CO_2e/m^2$)	A4-A5 ($kg\ CO_2e/m^2$)	B1 ($kg\ CO_2e/m^2$)	B2-B5 ($kg\ CO_2e/m^2$)	C ($kg\ CO_2e/m^2$)	D ($kg\ CO_2e/m^2$)
Building	**528**	**797**						
Emissions	528	873	406	122	52	202	91	0
Removals	-62	-76	-62	0	-4	0	-10	-67
External works	**94**	**150**						
Emissions	94	152	78	16	0	48	10	0
Removals	0	-2	0	0	0	0	-2	0

Building Gross Floor Area = 1,000 m^2 | External Works Area = 2,000 m^2

This table aligns with MBIE's *Whole-of-Life Embodied Carbon Assessment: Technical Methodology*. MBIE's methodology requires greenhouse gas removals (e.g., stored biogenic carbon in wood products and recarbonation of concrete) to be reported separately to emissions (e.g., combustion of fossil fuels). It also requires emissions that occur before building occupation to be reported separately to emissions that occur in the future. Module B1 is included in the Whole-of-Life Embodied Carbon calculation but is presented separately to the other items in Stage B due to a lack of consensus on whether it is an embodied emission or operational emission (see section 4.3). Table 4 describes common sources of GHG emissions and removals per life cycle module.

Table 4: Common sources of GHG emissions and removals within a building's life cycle

Life cycle module	Sources of GHG emissions	Sources of GHG removals
A1-A3 (building products)	Fossil fuel emissions associated with the manufacture of building products	Long-term storage of carbon within building products, e.g., stored biogenic carbon in structural wood products
A4 (transport of products to site)	Burning of fossil fuels in trucks and other modes of transport	n/a
A5 (construction)	Land use change, construction waste, on-site construction energy and commissioning	n/a
B1 (direct emissions)	Fugitive emissions from HVAC systems and HFC blown insulation	Recarbonation in concrete
B2 (maintenance)	Can be omitted as likely below cut-off criteria	Can be omitted as likely below cut-off criteria
B3 (repair)	Can be omitted as likely below cut-off criteria	Can be omitted as likely below cut-off criteria
B4+B5 (materials replacement)	Fossil fuel emissions associated with the manufacture of building products	Not applicable, assuming that any wood products are replacements only, meaning that the carbon in cancels the carbon out
C1 (deconstruction/demolition)	Fossil fuel emissions associated with deconstruction/demolition	n/a
C2 (transport of scrap off-site)	Burning of fossil fuels in trucks and other modes of transport	n/a
C3 (waste processing for recycling)	Fossil fuel emissions associated with off-site recycling/recovery facilities	Recarbonation in concrete
C4 (landfill and incineration)	Fugitive emissions from building products in landfill and fossil fuel emissions from operating a landfill	Recarbonation in concrete
D (benefits and loads beyond the system boundary)	Not applicable, unless Module D is a positive number	Avoided emissions in future product systems through recovery, reuse and recycling

Table 3 presents the minimum requirements only and can be extended to present additional data, such as:

- Additional parts of the building that are not within the core scope of this Methodology.
- The impact of artificially releasing CO_2 from landfill at end-of-life following EN 15804+A2, where this is relevant. This requirement was not present in the previous version of EN 15804 (EN 15804+A1), nor is it required by ISO 21930. It was included in EN 15804+A2 to prevent carbon storage in landfill, despite there being evidence that carbon can and is stored in landfill. See Appendix H: Default Emission Factors for Waste Treatment for further details.

8 DEPARTURES FROM OTHER STANDARDS

8.1 MBIE's WoLEC Assessment: Technical Methodology

Differences between this *Methodology* and MBIE's *Whole-of-Life Embodied Carbon Assessment: Technical Methodology* (MBIE, 2022) are highlighted in Table 5 below.

Table 5: Departures from MBIE's *Technical Methodology* (MBIE, 2022)

Topic	This *Methodology*	MBIE WoLEC	Reason for deviation
Ceilings	Mandatory	Optional	Ceilings are included in the base scope. This is consistent with including floor finishes. Suspended ceilings in commercial buildings can be environmentally relevant.
Stairs, lifts and escalators	Mandatory	Optional	Can be material for high-rise buildings, such as offices.
External works	Mandatory separate disclosure	Optional	Can be significant for schools, aged care, warehouses, industrial buildings and retail.

8.2 RICS WLCA Standard (2nd Ed.)

Differences between this *Methodology* and RICS' standard *Whole Life Carbon Assessment (WLCA) for the Built Environment* (RICS, 2024) are highlighted in Table 6 below.

Table 6: Departures from RICS WLCA Standard (2nd Ed.) (RICS, 2024)

Topic	This *Methodology*	RICS WLCA (2nd Ed.)	Reason for deviation
Floor area used for normalising results	Gross Floor Area	Gross Internal Area	GIA is not widely used within New Zealand
Assumed building life	50 years	60 years	50 years is specified in MBIE (2022) and is the minimum life required for structural elements under the Building Code and Building Act in New Zealand
Emissions from construction activity in module A5	15 kg CO_2e/m^2 GFA (NZS 3604-scale) and 25 kg CO_2e/m^2 GFA (all other buildings)	40 kg CO_2e/m^2 GIA	Less excavation in New Zealand vs the UK due to smaller basements + renewable electricity.
Emissions from demolition works	Out of scope	In scope. A default value of 35 kg CO_2e/m^2 is provided where relevant.	Demolition is part of the previous building's life cycle. RICS requires demolition to be reported separately as A5.1. Module A5.1 should be excluded from assessments aligned with this methodology.

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APPENDIX A: DETAILED SCOPE OF BUILDING ELEMENTS

Table 7 shows the building elements that must be included following Masterspec's Co-ordinated Building Information (CBI) classification system.

Table 7: Building elements in scope by Masterspec CBI classification number

CBI no.	CBI name	Included?	Reason for exclusion	Note
1	**General**	**NO**	**Module A0 out of scope**	
11	Contract conditions	NO		
12	General requirements	NO		
2	**Site**	**YES**		
21	Demolition	NO	Previous building	Included in the previous building's life cycle
22	Preparation and groundwork	YES		
23	Foundations	YES		
24	Minor demolition and alterations	YES		Alterations are in scope
3	**Structure**	**YES**		
31	Concrete	YES		
32	Earth	YES		
33	Masonry	YES		
34	Steel	YES		
35	Stainless steel	YES		
36	Other metals	YES		
37	Plastics	YES		
38	Timber	YES		
39	Miscellaneous Structure	YES		
4	**Enclosure**	**YES**		
41	Tanking and pre-cladding	YES		
42	Wall and soffit cladding	YES		
43	Roofing and decking	YES		
44	Membrane roofing	YES		
45	Windows and doors	YES		
46	Glazing	YES		
47	Insulation	YES		

CBI no.	CBI name	Included?	Reason for exclusion	Note
48	Enclosure sundries	PARTIAL		See Level 3 breakdown
481	Sealants and fillers	NO	Below cut-off rules	
482	Flashings and joint barriers	NO	Below cut-off rules	
483	Adhesives and fastenings	NO	Below cut-off rules	
484	Stairs and other discrete primary elements	YES		
485	Balustrades and barriers	YES		
486	Separate secondary access and platform systems	YES		
487	Post-cladding Facade Elements	YES		
488	Enclosure miscellaneous	PARTIAL		Only include if expected to be above cut-off criteria
489	Ancillary items	NO	Below cut-off rules	
49	Metalwork	YES		
5	**Interior**	**PARTIAL**		
52	Partitions, screens and doors	NO	Not permanent	
521	Partitions	NO	Not permanent	
522	Special performance partitions	NO	Not permanent	
523	Interior doors and windows	PARTIAL		Only include permanent doors and windows. Non-permanent doors and windows are out of scope.
524	Fire-rated and acoustic interior doors and windows	PARTIAL		Only include permanent doors and windows. Non-permanent doors and windows are out of scope.
525	Special function interior doors and windows	PARTIAL		Only include permanent doors and windows. Non-permanent doors and windows are out of scope.
526	Screens and miscellaneous items	NO	Not permanent	
529	Ancillary items	NO	Below cut-off rules	
53	Ceiling systems	YES		Must be included based on a likely scenario, even if not delivered under the contract
54	Floors	YES		Must be included based on a likely scenario, even if not delivered under the contract
55	Joinery fixtures and hardware	PARTIAL	Likely to be below cut-off rules for commercial and industrial. Include for residential.	
56	Specialist equipment and assemblies	PARTIAL		Only include if expected to be above cut-off criteria

CBI no.	CBI name	Included?	Reason for exclusion	Note
57	Furniture and appliances	NO	Not permanent	
58	Signs and features	NO	Below cut-off rules	
6	**Finish**	**PARTIAL**		
61	Applied coatings	YES		
62	Tiling	YES		
63	Overlay flooring and wall panelling	PARTIAL		Only include if permanently installed
64	Resilient surfacing	YES		Must be included based on a likely scenario, even if not delivered under the contract
65	Carpeting	YES		Must be included based on a likely scenario, even if not delivered under the contract
66	Flooring ancillaries	NO	Below cut-off rules	
67	Painting, decoration and coating	PARTIAL		Only include if expected to be above cut-off criteria
68	Finishes sundries	YES		
7	**Services**	**YES**		**Note: Default emission factors for building services are provided in Table 11 on page 53**
71	Liquid supply	YES		
72	Gas	YES		
73	Fire	YES		
74	Liquid disposal	YES		
75	Heating and cooling	YES		
76	Ventilation and air-conditioning	YES		
77	Electrical	YES		
78	Communications, Detection, Monitoring, Protection & Controls	YES		
79	Transport	YES		
8	**External**	**SEPARATE**	**Not within the dripline**	**Must be reported separately**
81	Retaining walls	SEPARATE		
82	Pavements	SEPARATE		
83	Landscape cultivation	NO	Soft landscaping is not in scope	
84	Landscape structures	SEPARATE		Only include if expected to be above cut-off criteria

CBI no.	CBI name	Included?	Reason for exclusion	Note
85	Landscape services	SEPARATE		Only include significant materials (e.g., concrete and paving) in external pool/spa/sauna complexes as part of External Works
86	Civil engineering infrastructure	SEPARATE		See Level 3 breakdown
860	Infrastructure common requirements	NO	Site infrastructure is out of scope	
861	Earthworks and preparation	SEPARATE		Hard landscaping should be declared as part of External Works
862	Services - Public and non-public mains	NO	Site infrastructure is out of scope	
863	Sub-bases and basecourses	SEPARATE		Hard landscaping should be declared as part of External Works
864	Roading and paving	SEPARATE		Hard landscaping should be declared as part of External Works
867	Engineering infrastructure structures	NO	Site infrastructure is out of scope	
868	Miscellaneous engineering works	NO	Site infrastructure is out of scope	
869	Ancillary items; repairing and altering engineering infrastructure	NO	Site infrastructure is out of scope	
88	Specialist structures	PARTIAL		Declare with building if the specialist structure is within the main building's dripline; declare as part of External Works if this is an ancillary building

APPENDIX B: GENERIC EMISSION FACTORS FOR PRODUCT MANUFACTURE

Table 8 presents two different types of emission factor for the manufacture of common groups of building products. These emission factors can be used for initial manufacture of building products (Modules A1-A3), construction waste (Module A5) and Use Stage Embodied Carbon (Modules B2-B5).

- **Baseline:** These emission factors aim to represent the average carbon footprint of building products available on the New Zealand market circa 2020. Due to limitations in data availability, they typically represent 2020 ±3 years (i.e., 2017 to 2023). Baseline emission factors are suitable for tracking decarbonisation against a 2020 base year. They represent a fixed point against which New Zealand building and construction sector can measure its decarbonisation.

- **Conservative:** These emission factors aim to represent worst-in-class performance on the New Zealand market in 2024. They are suitable for providing a conservative estimate of the carbon footprint of a building product in the absence of producer-specific data. Conservative emission factors are suitable for use in tools like Green Star that aim to drive behaviour change. When used in this way, they help encourage product manufacturers to publish product-specific emission factor data for their products, even if their carbon footprint is worse than average. Without such an approach, building product manufacturers whose carbon footprint is near-average or worse-than-average do not have an incentive to publish producer-specific emissions data.

Table 8: Default emission factors for building products

Category	Material/product group	Products in this group	GWP-total baseline $kgCO_2e/UoM$	GWP-total conservative $kgCO_2e/UoM$	GWP-stored $kgCO_2e/UoM$	UoM	Note
Concrete	10MPa	Concrete ≤10 MPa	223	268	0	m^3	This is the national average. See Table 9 and Table 10 for regions.
Concrete	17.5MPa	Concrete >10 MPa to ≤17.5 MPa	235	301	0	m^3	This is the national average. See Table 9 and Table 10 for regions.
Concrete	20MPa	Concrete >17.5 MPa to ≤20 MPa	249	315	0	m^3	This is the national average. See Table 9 and Table 10 for regions.
Concrete	25MPa	Concrete >20 MPa to ≤25 MPa	274	348	0	m^3	This is the national average. See Table 9 and Table 10 for regions.
Concrete	30MPa	Concrete >25 MPa to ≤30 MPa	297	374	0	m^3	This is the national average. See Table 9 and Table 10 for regions.
Concrete	35MPa	Concrete >30 MPa to ≤35 MPa	325	416	0	m^3	This is the national average. See Table 9 and Table 10 for regions.
Concrete	40MPa	Concrete >35 MPa to ≤40 MPa	352	445	0	m^3	This is the national average. See Table 9 and Table 10 for regions.

Category	Material/product group	Products in this group	GWP-total baseline $kgCO_2e/UoM$	GWP-total conservative $kgCO_2e/UoM$	GWP-stored $kgCO_2e/UoM$	UoM	Note
Concrete	45MPa	Concrete >40 MPa to ≤45 MPa	379	469	0	m³	This is the national average. See Table 9 and Table 10 for regions.
Concrete	50MPa	Concrete >45 MPa to ≤50 MPa	408	482	0	m³	This is the national average. See Table 9 and Table 10 for regions.
Concrete	55MPa	Concrete >50 MPa to ≤55 MPa	428	528	0	m³	This is the national average. See Table 9 and Table 10 for regions.
Concrete	60MPa	Concrete >55 MPa to ≤60 MPa	445	545	0	m³	This is the national average. See Table 9 and Table 10 for regions.
Concrete	65MPa	Concrete >60 MPa to ≤65 MPa	458	558	0	m³	This is the national average. See Table 9 and Table 10 for regions.
Concrete	80MPa	Concrete >65 MPa to ≤80 MPa	480	580	0	m³	This is the national average. See Table 9 and Table 10 for regions.
Concrete	100MPa	Concrete >80 MPa to ≤100 MPa	506	606	0	m³	This is the national average. See Table 9 and Table 10 for regions.
Steel	Hot rolled sections	Universal beams/columns, angles	1,920	3,720	0	t	100% imported product. Weighted average calculated from import statistics for the 2019 calendar year (i.e., pre COVID): 30% Australia (InfraBuild) + 30% Thailand (assume SYS) + 20% Taiwan (assume Tung Ho) + 20% Korea (assume Hyundai).
Steel	Welded sections	Welded beams/columns	3,410	4,090	0	t	Assume 50% domestic steel plate from NZ Steel + 50% worldsteel average steel plate. This is an approximation as no organisation was able to provide this data through the consultation process. Welding/fabrication carbon footprint has been added to plate.
Steel	Plate	Structural bracing	3,140	3,820	0	t	Assume 50% domestic steel plate from NZ Steel + 50% worldsteel average steel plate. This is an approximation as no organisation

Category	Material/product group	Products in this group	GWP-total baseline $kgCO_2e/UoM$	GWP-total conservative $kgCO_2e/UoM$	GWP-stored $kgCO_2e/UoM$	UoM	Note
							was able to provide this data through the consultation process. Emissions of NZ Steel plate estimated from Pacific Steel reinforcing coil.
Steel	Hollow sections ≤660mm OD	CHS/tubes, SHS, RHS	2,510	2,510	0	t	100% imported product. Emission factor is worldsteel average welded pipe. 660mm outer diameter is taken as this is typically the maximum achievable using seam/spiral welding of hot rolled coil.
Steel	Hollow sections >660mm OD	CHS/tubes, SHS, RHS	3,020	3,020	0	t	100% imported product. Emission factor is worldsteel average UO pipe. Larger pipes and hollow sections (>660mm outer diameter) are generally manufactured from steel plate using submerged arc welding.
Steel	Cold formed sections	Purlins, girts	3,760	4,130	0	t	Assume 75% from NZ Steel (cold formed + galvanised + roll formed) + 25% worldsteel average.
Steel	Reinforcing bar		3,650	3,970	0	t	Assume 85% Pacific Steel + 15% worldsteel average.
Steel	Reinforcing mesh		3,860	4,180	0	t	Assume 85% Pacific Steel + 15% worldsteel average. Forming carbon footprint has been added to reinforcing wire.
Steel	PC strand	Prestressed concrete steel strand	2,340	2,490	0	t	100% imported product. Very little carbon footprint data available. This emission factor is an average carbon footprint based on two EPDs: one from China and one from Thailand.

Category	Material/product group	Products in this group	GWP-total baseline $kgCO_2e/UoM$	GWP-total conservative $kgCO_2e/UoM$	GWP-stored $kgCO_2e/UoM$	UoM	Note
Steel	Decking	Steel for composite floor slabs	3,760	4,130	0	t	Assume 75% from NZ Steel (cold formed + galvanised + roll formed) + 25% worldsteel average.
Steel	Stainless steel (ferritic)	Type 430	4,650	4,860	0	t	Imported product, primarily from China and Taiwan. Carbon footprint is an average of two Chinese EPDs.
Steel	Stainless steel (austenitic)	Type 304 and Type 316	3,500	3,870	0	t	Imported product, primarily from China and Taiwan. Carbon footprint is an average of two Chinese EPDs.
Timber & engineered woods	Sawn softwood (H1.2)	Structural and non-structural timber used in an enclosed environment	60	98	-801	m^3	Assume 100% domestic supply. Assume WPMA EPD is reflective of industry-average practice.
Timber & engineered woods	Sawn softwood (H3.2)	Structural and non-structural timber used outdoors, not in ground contact	74	112	-801	m^3	Assume 100% domestic supply. Assume WPMA EPD is reflective of industry-average practice.
Timber & engineered woods	Sawn softwood (H4/H5)	Structural and non-structural timber used outdoors, in ground contact	82	120	-801	m^3	Assume 100% domestic supply. Assume WPMA EPD is reflective of industry-average practice.
Timber & engineered woods	Glulam (H1.2)	Glue laminated timber (glulam, gluelam or GLT) for structural and non-structural applications in an enclosed environment	149	215	-809	m^3	Assume 100% domestic supply. Assume WPMA EPD is reflective of industry-average practice.
Timber & engineered woods	Glulam (H3.2)	Glue laminated timber (glulam, gluelam or GLT) for structural and non-structural applications outdoors, not in ground contact	169	235	-809	m^3	Assume 100% domestic supply. Assume WPMA EPD is reflective of industry-average practice.

Category	Material/product group	Products in this group	GWP-total baseline $kgCO_2e/UoM$	GWP-total conservative $kgCO_2e/UoM$	GWP-stored $kgCO_2e/UoM$	UoM	Note
Timber & engineered woods	Glulam (H4/H5)	Glue laminated timber (glulam, gluelam or GLT) for structural and non-structural applications outdoors, in ground contact	179	245	-809	m^3	Assume 100% domestic supply. Assume WPMA EPD is reflective of industry-average practice.
Timber & engineered woods	CLT (untreated)	Cross laminated timber (CLT) for structural and non-structural applications in an enclosed environment	279	287	-783	m^3	Assume 50% imports (XLam) + 50% domestic supply (Red Stag) from 2021.
Timber & engineered woods	CLT (H1.2)	Cross laminated timber (CLT) for structural and non-structural applications in an enclosed environment	288	296	-783	m^3	Assume 50% imports (XLam) + 50% domestic supply (Red Stag) from 2021.
Timber & engineered woods	CLT (H3.2)	Cross laminated timber (CLT) for structural and non-structural applications outdoors, not in ground contact	298	298	-783	m^3	Assume 50% imports (XLam) + 50% domestic supply (Red Stag) from 2021.
Timber & engineered woods	LVL (untreated)	Laminated veneer lumber (LVL) for structural and non-structural applications in an enclosed environment	119	144	-901	m^3	Assume 100% domestic supply: 50% from Nelson Pine, 50% from Carter Holt Harvey.
Timber & engineered woods	LVL (H1.2)	Laminated veneer lumber (LVL) for structural and non-structural applications in an enclosed environment	129	242	-901	m^3	Assume 100% domestic supply: 50% from Nelson Pine, 50% from Carter Holt Harvey.
Timber & engineered woods	LVL (H3.1)	Laminated veneer lumber (LVL) for non-structural applications	170	292	-901	m^3	Assume 100% domestic supply: 50% from Nelson Pine, 50% from Carter Holt Harvey.

Category	Material/product group	Products in this group	GWP-total baseline $kgCO_2e/UoM$	GWP-total conservative $kgCO_2e/UoM$	GWP-stored $kgCO_2e/UoM$	UoM	Note
		outdoors, not in ground contact (must be painted)					
Asphalt	Asphalt	DG10 asphalt	67.7	91.1	0	t	Unweighted average of 19 x DG10 asphalt mixes. DG10 was selected as it is common for carparks. The list includes both straight run asphalts and polymer modified asphalts.
Cement	GP cement	General purpose (GP) cement	792	876	0	t	Weighted average of GP cement on the market circa 2020 using calculated market share. Annual cement consumption in the period 2017-2023 was approximately 1.5 Mt (Holcim NZ EPD S-P-00850 v2.0). Golden Bay's production in the 2017-18 financial year was 915 kt, which was noted as a record at the time (Concrete Magazine, 2018). HR Cement declare annual production of approximately 100-120 kt. The remainder of the market is assumed to be supplied by Holcim NZ.
Aggregates	Sand		4.36	5.34	0	t	Average of natural and manufactured sands, assuming 80% Winstone Aggregates EPD + 20% HiRock EPD.
Aggregates	Crushed rock		4.11	5.11	0	t	Average of concrete aggregates (secondary/tertiary processing with washing), assuming 80% Winstone Aggregates EPD + 20% HiRock EPD.
Aggregates	Aggregate – 1.5% cement stabilised		15.4	17.9	0	t	Blend of market average aggregates and market average cement.

Category	Material/product group	Products in this group	GWP-total baseline $kgCO_2e/UoM$	GWP-total conservative $kgCO_2e/UoM$	GWP-stored $kgCO_2e/UoM$	UoM	Note
Aggregates	Aggregate – 3% cement stabilised		26.3	31.3	0	t	Blend of market average aggregates and market average cement.
Aggregates	Aggregate – 5% cement stabilised		40.9	49.1	0	t	Blend of market average aggregates and market average cement.
Mortar	Mortar (1:3)		178	197	0	t	Mass is dry weight, excluding water. Calculated as 1 part cement to 3 parts sand by volume, assuming bulk density of cement is 1400 kg/m³ and sand is 1650 kg/m³.
Windows & doors	Windows, aluminium framed	Hinged and sliding windows	96.8	130	-2.82	m² façade	Assume 100% domestic supply: 50% from APL, 50% from Altus.
Windows & doors	Doors, sliding, aluminium framed		121	123	-2.04	m² façade	Assume 100% domestic supply: 50% from APL, 50% from Altus.
Curtain wall - single skin	Curtain wall, aluminium unitised, 100% DGU 8T-16-44.2		163	283	0	m² façade	Assume 90% domestic (hydro-powered or recycled aluminium), 10% imports (global average aluminium).
Curtain wall - single skin	Curtain wall, aluminium unitised, aluminium cladding, 50% DGU 8T-16-44.2		198	423	0	m² façade	Assume 90% domestic (hydro-powered or recycled aluminium), 10% imports (global average aluminium).
Curtain wall - single skin	Curtain wall, aluminium unitised, aluminium cladding with vertical fins, 50% DGU 8T-16-44.2		251	558	0	m² façade	Assume 90% domestic (hydro-powered or recycled aluminium), 10% imports (global average aluminium).
Curtain wall - single skin	Curtain wall, aluminium unitised, aluminium cladding, 50% TGU 8T-16-6-16-44.2		209	428	0	m² façade	Assume 90% domestic (hydro-powered or recycled aluminium), 10% imports (global average aluminium).
Curtain wall - single skin	Curtain wall, aluminium unitised, insulated		201	373	0	m² façade	Assume 90% domestic (hydro-powered or recycled aluminium),

Category	Material/product group	Products in this group	GWP-total baseline $kgCO_2e/UoM$	GWP-total conservative $kgCO_2e/UoM$	GWP-stored $kgCO_2e/UoM$	UoM	Note
	shadow box, 50% DGU 8T-16-44.2						10% imports (global average aluminium).
Curtain wall - single skin	Curtain wall, aluminium unitised, GRC cladding, 50% DGU 8T-16-44.2		237	493	0	m² façade	Assume 90% domestic (hydro-powered or recycled aluminium), 10% imports (global average aluminium).
Curtain wall - single skin	Curtain wall, aluminium stick, aluminium cladding, 50% DGU 8T-16-44.2		158	315	0	m² façade	Assume 90% domestic (hydro-powered or recycled aluminium), 10% imports (global average aluminium).
Curtain wall - single skin	Curtain wall, steel stick, aluminium cladding, 50% DGU 8T-16-44.2		230	295	0	m² façade	Assume 90% domestic (hydro-powered or recycled aluminium), 10% imports (global average aluminium).
Curtain wall - single skin	Curtain wall, timber stick, aluminium cladding, 50% DGU 8T-16-44.2		125	227	0	m² façade	Assume 90% domestic (hydro-powered or recycled aluminium), 10% imports (global average aluminium).
Curtain wall - double skin	Curtain wall, double skin, deep cavity aluminium façade, 100% single + DGU 66.2 + 8T-16-44.2		423	784	0	m² façade	Assume 90% domestic (hydro-powered or recycled aluminium), 10% imports (global average aluminium).
Curtain wall - double skin	Curtain wall, double skin, narrow cavity aluminium façade, 100% single + DGU 66.2 + 8T-16-44.2		249	425	0	m² façade	Assume 90% domestic (hydro-powered or recycled aluminium), 10% imports (global average aluminium).
Wall system	Wall system, precast concrete, 50% DGU 8T-16-44.2		291	291	0	m² façade	
Wall system	Wall system, steel frame, aluminium rainscreen, 50% DGU 8T-16-44.2		260	260	0	m² façade	

Category	Material/product group	Products in this group	GWP-total baseline $kgCO_2e/UoM$	GWP-total conservative $kgCO_2e/UoM$	GWP-stored $kgCO_2e/UoM$	UoM	Note
Wall system	Wall system, steel frame, stone cladding, 50% DGU 8T-16-44.2		215	215	0	m² façade	
Wall system	Wall system, steel frame, brick cladding, 50% DGU 8T-16-44.2		198	198	0	m² façade	
Wall system	Wall system, cross laminated timber backing, brick cladding, 50% DGU 8T-16-44.2		168	168	0	m² façade	
Curtain wall - components	Double glazing unit, 4-16-4	4mm glass + 4mm glass	50.7	50.7	0	m²	Imported glass with domestic or overseas fabrication into an IGU.
Curtain wall - components	Double glazing unit, 6-16-4	6mm glass + 4mm glass	56.4	56.4	0	m²	Imported glass with domestic or overseas fabrication into an IGU.
Curtain wall - components	Double glazing unit, 8-16-4	8mm glass + 4mm glass	62.5	62.5	0	m²	Imported glass with domestic or overseas fabrication into an IGU.
Curtain wall - components	Aluminium extrusion profile, powder coated		8.07	33.0	0	kg	Assume 90% domestic (hydro-powered or recycled aluminium), 10% imports (Chinese aluminium).
Curtain wall - components	Aluminium cladding		18.0	38.1	0	kg	Imported product (assume global average aluminium)
Curtain wall - components	Stainless steel cladding	Type 430	4.65	4.86	0	kg	Imported product, primarily from China. Carbon footprint is an average of two Chinese EPDs.
Curtain wall - components	Brick cladding	Clay brick	0.270	0.270	0	kg	Imported
Curtain wall - components	EPDM gasket		2.79	2.79	0	kg	Imported
Curtain wall - components	Polyamide thermal break		6.74	6.74	0	kg	Imported
Curtain wall - components	Silicone gasket		3.02	3.02	0	kg	Imported
Curtain wall - components	Stainless steel profiles and fixings	Type 304 or Type 316	3.50	3.87	0	kg	Imported product, primarily from China. Carbon footprint is an average of two Chinese EPDs.

Category	Material/product group	Products in this group	GWP-total baseline $kgCO_2e/UoM$	GWP-total conservative $kgCO_2e/UoM$	GWP-stored $kgCO_2e/UoM$	UoM	Note
Plasterboard	Standard (10mm)		1.89	2.03	0	m² board	Assume 90% GIB (WWB), 10% imports.
Plasterboard	Standard (13mm)		2.38	2.61	-0.67	m² board	Assume 90% GIB (WWB), 10% imports.
Plasterboard	Wet area (10mm)		2.23	2.78	0	m² board	Assume 90% GIB (WWB), 10% imports.
Plasterboard	Wet area (13mm)		3.14	3.35	-0.64	m² board	Assume 90% GIB (WWB), 10% imports.
Plasterboard	Fire resistant (13mm)		3.09	3.31	-0.64	m² board	Assume 90% GIB (WWB), 10% imports.
Plasterboard	Reinforced (13mm)		3.63	4.11	-0.66	m² board	Assume 90% GIB (WWB), 10% imports.
Plasterboard	Intertenancy (25mm)		6.56	6.65	-0.91	m² board	Assume 90% GIB (WWB), 10% imports.
Roofing	Steel (0.40mm BMT)	Zinc/aluminium coated pre-painted long-run steel, 0.55mm base metal thickness	13.9	13.9	0	m² flat metal	Assume 0.40mm base metal thickness, zincalume (AZ150), paint coated, 100% local manufacture. Results are for a flat square metre of coated metal and must be adjusted to account for the profile of the metal and the overlap between sheets.
Roofing	Steel (0.55mm BMT)	Zinc/aluminium coated pre-painted long-run steel, 0.55mm base metal thickness	18.0	18.1	0	m² flat metal	Assume 0.55mm base metal thickness, zincalume (AZ150), paint coated, 100% local manufacture. Results are for a flat square metre of coated metal and must be adjusted to account for the profile of the metal and the overlap between sheets.
Roofing	Aluminium (0.90mm BMT)	Pre-painted long-run aluminium	42.6	92.6	0	m² flat metal	Assume 0.9mm base metal thickness, paint coated, imported aluminium sheet with local painting and rollforming. Results are for a flat square metre of coated metal and must be adjusted to account

Category	Material/product group	Products in this group	GWP-total baseline $kgCO_2e/UoM$	GWP-total conservative $kgCO_2e/UoM$	GWP-stored $kgCO_2e/UoM$	UoM	Note
							for the profile of the metal and the overlap between sheets.
Wall cladding	Steel (0.40mm BMT)	Zinc/aluminium coated pre-painted long-run steel, 0.55mm base metal thickness	13.9	13.9	0	m² flat metal	Assume 0.40mm base metal thickness, zincalume (AZ150), paint coated, 100% local manufacture. Results are for a flat square metre of coated metal and must be adjusted to account for the profile of the metal and the overlap between sheets.
Wall cladding	Steel (0.55mm BMT)	Zinc/aluminium coated pre-painted long-run steel, 0.55mm base metal thickness	18.0	18.1	0	m² flat metal	Assume 0.55mm base metal thickness, zincalume (AZ150), paint coated, 100% local manufacture. Results are for a flat square metre of coated metal and must be adjusted to account for the profile of the metal and the overlap between sheets.
Wall cladding	Aluminium (0.90mm BMT)	Pre-painted long-run aluminium	42.6	92.6	0	m² flat metal	Assume 0.9mm base metal thickness, paint coated, imported aluminium sheet with local painting and rollforming. Results are for a flat square metre of coated metal and must be adjusted to account for the profile of the metal and the overlap between sheets.
Wall cladding	Brick cladding (veneer)	Clay brick veneer	31.9	31.9	0	m² wall	Assume 70mm deep clay brick veneer with density 1690 kg/m² (as per the Australian National Construction Code 2016, "Specification J1.2 Material Properties").
Masonry	Concrete block, 15 series (140mm thick)		21.7	26.1	0	m² wall	Averages calculated from Firth masonry EPDs, adjusted for estimated market share of cement suppliers. Measured per wall face

Category	Material/product group	Products in this group	GWP-total baseline $kgCO_2e/UoM$	GWP-total conservative $kgCO_2e/UoM$	GWP-stored $kgCO_2e/UoM$	UoM	Note
							area. Excludes grout, reinforcing and block filling.
Masonry	Concrete block, 20 series (190mm thick)		26.8	32.7	0	m^2 wall	Averages calculated from Firth masonry EPDs, adjusted for estimated market share of cement suppliers. Measured per wall face area. Excludes grout, reinforcing and block filling.
Masonry	Concrete block, 25 series (240mm thick)		32.7	39.3	0	m^2 wall	Averages calculated from Firth masonry EPDs, adjusted for estimated market share of cement suppliers. Measured per wall face area. Excludes grout, reinforcing and block filling.

The carbon footprint of concrete varies by region. Any final calculations of Upfront Carbon or Whole-of-Life Embodied Carbon must use the regional values in Table 9 (baseline) and Table 10 (conservative). The national averages in Table 8 can be used in earlier design stages where an estimate of embodied carbon is all that is required.

Table 9: Default regional emission factors for concrete (baseline)

Region	10MPa	17.5MPa	20MPa	25MPa	30MPa	35MPa	40MPa	45MPa	50MPa	55MPa	60MPa	65MPa	80MPa	100MPa
Auckland	218	229	248	273	295	319	342	379	402	423	440	453	475	501
Hamilton	230	241	262	284	309	332	360	374	388	408	425	439	461	487
Tauranga	226	238	251	271	298	318	344	355	396	416	433	447	469	495
Wellington	218	229	237	266	290	322	347	338	397	417	434	447	469	495
Rest of North Island	229	241	253	277	299	329	354	382	401	422	439	452	474	500
Christchurch	208	219	230	250	271	294	324	367	396	416	433	447	468	495
Rest of South Island	234	245	259	283	310	345	384	410	448	469	486	499	521	547
National average	**223**	**235**	**249**	**274**	**297**	**325**	**352**	**379**	**408**	**428**	**445**	**458**	**480**	**506**

Table 10: Default regional emission factors for concrete (conservative)

Region	10MPa	17.5MPa	20MPa	25MPa	30MPa	35MPa	40MPa	45MPa	50MPa	55MPa	60MPa	65MPa	80MPa	100MPa
Auckland	251	261	273	297	344	369	396	436	458	482	499	512	534	560
Hamilton	263	271	291	314	348	376	401	425	427	468	485	498	520	546
Tauranga	260	243	258	272	310	337	364	345	431	476	493	506	528	554
Wellington	251	249	259	296	333	367	406	406	482	476	493	507	529	555
Rest of North Island	263	301	315	348	374	416	445	469	476	481	498	511	533	559
Christchurch	241	226	231	254	282	308	339	387	417	476	492	506	528	554
Rest of South Island	268	266	290	311	331	399	435	442	475	528	545	558	580	606
National average	**268**	**301**	**315**	**348**	**374**	**416**	**445**	**469**	**482**	**528**	**545**	**558**	**580**	**606**

Table 11 presents default emission factors for building services for Whole-of-Life Embodied Carbon assessments. These values shall be used where specific data are not available. These default emission factors cover all services (mechanical, electrical, plumbing, etc.) except for vertical transportation (lifts and escalators) The office building category shall be used for all commercial buildings. Vertical transportation must be modelled separately.

Table 11: Default emission factors for building services over the building life cycle

EF type	Module	Residential (detached)	Residential (townhouse)	Residential (apartment)	Office	Warehouse/industrial
Average	A1-A5	10.0	10.0	17.5	45.0	17.5
Average	B1	10.0	12.5	37.5	160.0	0.0
Average	B4	22.5	35.0	90.0	65.0	27.5
Average	C1-C4	2.5	5.0	10.0	2.5	2.5
Average	D	0.0	0.0	0.0	-20.0	0.0
Conservative	A1-A5	12.5	12.5	17.5	70.0	22.5
Conservative	B1	12.5	12.5	37.5	390.0	0.0
Conservative	B4	35.0	35.0	90.0	95.0	35.0
Conservative	C1-C4	5.0	5.0	10.0	2.5	2.5
Conservative	D	0.0	0.0	0.0	-15.0	0.0

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Source: BRANZ*. Compiled from Bullen & Dowdell (2023) with some rounding.*

Sources used to compile the emission factors:

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Altus (2023). Environmental Product Declaration – Aluminium & Window Systems. EPD registration number S-P-07443. EPD Australasia.

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Arup & Saint-Gobain Glass (2022). "Carbon footprint of façades: significance of glass". Adapted to NZ conditions by thinkstep-anz.

BlueScope Steel Limited (2020). Steel – Welded Beams and Columns – Environmental Product Declaration. EPD registration number S-P-00559. Version 2.0. EPD Australasia.

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Bullen, L. & D. Dowdell (2023). Embodied carbon of NZ office and residential building services. Study Report SR479 v2. Porirua: BRANZ.

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Firth (2024). Environmental Product Declaration – Firth Masonry Group E products with a GWP-GHG intensity of 31.1 kg CO2e/m2 to 33 kg CO2e/m2. EPD registration number EPD-IES-0016346 v1.0. EPD Australasia.

Firth (2024). Environmental Product Declaration – Firth Masonry Group F products with a GWP-GHG intensity of 27.6 kg CO2e/m2 to 30 kg CO2e/m2. EPD registration number EPD-IES-0016347 v1.0. EPD Australasia.

Firth (2024). Environmental Product Declaration – Firth Masonry Group G products with a GWP-GHG intensity of 24.7 kg CO2e/m2 to 27.3 kg CO2e/m2. EPD registration number EPD-IES-0016348 v1.0. EPD Australasia.

Firth (2024). Environmental Product Declaration – Firth Masonry Group H products with a GWP-GHG intensity of 21.6 kg CO2e/m2 to 24.5 kg CO2e/m2. EPD registration number EPD-IES-0016349 v1.0. EPD Australasia.

Firth (2024). Environmental Product Declaration – Firth Masonry Group I products with a GWP-GHG intensity of 17.7 kg CO2e/m2 to 21.5 kg CO2e/m2. EPD registration number EPD-IES-0016350 v1.0. EPD Australasia.

Firth (2024). Environmental Product Declaration – Firth Masonry Group J products with a GWP-GHG intensity of 15.6 kg CO2e/m2 to 17.5 kg CO2e/m2. EPD registration number EPD-IES-0016351 v1.0. EPD Australasia.

Firth (2024). Environmental Product Declaration – Firth Masonry Group K products with a GWP-GHG intensity of 13.1 kg CO2e/m2 to 15.5 kg CO2e/m2. EPD registration number EPD-IES-0016352 v1.0. EPD Australasia.

Golden Bay (2023). Environmental Product Declaration – EcoSure® GP cement, EcoFast® HE cement. EPD registration number S-P-01170 v1.1. EPD Australasia.

Hirock (2023). Environmental Product Declaration for Hirock Aggregates. EPD registration number S-P-09360 v1.0. EPD Australasia.

Holcim NZ (2023). General Purpose Portland Cement (Ultracem) EPD. EPD registration number S-P-00850 v2.0. EPD Australasia.

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Noksel (2024). Environmental Product Declaration – Coated Spiral Steel Pipes. EPD registration number S-P-08775. International EPD System.

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Pacific Steel (2024). Environmental Product Declaration – Reinforcing Bar, Coil and Wire. EPD registration number S-P-01002. Version 2.0. EPD Australasia.

PT Gunung Raja Paksi Tbk (2024). Environmental Product Declaration – Structural steel welded I-section. EPD registration number S-P-04684. Revised 2024-01-24. International EPD System.

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Tisco Stainless Steel Co. Ltd. (2022). Environmental Product Declaration – 430 ferritic stainless steel cold-rolled sheets. CISA-EPD-TISCO-20220004. EPD Programme for China Iron and Steel Industry.

Tung Ho Steel Enterprise Corp (2021). Environmental Product Declaration – Hot Rolled Structural Steel Sections. EPD registration number 4789597922.102.1. UL Solutions.

Winstone Aggregates (2022). Environmental Product Declaration for Aggregate and Sand Products. EPD registration number S-P-04664 v1.0. EPD Australasia.

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APPENDIX C: DEFAULT ASSUMPTIONS FOR MATERIAL TRANSPORT

Table 12 presents emission factors for common types of freight. They come from the Ministry for the Environment (MfE, 2024) and are expressed in kilograms of carbon dioxide equivalent per tonne-kilometre of freight moved.

These emission factors can be used for:

- Module A4: Transport of building products to the building site
- Module A5: Transport of wasted building products to the building site and construction waste from the building site
- Modules B3-B5: Transport of replacement building products to the building site
- Module C1: Transport of demolition waste to waste treatment.

Table 12: Emission factors for transportation (source: MfE, 2024)

Transport mode	GWP-Total (kg CO_2e/tkm)
Truck (urban delivery)	0.390
Truck (long-haul heavy truck)	0.105
Truck (all trucks)	0.135
Rail	0.027
Ship (containerised cargo) (international)	0.0161
Ship (containerised cargo) (within NZ)	0.046
Ship (break-bulk cargo) (international)	0.00353
Ship (break-bulk cargo) (within NZ)	0.0300
Air (domestic)	4.67
Air (international – Australia and Pacific Islands)	1.67
Air (international – long-haul)	1.10

Note: This table is updated annually. *Please see https://nzgbc.org.nz/embodied-carbon for the latest data.*

Table 13 presents domestic truck freight distances within Aotearoa New Zealand, while Table 14 presents international sea freight distances between many of New Zealand's common trading partners a selection of ports. These approximate distances may be used within an embodied carbon calculation as freight generally contributes only a small portion to Upfront Carbon and Whole-of-Life Embodied Carbon.

Table 13: Default truck freight distance for regions within Aotearoa New Zealand

Truck freight	Auckland / Tāmaki Makaurau	Christchurch / Ōtautahi	Dunedin / Ōtepoti	Napier / Ahuriri	Wellington / Te Whanganui-a-Tara
Auckland / Tāmaki Makaurau	0	1,073	1,428	412	645
Christchurch / Ōtautahi	1,073	0	360	752	439
Dunedin / Ōtepoti	1,428	360	0	1,103	790
Gisborne / Tairāwhiti	480	963	1,318	214	535
Hamilton / Kirikiriroa	121	952	1,307	291	523
Invercargill / Waihōpai	1,631	564	204	1,307	994
Napier-Hastings / Ahuriri-Heretaunga	412	752	1,103	0	320
Nelson / Whakatū	848	409	764	523	210
New Plymouth / Ngāmotu	359	782	1,137	408	354
Palmerston North / Te Papa-i-Oea	514	571	926	179	142
Rotorua	228	881	1,236	217	453
Tauranga	200	957	1,311	281	528
Wellington / Te Whanganui-a-Tara	645	439	790	320	0
Whanganui	445	623	978	249	195
Whangārei	158	1,230	1,584	569	802

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Table 14: Default sea freight distance for defined countries/regions

Sea freight	Auckland / Tāmaki Makaurau	Christchurch / Ōtautahi	Dunedin / Ōtepoti	Napier / Ahuriri	Wellington / Te Whanganui-a-Tara
Australia - East Coast	2,378	2,547	2,315	2,645	2,284
Australia - West Coast	5,936	5,517	5,212	5,997	5,636
Brazil	12,431	11,788	11,727	11,860	11,777
China	9,510	10,129	10,379	10,043	9,866
European Union	21,065	21,135	21,354	20,892	21,037
India	13,131	12,710	12,405	13,192	12,831
Ireland	20,492	20,563	20,781	20,320	20,465
Japan	8,980	9,642	9,955	9,514	9,379
Malaysia	9,464	9,964	9,642	10,014	9,701
New Zealand - Auckland / Tāmaki Makaurau	0	1,250	1,554	696	1,019
New Zealand - Christchurch / Ōtautahi	1,250	0	376	622	322
New Zealand - Dunedin / Ōtepoti	1,554	376	0	926	632
New Zealand - Tauranga	265	1,082	1,383	526	848
New Zealand - Napier / Ahuriri	696	622	926	0	389
New Zealand - Wellington / Te Whanganui-a-Tara	1,019	322	632	389	0
Russia	19,715	19,292	18,987	19,774	19,415
South Korea	9,366	10,027	10,340	9,901	9,764
Thailand	10,327	10,827	10,553	10,875	10,564
Turkey	18,029	17,607	17,301	18,090	17,729
United Kingdom	21,052	21,122	21,341	20,879	21,026
USA - East Coast	15,838	15,909	16,127	15,666	15,811
USA - West Coast	10,632	11,327	11,631	10,773	11,093

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

APPENDIX D: DEFAULT ASSUMPTIONS FOR LAND USE CHANGE

Table 15 provides Upfront Carbon emission factors for land use change when converting from one land use type (e.g., cropland) to built land (settlement). These values must be included in Module A5 for greenfield sites.

The values in Table 15 include the loss of above-ground biomass and the first year of the transition in soil carbon from one land use type to another. For land use types that that have significant above-ground biomass, the amount of carbon lost depends on the age of the crop/trees on the land.

Table 15: Module A5 land use change emissions (kg CO_2e per m^2 of land converted)

	Age of crop (years)										
Land converted from…	0	10	20	30	40	50	60	70	80	90	100
Cropland - Annual	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54
Cropland - Perennial	-0.32	2.14	4.59	7.05	9.51	11.96	14.42	16.88	19.33	21.79	24.25
Forest - Exotic	1.04	25.08	64.63	104.92	140.59	169.57	192.64	223.30	246.72	267.56	285.81
Forest - Natural	0.48	8.54	20.42	29.55	41.07	51.63	62.19	72.75	83.34	89.61	89.61
Grassland - High producing	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31
Grassland - Low producing	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Grassland - With woody biomass	4.66	11.59	21.82	29.67	39.57	48.62	57.72	66.81	75.90	85.00	89.73
Settlement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wetland - Open water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wetland - Vegetated	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Other land	-0.87	-0.87	-0.87	-0.87	-0.87	-0.87	-0.87	-0.87	-0.87	-0.87	-0.87

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Table 16 provides Whole-of-Life Embodied Carbon emission factors for land use change when converting from one land use type (e.g., cropland) to built land (settlement). These values should be reported in Module B1. They represent the change in soil carbon from one land use type to another – a process that is estimated to take 20 years following the IPCC's Tier 1 method, as used in *New Zealand's Greenhouse Gas Inventory*.

Table 16: Module B1 land use change emissions (kg CO_2e per m^2 of land converted)

Land converted from…	Long-term emissions (kg CO_2e per m^2 of land converted)
Cropland - Annual	-5.65
Cropland - Perennial	-6.11
Forest - Exotic	-4.90
Forest - Natural	-4.90
Grassland - High producing	-0.22
Grassland - Low producing	0.00
Grassland - With woody biomass	-2.70
Settlement	0.00
Wetland - Open water	0.00
Wetland - Vegetated	10.48
Other land	-16.58

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

The values in Table 15 and Table 16 were calculated by thinkstep-anz from *New Zealand's Greenhouse Gas Inventory 1990-2020* (MfE, 2022) for the original release of this document as per MfE (2022, p. 240):

The formula used to calculate emissions from biomass changes on land use conversion is:

$$\left(\text{Loss of biomass present in previous crop} \times \text{Activity data (Area)}\right) + \left(\text{Annual growth in biomass carbon stocks in new land use} \times \text{Activity data (Area)}\right) \quad (1)$$

The formula used to calculate emissions from mineral soil changes on land use conversion is:

$$\frac{\text{Mineral soil carbon at steady state in the new land use} - \text{Mineral soil carbon at steady state in the previous land use}}{\text{20 years (transition period)}} \times \left(\text{Activity data (Area)}\right) \quad (2)$$

The land use types in Table 15 and Table 16 are sub-categories of land use reported by New Zealand. Forest subcategories have been simplified by the species type: exotic (e.g. Pinus radiata) and native, due to very different growth rates. Indirect N_2O emissions from leaching and runoff of N_2O are not disaggregated at the national level for each land use type and so are excluded from the land use change model.

Intermediate calculation steps are shown in Table 17.

Table 17: Land use change to settlement – intermediate calculation steps

Land converted from	Crop age	Biomass carbon - old land use (t C/ha)	Biomass carbon - new land use (t C/ha)	Soil carbon - old land use (t C/ha)	Soil carbon - new land use (t C/ha)	Upfront carbon change (t C/ha)	Upfront CO_2 emissions (kg CO_2/m^2)	Long-term carbon change (t C/ha)	Long-term CO_2 emissions (kg CO_2/m^2)	Total carbon change (t C/ha)	Total CO_2 change (kg CO_2/m^2)
Cropland - Annual	n/a	5.00	0.00	89.77	105.98	-4.19	1.54	15.40	-5.65	11.21	-4.11
Cropland - Perennial	30 years	20.10	0.00	88.44	105.98	-19.22	7.05	16.66	-6.11	-2.56	0.94
Forest - Exotic	30 years	286.86	0.00	91.92	105.98	-286.16	104.92	13.36	-4.90	-272.80	100.03
Forest - Natural	Mature	245.10	0.00	91.92	105.98	-244.40	89.61	13.36	-4.90	-231.04	84.71
Grassland - High producing	n/a	6.35	0.00	105.34	105.98	-6.31	2.31	0.61	-0.22	-5.71	2.09
Grassland - Low producing	n/a	2.87	0.00	105.98	105.98	-2.87	1.05	0.00	0.00	-2.87	1.05
Grassland - With woody biomass	30 years	81.30	0.00	98.23	105.98	-80.91	29.67	7.36	-2.70	-73.55	26.97
Settlement	n/a	0.00	0.00	105.98	105.98	0.00	0.00	0.00	0.00	0.00	0.00
Wetland - Open water	n/a	0.00	0.00	105.98	105.98	0.00	0.00	0.00	0.00	0.00	0.00
Wetland - Vegetated	n/a	0.00	0.00	136.06	105.98	-1.50	0.55	-28.58	10.48	-30.08	11.03
Other land	n/a	0.00	0.00	58.37	105.98	2.38	-0.87	45.23	-16.58	47.61	-17.46

Note: This table is for information only and is not regularly updated.

Underlying data from the Ministry for the Environment (2022) is shown in Table 18.

Table 18: Land use change underlying data (based on MfE, 2022)

Category	Sub-category	Carbon in soil (t C/ha)	Time to steady state - soil (years)	Time to steady state - biomass (years)	Source for soil data	Source for biomass data
Forest	Forest - Exotic	91.92	20	20	Table A3.2.6 (MfE, 2022)	Average of Table A3.2.17, Table A3.2.18 and Table A3.2.19, with extrapolation (MfE, 2022)
Forest	Forest - Natural	91.92	20	20	Table A3.2.6 (MfE, 2022)	Table A3.2.15 for new growth and Table A3.2.13 for steady state, with extrapolation (MfE, 2022)
Cropland	Cropland - Annual	89.77	20	1	Table A3.2.6 (MfE, 2022)	Table 6.4.5 (MfE, 2022)
Cropland	Cropland - Perennial	88.44	20	28	Table A3.2.6 (MfE, 2022)	Table 6.4.5 (MfE, 2022)
Grassland	Grassland - High producing	105.34	20	1	Table A3.2.6 (MfE, 2022)	Table 6.5.4 (MfE, 2022)
Grassland	Grassland - Low producing	105.98	20	1	Table A3.2.6 (MfE, 2022)	Table 6.5.4 (MfE, 2022)
Grassland	Grassland - With woody biomass	98.23	20	20	Table A3.2.6 (MfE, 2022)	Table A3.2.16 for new growth and Table A3.2.13 for steady state, with extrapolation (MfE, 2022)
Wetland	Wetland - Open water	105.98	Unavailable		Table A3.2.6 (MfE, 2022)	No data in NZ's GHG Inventory for this land use type
Wetland	Wetland - Vegetated	136.06			Table A3.2.6 (MfE, 2022)	No data in NZ's GHG Inventory for this land use type
Settlement	Settlement	105.98	20		Table A3.2.6 (MfE, 2022)	No data in NZ's GHG Inventory for this land use type
Other land	Other land	58.37	20		Table A3.2.6 (MfE, 2022)	No data in NZ's GHG Inventory for this land use type

Note: This table is for information only and is not regularly updated.

APPENDIX E: DEFAULT ASSUMPTIONS FOR CONSTRUCTION ENERGY

Table 19 presents emissions factors for the use of energy on-site. These values are applicable in Module A5 and can be used for on-site construction activities and building commissioning. The emission factors are from the Ministry for the Environment (MfE, 2024). The electricity emission factor includes transmission and distribution losses.

Table 19: Emission factors for on-site construction (MfE, 2024)

Energy source	Unit	Emission factor (kg CO_2e/Unit)
Diesel	L	2.68
Petrol	L	2.37
Electricity (grid)	kWh	0.0782
Electricity (100% REC)	kWh	0

Note: This table is updated annually. *Please see https://nzgbc.org.nz/embodied-carbon for the latest data.*

APPENDIX F: DEFAULT ASSUMPTIONS FOR CONSTRUCTION WASTE

Table 20: Default construction waste rates and fates (Module A5) (reproduced from BRANZ)

			Construction waste fate			
Material	**Waste EF category**	**Waste rate***	**Reuse**	**Recycling**	**Energy Recovery**	**Landfill**
Aluminium	Aluminium	1%	0%	95%	0%	5%
Bitumen	Inert waste	5%	0%	0%	0%	100%
Blocks (AAC, solid)	Inert rubble	5%	90%	0%	0%	10%
Blocks (concrete, hollow)	Inert rubble	5%	90%	0%	0%	10%
Blocks (concrete, solid)	Inert rubble	5%	90%	0%	0%	10%
Bricks (clay)	Inert rubble	5%	90%	0%	0%	10%
Bricks (concrete)	Inert rubble	10%	0%	0%	0%	100%
Building wrap	Inert waste	2%	95%	0%	0%	5%
Chips/gravel	Inert rubble	5%	90%	0%	0%	10%
Clay (bentonite)	Inert rubble	0%	0%	0%	0%	100%
Composite panel	Inert waste	4%	0%	0%	0%	100%
Concrete (aerated autoclaved)	Inert rubble	4%	0%	10%	0%	90%
Concrete (in situ)	Inert rubble	4%	0%	10%	0%	90%
Concrete (in situ, light weight)	Inert rubble	4%	0%	10%	0%	90%
Concrete (in situ, light weight, fibre reinforced)	Inert rubble	0%	0%	100%	0%	0%
Concrete (precast)	Inert rubble	0%	0%	100%	0%	0%
Concrete (precast, light weight)	Inert rubble	1%	0%	95%	0%	5%
Copper	Copper	18%	25%	0%	0%	75%
Fibre cement sheets	Inert waste	1%	0%	0%	0%	100%
Glass	Inert waste	1%	0%	0%	0%	100%
Glass fibre reinforced cement (GRC) panels	Inert waste	10%	0%	0%	0%	100%
Grout	Inert waste	15%	0%	0%	0%	100%

			Construction waste fate			
Material	**Waste EF category**	**Waste rate***	**Reuse**	**Recycling**	**Energy Recovery**	**Landfill**
Insulation	Inert waste	15%	0%	0%	0%	100%
Insulation (board)	Inert waste	5%	0%	0%	0%	100%
Mastic asphalt waterproofing	Inert waste	5%	0%	0%	0%	100%
Mortar	Inert waste	10%	0%	0%	0%	100%
Plaster	Inert waste	5%	0%	0%	0%	100%
Plastics	Inert waste	10%	0%	25%	0%	75%
Plywood	Plywood	5%	0%	0%	0%	100%
Protective coating/decorative finish	Inert waste	23%	0%	10%	0%	90%
Sheet (gypsum wallboard)	Plasterboard	1%	0%	95%	0%	5%
Stainless steel	Steel	5%	0%	95%	0%	5%
Steel (reinforcing or mesh)	Steel	1%	0%	95%	0%	5%
Steel (sheet)	Steel	1%	5%	95%	0%	0%
Steel (structural)	Steel	5%	0%	0%	0%	100%
Stone (natural)	Inert rubble	10%	0%	0%	0%	100%
Tile (clay)	Inert rubble	10%	0%	0%	0%	100%
Tile (concrete)	Inert rubble	10%	0%	75%	0%	25%
Timber (solid)	Inert rubble	5%	0%	25%	0%	75%
Timber (engineered wood) eg. laminates, LVL, glulam	Timber (engineered wood)	10%	0%	25%	0%	75%
Timber (engineered panels) eg. MDF, OSB, particleboard	Timber (engineered panels)	1%	0%	95%	0%	5%
Zinc	Zinc	10%	0%	0%	0%	100%
Miscellaneous materials - waste	Inert waste	0%	0%	0%	0%	100%
Miscellaneous materials - no waste	Inert waste	1%	0%	95%	0%	5%

** Waste rate is expressed as the mass of waste divided by the mass of material installed in the building.*

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data*

Source: BRANZ (2016) *"Construction Site Waste Data - % by Mass that becomes Waste during Building Construction" for Module A5 (v1.0, 09/05/2016).*

APPENDIX G: DEFAULT ASSUMPTIONS FOR MATERIAL LIFETIME AND END-OF-LIFE

Table 21: Default lifetime assumptions (module B) and end-of-life fate (module C) per building product type (compilation of BRANZ data)

	Default lifetime when located in…				End-of-life fate (Module C3, C4 & D)			
Material	**Structure (years)**	**Enclosure (years)**	**Interior (years)**	**Finish (years)**	**Reuse**	**Recycling**	**Energy Recovery**	**Landfill**
Aluminium	100	Variable[a]	60	N/A	0%	100%	0%	0%
Bitumen	N/A	20[b]	N/A	N/A	0%	10%	0%	90%
Blocks (AAC, solid)	100	60	N/A	N/A	0%	20%	0%	80%
Blocks (concrete, hollow)	100	60	N/A	N/A	0%	100%	0%	0%
Blocks (concrete, solid)	100	60	N/A	N/A	10%	90%	0%	0%
Bricks (clay)	100	100	N/A	N/A	10%	90%	0%	0%
Bricks (concrete)	100	50	N/A	N/A	10%	90%	0%	0%
Building wrap	N/A	60	N/A	N/A	0%	0%	0%	100%
Chips/gravel	N/A	N/A	N/A	N/A	100%	0%	0%	0%
Clay (bentonite)	N/A	N/A	N/A	N/A	0%	0%	0%	100%
Composite panel	100	60	90	N/A	0%	25%	0%	75%
Concrete (aerated autoclaved)	100	N/A	N/A	N/A	0%	20%	0%	80%
Concrete (in situ)	100	N/A	N/A	N/A	0%	100%	0%	0%
Concrete (in situ, light weight)	100	N/A	N/A	N/A	0%	100%	0%	0%
Concrete (in situ, light weight, fibre reinforced)	100	N/A	N/A	N/A	0%	0%	0%	100%
Concrete (precast)	100	N/A	N/A	N/A	0%	100%	0%	0%
Concrete (precast, light weight)	100	N/A	N/A	N/A	0%	100%	0%	0%
Copper	N/A	250	N/A	N/A	0%	100%	0%	0%
Fibre cement sheets	N/A	50	60	N/A	10%	10%	0%	80%
Glass	N/A	60	60	60	0%	20%	0%	80%
Glass fibre reinforced cement (GRC) panels	100	60	20	N/A	0%	50%	0%	50%
Grout	100	50	N/A	N/A	0%	90%	0%	10%

	Default lifetime when located in…				End-of-life fate (Module C3, C4 & D)			
Material	**Structure (years)**	**Enclosure (years)**	**Interior (years)**	**Finish (years)**	**Reuse**	**Recycling**	**Energy Recovery**	**Landfill**
Insulation	N/A	50	60	N/A	5%	0%	0%	95%
Insulation (board)	N/A	60	N/A	N/A	5%	0%	0%	95%
Mastic asphalt waterproofing	N/A	60	N/A	N/A	0%	10%	0%	90%
Mortar	100	60	N/A	60	0%	90%	0%	10%
Plaster	N/A	50	90	Unknown	0%	0%	0%	100%
Plastics	N/A	60	60	15	0%	60%	0%	40%
Plywood	N/A	60	90	60	5%	10%	10%	75%
Protective coating/decorative finish	100	100	60	90	0%	0%	0%	100%
Sheet (gypsum wallboard)	N/A	90	90	N/A	0%	95%	0%	5%
Stainless steel	100	100	N/A	N/A	0%	100%	0%	0%
Steel (reinforcing or mesh)	100	60	N/A	N/A	0%	100%	0%	0%
Steel (sheet)	100	Variable[c]	60	N/A	0%	100%	0%	0%
Steel (structural)	100	90	60	N/A	10%	90%	0%	0%
Stone (natural)	N/A	60	20	60	10%	90%	0%	0%
Tile (clay)	N/A	75	N/A	60	10%	90%	0%	0%
Tile (concrete)	N/A	75	N/A	N/A	10%	90%	0%	0%
Timber (solid)	100	60	90	60	10%	50%	15%	25%
Timber (engineered wood) eg. laminates, LVL, glulam	100	60	90	35	5%	10%	10%	75%
Timber (engineered panels) eg. MDF, OSB, particleboard	100	40	90	N/A	5%	10%	10%	75%
Zinc	N/A	100	N/A	N/A	0%	100%	0%	0%
Miscellaneous materials	N/A	N/A	N/A	N/A	0%	0%	0%	100%

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Source: BRANZ. This table is a compilation of data from BRANZ:

- Material lifetime data comes from BRANZ's "Replacement by CBI Code Datasheet" for Module B4. While the data in Table 21 is provided at the material level for simplicity, in practice the lifetime of a material also depends upon the building product and/or Building Element that it is a part of.

- End-of-life data comes from BRANZ's "Building End of Life Waste Datasheet - Waste from NZ Commercial Buildings by Material" for Module C1. The "Best practice (case studies/future)" columns have been used as building end-of-life is a future scenario, likely taking place decades from now.

[a] "Considering environmental conditions in corrosion zone B (very limited pollution and marine salt), and based on BRANZ testing, prepainted powder coated aluminium should last more than 60 years. Anodised aluminium should last 100 years in zone B (tests performed in New Zealand have confirmed that unsealed and completely sealed anodic coatings (>20 um) can provide a service life longer than 100 years). In corrosion zones C, D and E powder coated aluminium is estimated to last 25 years, 20 years and 20 years respectively. Anodised aluminium is estimated to last 30 years, 30 years and 25 years in each of corrosion [sic] zones C, D and E. Potential risk of galvanic corrosion when in contact with copper or timber treated with copper-bearing preservatives. If water runs off of copper or brass onto aluminium, rapid corrosion can occur. Aluminium has a low uniform rate of corrosion. Corrosion is dependent on localised issues caused by a [range] of factors such as product quality, installation quality (in particular, how fixed) and presence of atmospheric corrosive salts (chloride), which can lead to pitting." (BRANZ Module B4 Datasheet v1.01)

[b] Assuming bitumen-based sheet roofing. Replacement material can generally be laid directly over the old material.

[c] For pre-painted steel with a zinc/aluminium metal coating:
"Depends on corrosion zone, thickness and quality of aluminium/zinc alloy coating. Use of product with 150 g/m2 aluminium/zinc coating thickness (AZ150) + organic coat in corrosion zone B and zone C is estimated to have a service life of 45 years and 15 years respectively. The product is not recommended for this application in corrosion zones D and E. Use of product with 200 g/m2 aluminium/zinc coating thickness (AZ200) + organic coat in corrosion zone B and zone C is estimated to have a service life of 60 years and 15 years respectively. The estimated service life of the product in corrosion zone D is 15 years. It is not recommnended [sic] for application in corrosion zone E." (BRANZ Module B4 Datasheet v1.01)

[c] For pre-pained steel with a aluminium/zinc/magnesium coasting:
"Depends on corrosion zone, thickness and quality of aluminium/zinc/magnesium alloy coating. Use of product with 200 g/m2 aluminium/zinc/magnesium coating thickness + organic coat in corrosion zone B, C and D is estimated to have a service life of 60 years, 25 years and 20 years respectively. The product is not recommended for this application in corrosion zone E. Contact should be avoided with discharges of water from copper or brass pipes. Non-galvanised steel, copper, brass, lead, stainless steel or monel metal should not be in direct contact (including lead flashings). Treated timber containing copper-bearing preservatives should not be in direct contact." (BRANZ Module B4 Datasheet v1.01)

APPENDIX H: DEFAULT EMISSION FACTORS FOR WASTE TREATMENT

This section provides tables of emission factors for different types of waste treatment. These emission factors should be used for construction waste (Module A5), renovation/refurbishment waste (Modules B4 and B5) and end-of-life waste (Module C).

The data provided in this section is highly aggregated to reflect end-of-life treatment in a typical building after demolition, where many of the heavy building elements (concrete, masonry, bricks, tiles) become rubble for recycling or disposal, and only a relatively small number of material categories (typically metals, timber and engineered wood products) are separated for alternative processing. Specific end-of-life data for certain materials can be used where it is available and where specific building products are separately collected for disposal, recycling or recovery.

Building products used in Module A and Module B should be classified into these groups to calculate end-of-life carbon emissions. Default assignments of building product categories within BRANZ's CO_2NSTRUCT database per end-of-life category are provided in Table 32.

For demolition (Module C1), the entire weight of the building should be calculated and multiplied by:

- Table 22: Demolition (Module C1) per kg of material

For recycling at end-of-life, the weighted-average recycled content of each incoming material must be calculated to correctly calculate the Module D recycling credits. These credits depend on the recycled content of each input material. Table 24 and Table 25 provide recycling potential (i.e., avoided impacts of primary production) in Module D for 0% recycled content and 100% recycled content. Module D credits must be pro-rated by recycled content.

- Table 23: Recycling (Module C3) per kg of material
- Table 24: Recycling potential (Module D) with ~0% recycled content in A1-A3, per kg of material
- Table 25: Recycling potential (Module D) with ~100% recycled content in A1-A3, per kg of material

For reuse at end-of-life:

- Table 26: Reuse (Module C3) per kg of material
- Table 27: Reuse (Module D) per kg of material

For energy recovery at end-of-life:

- Table 28: Energy recovery (Module C3) per kg of material
- Table 29: Energy recovery (Module D) per kg of material

For landfill at end-of-life, emission factors are provided for both EN 15804+A1 and EN 15804+A2. The difference between these two methods is that EN 15804+A2 requires all carbon calculated to still be stored in landfill after 100 years to be treated as if it was emitted to air as CO_2.

- Table 30: Landfill (Module C4) following EN 15804+A1 per kg of material
- Table 31: Landfill (Module C4) following EN 15804+A2 per kg of material

There are many studies which show that carbon is likely to be stored in timber in landfill over the long term, and potentially indefinitely. Examples include:

- Barlaz, M. (1998). Carbon storage during biodegradation of municipal solid waste components in laboratory scale landfills. *Global Biogeochemical Cycles, 12*(2), pp. 373–380.
- Wang, W., Padgett, J., De La Cruz, F. and Barlaz, M. (2011). Wood biodegradation in laboratory-scale landfills. *Environmental Science & Technology, 45*(16), pp. 6864-6871.
- Ximenes, F., Brooks, P., Wilson, C. and Giles, D. (2013). Carbon Storage in Engineered Wood Products in Landfills. Forest and Wood Products Australia.

Table 22: Demolition (Module C1) per kg of material

Material	GWPT ($kg CO_2e/kg$)	GWPF ($kg CO_2e/kg$)	GWPB ($kg CO_2e/kg$)	GWPLULUC ($kg CO_2e/kg$)	Source
Demolition (per kg of building)	0.000633	0.000633	0	0	EN 15804+A1 GWP (total) indicator for C1 from Stevenson (2022). "Ready-Mix Concrete". EPD No. S-P-03727. Version 1.0 of 24 January 2022. EPD Australasia.

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Table 23: Recycling (Module C3) per kg of material

Material	GWPT ($kg CO_2e/kg$)	GWPF ($kg CO_2e/kg$)	GWPB ($kg CO_2e/kg$)	GWPLULUC ($kg CO_2e/kg$)	Source
Aluminium	0.00873	0.00873	0	0	Based on "Steel"
Aluminium (in product)	0.00873	0.00873	0	0	Based on "Steel"
Carpet	0.00577	0.00577	0	0	GUT (2016). "Tufted carpet tiles - luxury class LC1-LC5 - with 1200 g/m² maximum surface pile weight - pile material made of polyamide 6.6, bitumen based heavy backing". EPD-GUT-20160019-CCA1-EN. Version of 11 March 2016. Institut Bauen und Umwelt e.V. (IBU).
Copper	0.00873	0.00873	0	0	Based on "Steel"
Copper (in product)	0.00873	0.00873	0	0	Based on "Steel"

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Inert rubble	0.00163	0.00163	0	0	Based on combustion of 0.52 L of diesel per tonne of recycled crushed concrete produced * EF of 3.65 kg CO2e/kg * 0.86 kg/L diesel from Vickers, Riordan & Kershaw (2022). "Life cycle assessment of pavements: Development of a calculator". Waka Kotahi NZ Transport Agency.
Inert waste	N/A	N/A	N/A	N/A	N/A. This category is for general waste that is typically not recyclable.
Paper	1.65	0	1.65	0	Calculated assuming 10% water content (=air dry paper) and 50% of the dry content is carbon
Plasterboard	0	0	0	0	No data
Plywood	1.76	0.163	1.60	0	"Formply A-bond 17 mm" from FWPA (2017). "Environmental Product Declaration for Plywood". Version 1.2 of 8 December 2017. EPD Australasia.
Stainless steel	0.00873	0.00873	0	0	Based on "Steel"
Steel	0.00873	0.00873	0	0	Pacific Steel (2018). "Pacific Steel Environmental Product Declaration". EPD No. S-P-01002. Version 1.0 of 25 October 2018. EPD Australasia. Scaled up to account for 11% landfill rate (and 89% recycling rate) assumed.
Steel (in product)	0.00873	0.00873	0	0	Based on "Steel"
Straw bale	1.65	0	1.65	0	Calculated assuming 10% water content and 50% of the dry content is carbon
Timber (engineered panels)	1.72	0.161	1.56	0.0000	"Thick, uncoated MDF" from Daiken (2019). "Medium Density Fibreboard (MDF) Environmental Product Declaration". EPD No. S-P-01168. Version 1.0 of 25 January 2019. EPD Australasia. The density is an estimate from FWPA EPD which states a range of 701-732 kg/m3 for MDF because Daiken provide a very large range (350 to 750 kg/m3).
Timber (engineered wood)	1.65	0.0102	1.64	0	Red Stag (2022). "Environmental Product Declaration for Cross Laminated Timber". EPD No. S-P-03711. Version 1.0 of 28 February 2022. EPD Australasia.

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Timber (solid)	1.65	0.0100	1.64	0	"Sawn kiln dried radiata pine" from WPMA (2021). "Environmental Product Declaration for Solid, Finger-Jointed and Laminated Timber Products including timber preservation options". EPD No. S-P-00997. Version 1.1 of 9 September 2021. EPD Australasia.
Zinc	0.00873	0.00873	0	0	Based on "Steel"

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Table 24: Recycling potential (Module D) with ~0% recycled content in A1-A3, per kg of material

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Aluminium	-14.0	-14.0	0.0000	0.0000	Calculated as the difference between primary and secondary production of aluminium in China, the world's largest aluminium producer, and accounting for 10,000 km sea freight from NZ to China. New Zealand has no large-scale domestic aluminium recycling capability, meaning most is exported, and China is by far the world's largest producer of aluminium. Peng et al. (2019). "Life-cycle analysis of energy consumption and GHG emissions of aluminium production in China". Energy Procedia 158 (2019) 3937–3943.
Aluminium (in product)	-6.98	-6.98	0	0	Based on "Aluminium". Assume 50% of the material is aluminium.
Carpet	-0.108	-0.108	0	0	GUT (2016). "Tufted carpet tiles - luxury class LC1-LC5 - with 1200 g/m² maximum surface pile weight - pile material made of polyamide 6.6, bitumen based heavy backing". EPD-GUT-20160019-CCA1-EN. Version of 11 March 2016. Institut Bauen und Umwelt e.V. (IBU).

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Copper	-4.10	-4.10	0	0	Inverse of copper from ICA (2021). "Copper Environmental Profile". International Copper Association. The blend of primary and secondy steel used in this dataset is approximately similar to the impacts of (primary production minus secondary production).
Copper (in product)	-2.05	-2.05	0	0	Based on "Copper". Assume 50% of the material is copper.
Inert rubble	-0.00386	-0.00386	0	0	Based on avoided carbon footprint of 1 kg of "Aggregate (Hard Rock)" from Vickers, Riordan & Kershaw (2022). "Life cycle assessment of pavements: Development of a calculator". Waka Kotahi NZ Transport Agency.
Inert waste	0	0	0	0	No credit awarded due to the wide mix of materials and uncertainty over what would be avoided
Paper	0	0	0	0	No data
Plasterboard	0	0	0	0	No data
Plywood	-0.275	-0.263	-0.0121	0.0000	"Formply A-bond 17 mm" from FWPA (2017). "Environmental Product Declaration for Plywood". Version 1.2 of 8 December 2017. EPD Australasia.
Stainless steel	-3.71	-3.71	0	0	Approximated as the inverse of unweighted average of stainless steels in BRANZ CO2NSTRUCT. These products contain a mix of primary and secondary metal content, which is similar to the impacts of (primary production minus secondary production).
Steel	-1.45	-1.45	0	0	Pacific Steel (2018). "Pacific Steel Environmental Product Declaration". EPD No. S-P-01002. Version 1.0 of 25 October 2018. EPD Australasia. Scaled up to account for 11% landfill rate (and 89% recycling rate) assumed.
Steel (in product)	-0.725	0.725	0	0	Based on "Steel". Assume 50% of the material is steel.
Straw bale	0	0	0	0	N/A

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Timber (engineered panels)	-0.0259	-0.0251	-0.000800	0	"Thick, uncoated MDF" from Daiken (2019). "Medium Density Fibreboard (MDF) Environmental Product Declaration". EPD No. S-P-01168. Version 1.0 of 25 January 2019. EPD Australasia. The density is an estimate from FWPA EPD which states a range of 701-732 kg/m3 for MDF because Daiken provide a very large range (350 to 750 kg/m3).
Timber (engineered wood)	-0.0498	-0.0488	-0.00110	0	Red Stag (2022). "Environmental Product Declaration for Cross Laminated Timber". EPD No. S-P-03711. Version 1.0 of 28 February 2022. EPD Australasia.
Timber (solid)	-0.0372	-0.0361	-0.00110	0	"Sawn kiln dried radiata pine" from WPMA (2021). "Environmental Product Declaration for Solid, Finger-Jointed and Laminated Timber Products including timber preservation options". EPD No. S-P-00997. Version 1.1 of 9 September 2021. EPD Australasia.
Zinc	-2.98	-2.98	0	0	Approximated as the inverse of unweighted average of zincs in BRANZ CO_2NSTRUCT. These products contain a mix of primary and secondary zinc content, which is similar to the impacts of (primary production minus secondary production).

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Table 25: Recycling potential (Module D) with ~100% recycled content in A1-A3, per kg of material

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Aluminium	0	0	0	0	No credit if 100% recycled content
Aluminium (in product)	0	0	0	0	No credit if 100% recycled content

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Carpet	-0.108	-0.108	0	0	GUT (2016). "Tufted carpet tiles - luxury class LC1-LC5 - with 1200 g/m² maximum surface pile weight - pile material made of polyamide 6.6, bitumen based heavy backing". EPD-GUT-20160019-CCA1-EN. Version of 11 March 2016. Institut Bauen und Umwelt e.V. (IBU).
Copper	0	0	0	0	No credit if 100% recycled content
Copper (in product)	0	0	0	0	No credit if 100% recycled content
Inert rubble	0	0	0	0	No credit if 100% recycled content
Inert waste	N/A	N/A	N/A	N/A	N/A
Paper	0	0	0	0	No data
Plasterboard	0	0	0	0	No data
Plywood	-0.275	-0.263	-0.0121	0	"Formply A-bond 17 mm" from FWPA (2017). "Environmental Product Declaration for Plywood". Version 1.2 of 8 December 2017. EPD Australasia.
Stainless steel	0	0	0	0	No credit if 100% recycled content
Steel	0.0717	0.0713	0.000400	0	PT Gunung Raja Paksi Tbk (2022). "Structural Steel Welded I-Section (Meeting: AS/NZS 3679.2:2016)". Version 1.0 of 22 February 2022. EPD Southeast Asia.
Steel (in product)	0.0717	0.0713	0.000400	0	Based on "Steel"
Straw bale	0	0	0	0	No data
Timber (engineered panels)	-0.0259	-0.0251	-0.000800	0	"Thick, uncoated MDF" from Daiken (2019). "Medium Density Fibreboard (MDF) Environmental Product Declaration". EPD No. S-P-01168. Version 1.0 of 25 January 2019. EPD Australasia. The density is an estimate from FWPA EPD which states a range of 701-732 kg/m3 for MDF because Daiken provide a very large range (350 to 750 kg/m3).
Timber (engineered wood)	-0.0498	-0.0488	-0.00110	0	Red Stag (2022). "Environmental Product Declaration for Cross Laminated Timber". EPD No. S-P-03711. Version 1.0 of 28 February 2022. EPD Australasia.

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Timber (solid)	-0.0372	-0.0361	-0.00110	0	"Sawn kiln dried radiata pine" from WPMA (2021). "Environmental Product Declaration for Solid, Finger-Jointed and Laminated Timber Products including timber preservation options". EPD No. S-P-00997. Version 1.1 of 9 September 2021. EPD Australasia.
Zinc	0	0	0	0	No credit if 100% recycled content

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Table 26: Reuse (Module C3) per kg of material

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Aluminium	0	0	0	0	Assumed to be burden free
Aluminium (in product)	0	0	0	0	Assumed to be burden free
Carpet	0	0	0	0	Assumed to be burden free
Copper	0	0	0	0	Assumed to be burden free
Copper (in product)	0	0	0	0	Assumed to be burden free
Inert rubble	0	0	0	0	Assumed to be burden free
Inert waste	0	0	0	0	Assumed to be burden free
Paper	1.65	0	1.65	0	Calculated assuming 10% water content (=air dry paper) and 50% of the dry content is carbon
Plasterboard	0.0904	0	0.0904	0	Assumed to be burden free, but adjust for paper exported to the next product system (as stored biogenic carbon is an inherent property of the paper)
Plywood	1.76	0.163	1.60	0	"Formply A-bond 17 mm" from FWPA (2017). "Environmental Product Declaration for Plywood". Version 1.2 of 8 December 2017. EPD Australasia.
Stainless steel	0	0	0	0	Assumed to be burden free

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Steel	0	0	0	0	Assumed to be burden free
Steel (in product)	0	0	0	0	Assumed to be burden free
Straw bale	1.65	0	1.65	0	Calculated assuming 10% water content and 50% of the dry content is carbon
Timber (engineered panels)	1.72	0.161	1.56	0	"Thick, uncoated MDF" from Daiken (2019). "Medium Density Fibreboard (MDF) Environmental Product Declaration". EPD No. S-P-01168. Version 1.0 of 25 January 2019. EPD Australasia. The density is an estimate from FWPA EPD which states a range of 701-732 kg/m3 for MDF because Daiken provide a very large range (350 to 750 kg/m3).
Timber (engineered wood)	1.65	0.0102	1.64	0	Red Stag (2022). "Environmental Product Declaration for Cross Laminated Timber". EPD No. S-P-03711. Version 1.0 of 28 February 2022. EPD Australasia.
Timber (solid)	1.64	0	1.64	0	"Sawn kiln dried radiata pine" from WPMA (2021). "Environmental Product Declaration for Solid, Finger-Jointed and Laminated Timber Products including timber preservation options". EPD No. S-P-00997. Version 1.1 of 9 September 2021. EPD Australasia.
Zinc	0	0	0	0	Assumed to be burden free

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Table 27: Reuse (Module D) per kg of material

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Aluminium	-14.7	-14.7	0	0	Primary aluminium production from Peng et al. (2019). "Life-cycle analysis of energy consumption and GHG emissions of aluminium production in China". Energy Procedia 158 (2019) 3937–3943. New Zealand has no large-scale domestic aluminium recycling capability, meaning most is exported, and China is by far the world's largest producer of aluminium.
Aluminium (in product)	-7.39	-7.39	0	0	Based on "Aluminium". Assume 50% of the material is aluminium.
Carpet	-3.48	-3.48	0	0	Inverse of unweighted average of carpets in BRANZ CO_2NSTRUCT
Copper	-4.10	-4.10	0	0	Inverse of copper from ICA (2021). "Copper Environmental Profile". International Copper Association.
Copper (in product)	-2.05	-2.05	0	0	Based on "Copper". Assume 50% of the material is copper.
Inert rubble	-0.110	-0.110	0	0	The rubble category is primarily concrete. If reused before it is rubble, the impact of primary concrete is avoided. Assume "North Island" average for 30 MPa concrete from Firth (2020). "Environmental Product Declaration for Ready-mixed Concrete". Version 1.0 of 18 September 2020. EPD Australasia.
Inert waste	N/A	N/A	N/A	N/A	Inert waste is unlikely to be reused and is typically landfilled
Paper	N/A	N/A	N/A	N/A	Paper is unlikely to be reused
Plasterboard	-0.269	-0.269	0	0	Inverse of "GIB® Standard 13mm" from Winstone Wallboards (2018). "Environmental Product Declaration for GIB® Plasterboard". EPD No. S-P-01000. Version 1.1 of 1 March 2018. EPD Australasia. GIB has a >90% market share in NZ as of early 2022.
Plywood	-1.02	-1.02	0	0	"Formply A-bond 17 mm" from FWPA (2017). "Environmental Product Declaration for Plywood". Version 1.2 of 8 December 2017. EPD Australasia.

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Stainless steel	-3.71	-3.71	0	0	Inverse of unweighted average of stainless steels in BRANZ CO_2NSTRUCT
Steel	-2.75	-2.75	0	0	Inverse of structural steel in BRANZ CO2NSTRUCT, "Steel, welded beams and columns (350 WC to 1200 WB), unpainted, imported (BlueScope, Australia)"
Steel (in product)	-1.38	1.38	0	0	Based on "Steel". Assume 50% of the material is steel.
Straw bale	0	0	0	0	No data available
Timber (engineered panels)	0	0	0	0	Not present in EPD from Daiken. Engineered panels are also unlikely to be reused due to breakage during deinstallation and reinstallation.
Timber (engineered wood)	-0.137	-0.137	0	0	Red Stag (2022). "Environmental Product Declaration for Cross Laminated Timber". EPD No. S-P-03711. Version 1.0 of 28 February 2022. EPD Australasia.
Timber (solid)	-0.111	-0.105	-0.00560	0	"Sawn kiln dried radiata pine" from WPMA (2021). "Environmental Product Declaration for Solid, Finger-Jointed and Laminated Timber Products including timber preservation options". EPD No. S-P-00997. Version 1.1 of 9 September 2021. EPD Australasia.
Zinc	-2.98	-2.98	0	0	Inverse of unweighted average of zincs in BRANZ CO_2NSTRUCT

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Table 28: Energy recovery (Module C3) per kg of material

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Aluminium	N/A	N/A	N/A	N/A	Not applicable. Not typically combusted in New Zealand.
Aluminium (in product)	N/A	N/A	N/A	N/A	Not applicable. Not typically combusted in New Zealand.

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Carpet	N/A	N/A	N/A	N/A	Not applicable. Insufficient energy content for energy recovery. See incineration.
Copper	N/A	N/A	N/A	N/A	Not applicable. Insufficient energy content for energy recovery.
Copper (in product)	N/A	N/A	N/A	N/A	Not applicable. Insufficient energy content for energy recovery.
Inert rubble	N/A	N/A	N/A	N/A	Not applicable. Insufficient energy content for energy recovery.
Inert waste	N/A	N/A	N/A	N/A	Not applicable. Insufficient energy content for energy recovery.
Paper	1.65	0	1.65	0	Calculated assuming 10% water content (=air dry paper) and 50% of the dry content is carbon
Plasterboard	0	0	0	0	Not applicable. Insufficient energy content for energy recovery.
Plywood	1.76	0.163	1.60	0	"Formply A-bond 17 mm" from FWPA (2017). "Environmental Product Declaration for Plywood". Version 1.2 of 8 December 2017. EPD Australasia.
Stainless steel	N/A	N/A	N/A	N/A	Not applicable. Insufficient energy content for energy recovery.
Steel	N/A	N/A	N/A	N/A	Not applicable. Insufficient energy content for energy recovery.
Steel (in product)	N/A	N/A	N/A	N/A	Not applicable. Insufficient energy content for energy recovery.
Straw bale	1.65	0	1.65	0	Calculated assuming 10% water content and 50% of the dry content is carbon
Timber (engineered panels)	1.72	0.161	1.56	0	"Thick, uncoated MDF" from Daiken (2019). "Medium Density Fibreboard (MDF) Environmental Product Declaration". EPD No. S-P-01168. Version 1.0 of 25 January 2019. EPD Australasia. The density is an estimate from FWPA EPD which states a range of 701-732 kg/m3 for MDF because Daiken provide a very large range (350 to 750 kg/m3).
Timber (engineered wood)	1.65	0.0102	1.64	0	Red Stag (2022). "Environmental Product Declaration for Cross Laminated Timber". EPD No. S-P-03711. Version 1.0 of 28 February 2022. EPD Australasia.

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Timber (solid)	1.65	0.0100	1.64	0	"Sawn kiln dried radiata pine" from WPMA (2021). "Environmental Product Declaration for Solid, Finger-Jointed and Laminated Timber Products including timber preservation options". EPD No. S-P-00997. Version 1.1 of 9 September 2021. EPD Australasia.
Zinc	N/A	N/A	N/A	N/A	Not applicable. Insufficient energy content for energy recovery.

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Table 29: Energy recovery (Module D) per kg of material

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Aluminium	N/A	N/A	N/A	N/A	N/A
Aluminium (in product)	N/A	N/A	N/A	N/A	N/A
Carpet	-0.7216	-0.721	0	0	GUT (2016). "Tufted carpet tiles - luxury class LC1-LC5 - with 1200 g/m² maximum surface pile weight - pile material made of polyamide 6.6, bitumen based heavy backing". EPD-GUT-20160019-CCA1-EN. Version of 11 March 2016. Institut Bauen und Umwelt e.V. (IBU).
Copper	N/A	N/A	N/A	N/A	N/A
Copper (in product)	N/A	N/A	N/A	N/A	N/A
Inert rubble	N/A	N/A	N/A	N/A	N/A
Inert waste	N/A	N/A	N/A	N/A	N/A
Paper	N/A	N/A	N/A	N/A	No data available
Plasterboard	N/A	N/A	N/A	N/A	N/A
Plywood	-1.01	-1.01	0.00250	0	"Formply A-bond 17 mm" from FWPA (2017). "Environmental Product Declaration for Plywood". Version 1.2 of 8 December 2017. EPD Australasia.

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Stainless steel	N/A	N/A	N/A	N/A	N/A
Steel	N/A	N/A	N/A	N/A	N/A
Steel (in product)	N/A	N/A	N/A	N/A	N/A
Straw bale	N/A	N/A	N/A	N/A	No data available
Timber (engineered panels)	-1.569	-1.571	0.00250	0	"Thick, uncoated MDF" from Daiken (2019). "Medium Density Fibreboard (MDF) Environmental Product Declaration". EPD No. S-P-01168. Version 1.0 of 25 January 2019. EPD Australasia. The density is an estimate from FWPA EPD which states a range of 701-732 kg/m3 for MDF because Daiken provide a very large range (350 to 750 kg/m3).
Timber (engineered wood)	-1.119	-1.12	0.00230	0	Red Stag (2022). "Environmental Product Declaration for Cross Laminated Timber". EPD No. S-P-03711. Version 1.0 of 28 February 2022. EPD Australasia.
Timber (solid)	-1.10	-1.10	0.00260	0	"Sawn kiln dried radiata pine" from WPMA (2021). "Environmental Product Declaration for Solid, Finger-Jointed and Laminated Timber Products including timber preservation options". EPD No. S-P-00997. Version 1.1 of 9 September 2021. EPD Australasia.
Zinc	N/A	N/A	N/A	N/A	N/A

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Table 30: Landfill (Module C4) following EN 15804+A1 per kg of material

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Aluminium	0.0143	0.0143	0	0	Based on "Inert rubble"
Aluminium (in product)	0.0143	0.0143	0	0	Based on "Inert rubble"

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Carpet	0.877	0.877	0	0	GUT (2016). "Tufted carpet tiles - luxury class LC1-LC5 - with 1200 g/m² maximum surface pile weight - pile material made of polyamide 6.6, bitumen based heavy backing". EPD-GUT-20160019-CCA1-EN. Version of 11 March 2016. Institut Bauen und Umwelt e.V. (IBU).
Copper	0.0143	0.0143	0	0	Based on "Inert rubble"
Copper (in product)	0.0143	0.0143	0	0	Based on "Inert rubble"
Inert rubble	0.0143	0.0143	0	0	EN 15804+A1 GWP (total) indicator for C4 from Stevenson (2022). "Ready-Mix Concrete". EPD No. S-P-03727. Version 1.0 of 24 January 2022. EPD Australasia.
Inert waste	0.0143	0.0143	0	0	EN 15804+A1 GWP (total) indicator for C4 from Stevenson (2022). "Ready-Mix Concrete". EPD No. S-P-03727. Version 1.0 of 24 January 2022. EPD Australasia.
Paper	1.82	0.0143	1.81	0	Fossil emissions for inert waste are used, as this represents the landfill itself. Biogenic emissions for "Paper" waste is overlaid from MfE (2022). "Measuring emissions: A guide for organisations". Ministry for the Environment. Assume 50/50 split between landfills with and without landfill gas capture. DOC = 45% (air dry paper @ 10% water content), DOCf = 49%.
Plasterboard	0.230	0.0844	0.146	0	"GIB® Standard 13mm" from Winstone Wallboards (2018). "Environmental Product Declaration for GIB® Plasterboard". EPD No. S-P-01000. Version 1.1 of 1 March 2018. EPD Australasia. DOCf 49% for paper component and DOCf 84% for starch component (NGA Factors 2021, Table 48).
Plywood	0.193	0.114	0.0799	0	"Landfill (typical)" from "Formply A-bond 17 mm" from FWPA (2017). "Environmental Product Declaration for Plywood". Version 1.2 of 8 December 2017. EPD Australasia. DOC = 0.43 (MfE 2022 guidance for organisations), DOCf = 1.4% from EPD.
Stainless steel	0.0478	0.0478	0	0	Based on "Steel"

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Steel	0.0478	0.0478	0	0	Pacific Steel (2018). "Pacific Steel Environmental Product Declaration". EPD No. S-P-01002. Version 1.0 of 25 October 2018. EPD Australasia. Scaled up to account for 11% landfill rate (and 89% recycling rate) assumed.
Steel (in product)	0.0478	0.0478	0	0	Pacific Steel (2018). "Pacific Steel Environmental Product Declaration". EPD No. S-P-01002. Version 1.0 of 25 October 2018. EPD Australasia. Scaled up to account for 11% landfill rate (and 89% recycling rate) assumed.
Straw bale	1.03	0.0143	1.02	0	Fossil emissions for inert waste are used, as this represents the landfill itself. Biogenic emissions for "Paper" waste is overlaid from MfE (2022). "Measuring emissions: A guide for organisations". Ministry for the Environment. Assume 50/50 split between landfills with and without landfill gas capture. DOC = 0.32, DOCf = 0.5
Timber (engineered panels)	0.118	0.0793	0.0390	0	"Thick, uncoated MDF" from Daiken (2019). "Medium Density Fibreboard (MDF) Environmental Product Declaration". EPD No. S-P-01168. Version 1.0 of 25 January 2019. EPD Australasia. The density is an estimate from FWPA EPD which states a range of 701-732 kg/m3 for MDF because Daiken provide a very large range (350 to 750 kg/m3). DOC = 0.43 (MfE 2022 guidance for organisations), DOCf = 0.7% from EPD.
Timber (engineered wood)	0.115	0.110	0.00470	0	Red Stag (2022). "Environmental Product Declaration for Cross Laminated Timber". EPD No. S-P-03711. Version 1.0 of 28 February 2022. EPD Australasia. DOC = 0.43 (MfE 2022 guidance for organisations), DOCf = 0.1% from EPD.
Timber (solid)	0.117	0.111	0.00610	0	"Sawn kiln dried radiata pine" from WPMA (2021). "Environmental Product Declaration for Solid, Finger-Jointed and Laminated Timber Products including timber preservation options". EPD No. S-P-00997. Version 1.1 of 9 September 2021. EPD Australasia. DOC = 0.43 (MfE 2022 guidance for organisations), DOCf = 0.1% from EPD.

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Zinc	0.0143	0.0143	0	0	Based on "Inert rubble"

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Table 31: Landfill (Module C4) following EN 15804+A2 per kg of material

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Aluminium	0.0143	0.0143	0	0	Based on "Inert rubble"
Aluminium (in product)	0.0143	0.0143	0	0	Based on "Inert rubble"
Carpet	0.877	0.877	0	0	GUT (2016). "Tufted carpet tiles - luxury class LC1-LC5 - with 1200 g/m² maximum surface pile weight - pile material made of polyamide 6.6, bitumen based heavy backing". EPD-GUT-20160019-CCA1-EN. Version of 11 March 2016. Institut Bauen und Umwelt e.V. (IBU).
Copper	0.0143	0.0143	0	0	Based on "Inert rubble"
Copper (in product)	0.0143	0.0143	0	0	Based on "Inert rubble"
Inert rubble	0.0143	0.0143	0	0	EN 15804+A1 GWP (total) indicator for C4 from Stevenson (2022). "Ready-Mix Concrete". EPD No. S-P-03727. Version 1.0 of 24 January 2022. EPD Australasia.
Inert waste	0.0143	0.0143	0	0	EN 15804+A1 GWP (total) indicator for C4 from Stevenson (2022). "Ready-Mix Concrete". EPD No. S-P-03727. Version 1.0 of 24 January 2022. EPD Australasia.
Paper	2.66	0.0143	2.65	0	Fossil emissions for inert waste are used, as this represents the landfill itself. Biogenic emissions for "Paper" waste is overlaid from MfE (2022). "Measuring emissions: A guide for organisations". Ministry for the Environment. Assume 50/50 split between landfills with and without landfill gas capture. DOC = 45% (air dry paper @ 10% water content), DOCf = 49%.

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Plasterboard	0.282	0.0844	0.198	0	"GIB® Standard 13mm" from Winstone Wallboards (2018). "Environmental Product Declaration for GIB® Plasterboard". EPD No. S-P-01000. Version 1.1 of 1 March 2018. EPD Australasia. DOCf 49% for paper component and DOCf 84% for starch component (NGA Factors 2021, Table 48).
Plywood	1.74	0.114	1.63	0	"Landfill (typical)" from "Formply A-bond 17 mm" from FWPA (2017). "Environmental Product Declaration for Plywood". Version 1.2 of 8 December 2017. EPD Australasia. DOC = 0.43 (MfE 2022 guidance for organisations), DOCf = 1.4% from EPD.
Stainless steel	0.0478	0.0478	0	0	Based on "Steel"
Steel	0.0478	0.0478	0	0	Pacific Steel (2018). "Pacific Steel Environmental Product Declaration". EPD No. S-P-01002. Version 1.0 of 25 October 2018. EPD Australasia. Scaled up to account for 11% landfill rate (and 89% recycling rate) assumed.
Steel (in product)	0.0478	0.0478	0	0	Pacific Steel (2018). "Pacific Steel Environmental Product Declaration". EPD No. S-P-01002. Version 1.0 of 25 October 2018. EPD Australasia. Scaled up to account for 11% landfill rate (and 89% recycling rate) assumed.
Straw bale	1.62	0.0143	1.60	0	Fossil emissions for inert waste are used, as this represents the landfill itself. Biogenic emissions for "Paper" waste is overlaid from MfE (2022). "Measuring emissions: A guide for organisations". Ministry for the Environment. Assume 50/50 split between landfills with and without landfill gas capture. DOC = 0.32, DOCf = 0.5

Material	GWPT (kg CO_2e/kg)	GWPF (kg CO_2e/kg)	GWPB (kg CO_2e/kg)	GWPLULUC (kg CO_2e/kg)	Source
Timber (engineered panels)	1.68	0.0793	1.60	0	"Thick, uncoated MDF" from Daiken (2019). "Medium Density Fibreboard (MDF) Environmental Product Declaration". EPD No. S-P-01168. Version 1.0 of 25 January 2019. EPD Australasia. The density is an estimate from FWPA EPD which states a range of 701-732 kg/m3 for MDF because Daiken provide a very large range (350 to 750 kg/m3). DOC = 0.43 (MfE 2022 guidance for organisations), DOCf = 0.7% from EPD.
Timber (engineered wood)	1.69	0.110	1.58	0	Red Stag (2022). "Environmental Product Declaration for Cross Laminated Timber". EPD No. S-P-03711. Version 1.0 of 28 February 2022. EPD Australasia. DOC = 0.43 (MfE 2022 guidance for organisations), DOCf = 0.1% from EPD.
Timber (solid)	1.69	0.111	1.58	0	"Sawn kiln dried radiata pine" from WPMA (2021). "Environmental Product Declaration for Solid, Finger-Jointed and Laminated Timber Products including timber preservation options". EPD No. S-P-00997. Version 1.1 of 9 September 2021. EPD Australasia. DOC = 0.43 (MfE 2022 guidance for organisations), DOCf = 0.1% from EPD.
Zinc	0.0143	0.0143	0	0	Based on "Inert rubble"

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*

Table 32: Default assignments of BRANZ CO_2NSTRUCT building product classifications to end-of-life categories

BRANZ material classification	End-of-life category	Recycled content (typical)
Acrylic (liquid applied, with/without reinforcing fibres)	Inert waste	0%
Adobe	Inert rubble	0%
Aluminium	Aluminium	0%
Aluminium (marine grade 5005/5052 + acrylic/polyester coating)	Aluminium	0%
Aluminium (powder coated / anodised)	Aluminium	0%

Asphalt (fibre-reinforced shingles) with mineral or ceramic granules to faces	Inert rubble	0%
Automatic doors, sensors, safety systems	Steel (in product)	0%
Bathroom ceramics	Inert waste	0%
Bitumen	Inert rubble	0%
Blocks (AAC, solid)	Inert rubble	0%
Blocks (concrete, hollow)	Inert rubble	0%
Blocks (concrete, solid)	Inert rubble	0%
Bricks (clay)	Inert rubble	0%
Bricks (concrete)	Inert rubble	0%
Building services (incorporated)	Steel (in product)	0%
Building wrap	Paper	0%
Carpet	Carpet	0%
Chips/gravel	Inert rubble	0%
Clay (bentonite)	Inert rubble	0%
Coating (cementitious)	Inert waste	0%
Coating (polyurethane, polyester, epoxy, polypropylene)	Inert waste	0%
Cold/hot applied coatings	Inert waste	0%
Composite panel	Inert waste	0%
Concrete (aerated autoclaved)	Inert rubble	0%
Concrete (in situ)	Inert rubble	0%
Concrete (in situ, light weight)	Inert rubble	0%
Concrete (in situ, light weight, fibre reinforced)	Inert rubble	0%
Concrete (precast)	Inert rubble	0%
Concrete (precast, light weight)	Inert rubble	0%
Copper	Copper	0%
Damp proof course (eg. bitumen)	Inert waste	0%
Door and frame assembly (steel)	Steel (in product)	0%
Electric motors	Copper (in product)	0%

Fibre cement sheets	Inert rubble	0%
Fibreglass reinforcing	Inert waste	0%
Fixings (fasteners)	Inert waste	0%
Glass	Inert rubble	0%
Glass fibre	Inert waste	0%
Glass fibre reinforced cement (GRC) panels	Inert rubble	0%
Grout	Inert rubble	0%
Gypsum board lathing	Inert rubble	0%
Insulation	Inert waste	0%
Insulation (board)	Inert waste	0%
Isolators	Inert waste	0%
Latex emulsion, gel (potassium or sodium silicate)	Inert waste	0%
Liquid compound (cementitious, gypsum or resin-bound)	Inert waste	0%
Mastic asphalt waterproofing	Inert waste	0%
Mortar	Inert rubble	0%
Panel (woodwool)	Timber (engineered panels)	0%
Panels (miscellaneous)	Inert waste	0%
Paper	Paper	0%
Plaster	Inert rubble	0%
Plaster (cement or polymer modified, reinforced or unreinforced)	Inert rubble	0%
Plastics	Inert waste	0%
Plastics (liquid applied)	Inert waste	0%
Plastics (liquid applied, with/without reinforcing fibres)	Inert waste	0%
Plywood	Plywood	0%
Profiled sheets (including textured and curved sheets) of factory coated steel (aluminium/zinc + organic coating), fixed to framing	Steel	0%
Profiled sheets (including textured and curved sheets) of factory coated steel (aluminium/zinc coating), fixed to framing	Steel	0%

Profiled sheets (including textured and curved sheets) of factory coated steel (aluminium/zinc/magnesium + organic coating), fixed to framing	Steel	0%
Protective coating/decorative finish	Inert waste	0%
Rigid air barriers	Inert waste	0%
Rubber (sheet or tile)	Inert waste	0%
Sand	Inert rubble	0%
Screed/topping (granolithic, concrete)	Inert rubble	0%
Screens (steel)	Steel (in product)	0%
Sheet (bituminous or plastic)	Inert waste	0%
Sheet (drainage cell)	Inert waste	0%
Sheet (film)	Inert waste	0%
Sheet (gypsum wallboard)	Plasterboard	0%
Sheet (mineral fibre reinforced bitumen on mineral fibre/bituminous felt)	Inert waste	0%
Sheet (modified bitumen sheet with/without glass/synthetic fibres, granule finish)	Inert waste	0%
Sheet (synthetic rubber)	Inert waste	0%
Sheet (vermiculite board, GRC, calcium silicate board, barium sulphate board)	Inert rubble	0%
Solar panel	Inert waste	0%
Stainless steel	Stainless steel	0%
Steel (aluminium/zinc alloy + organic coating)	Steel	0%
Steel (aluminium/zinc alloy coating)	Steel	0%
Steel (aluminium/zinc/magnesium alloy + organic coating)	Steel	0%
Steel (reinforcing or mesh)	Steel	0%
Steel (sheet)	Steel	0%
Steel (structural)	Steel	0%
Straw bale	Straw bale	0%
Stone (natural)	Inert rubble	0%
Stone (reconstructed or precast)	Inert rubble	0%
Tile (clay)	Inert rubble	0%

Tile (concrete)	Inert rubble	0%
Timber (engineered panels) eg. MDF, OSB, particleboard	Timber (engineered panels)	0%
Timber (engineered wood) eg. laminates, LVL, glulam	Timber (engineered wood)	0%
Timber (solid)	Timber (solid)	0%
Timber lathing	Timber (solid)	0%
Zinc	Zinc	0%

Note: This table is not regularly updated. *However, please always check https://nzgbc.org.nz/embodied-carbon for the latest data.*