

EMBODIED CARBON CALCULATOR GUIDE

MAY 2023

This guide is to be used for Credit 19 Life Cycle Impacts in Green Star – Design & As-Built NZ v1.1 and for the Net Zero Upfront Carbon Standard.

Document Information

For information on this document, please contact:

New Zealand Green Building Council
(09) 379-3996
greenstarnz@nzgbc.org.nz

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

Change Log

Release	Date	Description of changes
v0.1	13/10/2022	Draft for consultation
v1.0	01/05/2023	Revised version following consultation

Use of Trademarks

All third-party trademarks are the property of their respective owners. All third-party trademarks referenced in this document are used in an editorial fashion and not to the detriment of the trademark holders.

Intellectual Property Rights & Confidentiality

© Copyright New Zealand Green Building Council

No part of this document or the information contained within it may be (a) used for any purpose other than that stated within this document by the recipient; or (b) reproduced, transmitted or translated in any form or by any means, electronic, mechanical, manual, optical or otherwise, without prior written permission of The New Zealand Green Building Council.

Table of Contents

1	Introduction	6
1.1	Credit 19.1 Upfront Carbon Reduction Assessment	6
1.2	Credit 19.3: Long-term Carbon Storage	7
1.3	Structure of This Document	7
2	Definitions	8
2.1	Building-Related Terms	8
2.2	Project-Related Terms	8
2.3	Carbon-Related Terms	8
2.4	Stages of a Building's Life Cycle	9
2.5	Types of Carbon Footprint	9
2.6	Calculation of Carbon Footprint	10
2.7	Conduct and Review of LCA Studies	10
2.8	Environmental Impacts of Products	11
3	Scope	12
3.1	System Boundary	12
3.2	Building Elements	12
3.3	Demolition and Reuse of Existing Building(s)	12
3.4	Cut-off Rules	13
3.5	Exclusions	13
3.5.1	Operational Energy and Water Usage	13
3.5.2	Additional Building Services for Installed Equipment	13
3.5.3	External Works	14
3.5.4	Non-Physical Items	14
4	When to Use the Calculator	15
4.1	Use of the Calculator Through the Design Process	15
4.2	Occupancy and Allocation	15
4.3	Upfront Carbon in <i>Green Star Design & As-Built NZv1.1</i>	16
4.4	<i>Net-Zero Upfront Carbon Standard</i>	16
5	Overview of Calculator	17
5.1	Opening the Calculator File	17
5.2	Colour Coding	18
5.3	Progress Bar	19
5.4	Calculation Methodology	19
5.4.1	Modules A1-A3 (Upstream Emissions of Materials)	19

5.4.2	Upstream Transport.....	19
5.4.3	Replacement Over Building Service Life	20
5.4.4	Deconstruction.....	20
5.4.5	Transport to Waste Processing	20
5.4.6	Waste Processing/Disposal/Recycling	20
5.5	Scaling by Estimated Completeness	20
5.6	Use of Excel.....	21
6	Selecting Data	22
6.1	Types of Data Needed.....	22
6.2	Data Quality	23
6.2.1	Building Quantities.....	23
6.2.2	Emission Factors	23
6.3	Built-in Emission Factors, Replacement Cycles and End-of-Life Data	23
6.4	Adding Custom Emission Factors	23
6.4.1	How to Choose Data.....	23
6.4.2	How to Input Custom Data.....	26
6.5	Adding Custom Assemblies.....	27
7	The 'Metadata' Sheet.....	29
8	The 'Land' Sheet.....	30
9	The 'Completeness' sheet	31
10	The 'C_Energy' Sheet.....	32
11	The 'C_Waste' Sheet.....	33
12	Material Input ('Q_') Sheets.....	34
12.1	The 'Category' Column	34
12.2	The 'Assembly name / notes', and 'Component name' Columns.....	34
12.3	The 'Material type', 'Subtype', and 'Matching material' Columns	35
12.4	The 'Amount' and 'Unit' Columns	35
12.5	The 'Source' Column	35
12.6	The 'Waste % input' Column (Optional)	36
13	Other Data Input Sheets	37
13.1	The 'Q_Services' Sheet.....	37
13.2	The 'Q_Formwork' Sheet.....	37
13.3	The 'Q_Ext.Works' Sheet	38
13.4	The 'Carbonation' Sheet.....	38
13.5	The 'ExistingBuild' Sheet.....	38
14	Results.....	39

14.1 The 'Results' Sheet.....39

14.1 The 'Results_Detail' Sheet43

15 Calculating Points44

16 Alternative Tools46

17 Offsetting Demolition Works47

18 References49

1 INTRODUCTION

This document provides a how-to guide for use of the *Embodied Carbon Calculator NZv1.1* ('the Calculator') developed by the New Zealand Green Building Council (NZGBC) and thinkstep-anz. The Calculator is a tool built in Microsoft Excel that can be used to support projects seeking ratings under the *Green Star – Design & As-Built NZv1.1* rating tool and the *Net-Zero Upfront Carbon Standard*.

The intended audiences for this document are building projects that want to use the Calculator for:

- Upfront Carbon Reduction Assessment (Credit 19.1) of *Green Star – Design & As-Built NZv1.1*.
- Long-term Carbon Storage (Credit 19.3) of *Green Star – Design & As-Built NZv1.1*.
- NZGBC's forthcoming *Net-Zero Upfront Carbon Standard*.

Other users are welcome to use the Calculator and this guidance; however, NZGBC makes no warranties of any kind regarding its use or the results calculated. The quality of the results depends primarily on the quality of the input data entered and the appropriateness of the emission factors selected.

For information regarding the underlying methodology behind the Calculator, refer to NZGBC's *Green Star NZ Embodied Carbon Methodology* ("the Embodied Carbon Methodology").

The Calculator provides results for upfront carbon and whole-of-life embodied carbon only. As a result, it cannot be used to comply with Credit 19.2 of *Green Star – Design & As-Built NZv1.1*. Projects seeking to comply with this credit must use a third-party building LCA software tool and then paste their results into the *Life Cycle Impacts Calculator* to calculate the points awarded.

The Calculator, this document and NZGBC's *Green Star NZ Embodied Carbon Methodology* are intended to align with MBIE's Building for Climate Change (BfCC) programme (MBIE, 2022). The reader should be aware that all three documents/tools will likely evolve over time to reflect user feedback and to continue to align with MBIE's BfCC programme as it develops.

This is intended to be a living document that evolves as experience with embodied carbon grows.

1.1 Credit 19.1 Upfront Carbon Reduction Assessment

Credit 19.1 of *Green Star – Design & As-Built NZv1.1* requires that all buildings achieve a reduction in upfront carbon for the building to be awarded a star rating.

For projects demonstrating a 30% reduction in upfront carbon emissions or greater (4, 5 or 6 points), the calculations should comply with quality assurance requirements by meeting one of the following two options:

- Option A: The report is produced by an LCA Certified Practitioner, subject to organisational quality assurance, which has been certified in accordance with ISO9001.
- Option B: The report is produced by an Experienced Individual and is peer reviewed by an LCA Certified Practitioner or independent Experienced Individual.

To demonstrate compliance, projects can either:

- Calculate upfront carbon using the Embodied Carbon Calculator, or
- Calculate upfront carbon by modelling the proposed building following the methodology of the 19.2 Comparative Life Cycle Assessment for modules A1 – A5.

1.2 Credit 19.3: Long-term Carbon Storage

Credit 19.3 of *Green Star – Design & As-Built NZv1.1* rewards the long-term storage of carbon previously removed from the atmosphere and stored in the fabric of the building during its operating life. This is to encourage the use of materials which have intrinsic carbon storage properties, for example, wood/biomass. Note that storage of carbon is excluded as an upfront carbon emissions reduction method in credit 19.1.

The separation of carbon emissions from carbon removals is in line with the latest consultation documents produced by the New Zealand Government under its draft Building for Climate Change policy framework.

Long-term storage is defined as a forecasted period of at least 50 years.

1.3 Structure of This Document

This document is structured as follows:

1. Definitions of key terms (chapter 2).
2. Scope of assessment (chapter 3).
3. When to use the Calculator (chapter 4).
4. An overview of the Calculator (chapter 5).
5. How to select data (chapter 6)
6. How to use the Calculator (chapters 7 to 14).
7. Alternative tools (chapter 16).

2 DEFINITIONS

2.1 Building-Related Terms

Proposed Building: The building works to be rated under *Green Star – Design & As Built NZv1.1* or the *Net-Zero Upfront Carbon Standard*. This includes all buildings and any ancillary areas such as parking, landscaping and shared facilities.

Reference Building: A hypothetical building to be compared to the Proposed Building. The Reference Building may be an Actual Reference Building or a Standard Practice Reference Building.

Actual Reference Building: A building constructed in the last five years that is similar to the usage, construction and operation of the Project.

Standard Practice Reference Building: A hypothetical building that represents standard contemporary construction and operation practices.

Warm Shell: The warm shell includes the whole substructure, superstructure and building envelope. 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.

Tenant Improvements: Tenant improvements includes additions to the building beyond the Warm Shell. This includes, but is not limited to, kitchenettes, internal partition walls and doors, cabinets and loose furniture.

2.2 Project-Related Terms

Project: The same as Proposed Building.

External Works: This includes external carpark, driveways, hard landscaping, external walls and fences, and external drainage. It excludes soft landscaping.

Shared Site: Projects where only some of the buildings on the site will be assessed using the Calculator. Shared Sites are common in precinct-style developments.

Sole Occupant Site: Projects where all buildings on the site will be assessed together.

Practical Completion: The point in a building project when the contracted works have been completed, except for any minor outstanding works, and when possession is transferred to the owner of the building.

2.3 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 CO₂ 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.

2.4 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.

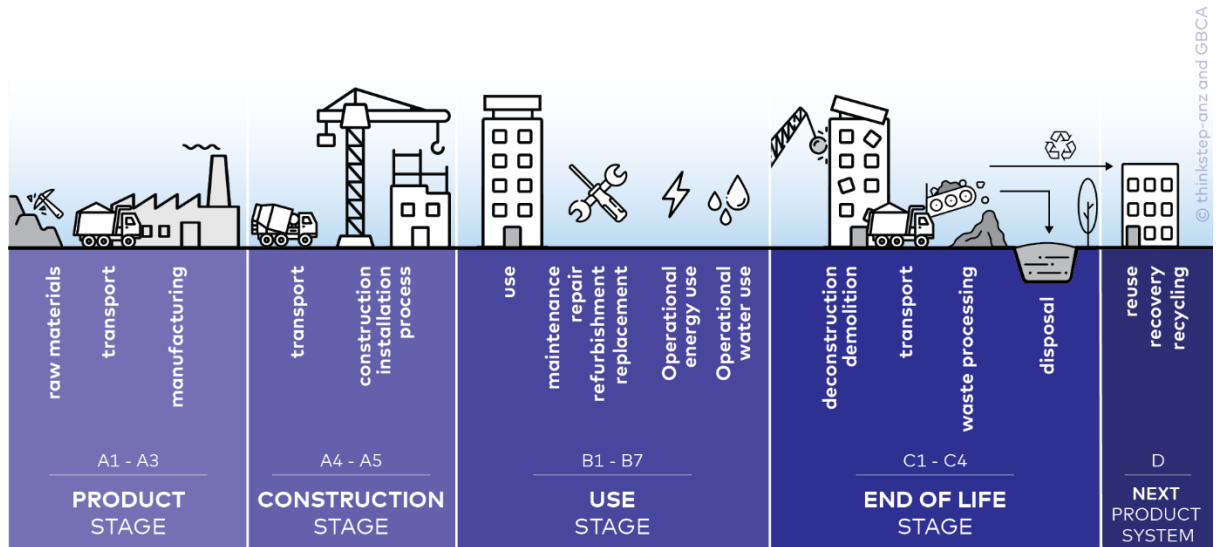


Figure 1: Stages of a building's life cycle (as per EN 15978)

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

Module B: Building use (module B1), maintenance (module B2) and repair and renovation (modules B2-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.

Module 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.

2.5 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).

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), operational water use (module B7) and fugitive emissions of refrigerants (module B1). In corporate carbon footprinting, these emissions are known as scope 1 and scope 2 emissions.

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. Depending on the standard followed, it may include or exclude module D (benefits and loads beyond the system boundary).

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 or GWPL): 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 CO₂ 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 CO₂ 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:

- 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 timber 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 Conduct and Review of LCA Studies

Competent LCA Practitioner: Any person who is an Experienced Individual or an LCA Certified Practitioner.

LCA Certified Practitioner: A person who is qualified as an "LCA Certified Practitioner" by LCA NZ, ALCAS, ACLCA, or another similar scheme.

Experienced Individual: An individual who has produced, co-produced and/or independently reviewed at least three LCA or carbon footprint studies of buildings or building products in accordance with EN15804/EN15978 and either ISO14040/14044 or ISO14067 within the past three years.

Independent Experienced Individual: An Experience Individual who is:

- Not employed in a full-time or part-time role by the commissioner or practitioner of the LCA study.
- Not the practitioner of the LCA study.
- Not involved in defining the scope or conducting the LCA study.
- Has no direct or indirect incentive or interest linked to the outcome of the LCA study.

2.8 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 include EN 15804 and ISO 21930.

3 SCOPE

3.1 System Boundary

The following activities are **included**:

- Manufacture of building products (Modules A1-A3).
- Transport of building products, formwork and construction machinery to/from site (Module A4).
- On-site construction activities, such as operation of cranes and excavators, and the manufacture, transport and disposal of any wasted building products (Module A5).

The following activities are **excluded**:

- Manufacture of machinery and other capital goods.
- Transport of staff to and from the construction site.
- Energy used off-site for professional services.

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

3.2 Building Elements

Building elements that are part of the Warm Shell must be included within the scope of assessment up to the point of Practical Completion, as outlined in Table 1. Those projects applying for the *Net-Zero Upfront Carbon Standard* must also include External Works and all permanently installed Tenant Improvements (but excluding fittings, furnishings and equipment).

Table 1: Building elements in scope

Building element	Inclusion within <i>Green Star Design & As-Built</i>	Inclusion within <i>Net-Zero Upfront Carbon</i>
Facilitating Works	Yes	Yes
Substructure	Yes	Yes
Superstructure	Yes	Yes
Internal Finishes	Yes	Yes
Fittings, Furnishing, and Equipment	No	No
Services	Yes	Yes
Prefabricated Buildings and Building Units	Yes	Yes
Work to Existing Buildings	Yes	Yes
External Works	Areas for vehicle traffic to be reported separately, but not part of the target	Yes

For more detail, see:

- Appendix A within the *Embodied Carbon Methodology*.
- 'Scope' sheet within the Calculator.

3.3 Demolition and Reuse of Existing Building(s)

Where an existing building less than 30 years old has been fully or partially demolished for construction, an embodied carbon calculation must be completed for the demolished portion.

Where the existing building is between 30 and 50 years old, the contribution of embodied emissions shall be calculated and discounted at 5% for every additional year past year 30. For example, if a 35-year-old building was demolished, projects would be required to account for 75% of upfront carbon emissions.

Projects which require demolition of an existing building as a result of it not being fit-for-purpose (e.g., due to earthquake damage, or a significant lack of NZ Building Code compliance) are able to be excluded from offsetting demolition works. This is to be justified clearly in the submission and agreed upon with NZGBC via a Technical Question.

Both the upfront emissions of the demolished materials (modules A1-A3) and the demolition process (modules C1-C4) must be offset through the purchase of carbon credits that meet the requirements of approved carbon neutral certification schemes (see the *Embodied Carbon Methodology*).

Reused building elements may then be considered zero emissions in the new project. Only additional activities – such as reprocessing and transporting of materials – needs to be included within the upfront carbon calculation.

For further information relating to the use of the Calculator's in-built 'ExistingBuild' sheet, refer to section 13.5.

3.4 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 used on-site that are not part of delivered building products (and should therefore be captured in that product's carbon footprint).
- Glues, sealants, caulking compounds and filling compounds used in small quantities throughout the building and not part of delivered building products. (This exclusion does not apply to mortars, block filling concretes and sealants used in membrane roofs.)
- Doorknobs, door hinges, light switches, power sockets and other minor fittings.

Modules B1 (direct emissions) and B2 (building maintenance, including washing and repainting) can also be excluded, unless there is a reason to believe the 5% threshold would be crossed.

3.5 Exclusions

Several elements are excluded from the Calculator due to low environmental relevance or inclusion elsewhere. For a full list of exclusions, please refer to the 'Scope' sheet in the Calculator.

3.5.1 Operational Energy and Water Usage

Operational energy (module B6) and operational water (module B7) are excluded from the Calculator because they fall within the definition of Operational Carbon. Operational energy is addressed in *Green Star Design & As Built NZv1.1* through Credit 15, Greenhouse Gas Emissions. Operational water is addressed through Credit 16, Potable Water.

3.5.2 Additional Building Services for Installed Equipment

In some cases, additional building services (power cables, ventilation equipment, etc.) may be required for the equipment installed in the building (computers, medical equipment, etc.). The purpose of *Green Star Design & As Built NZv1.1* is to rate buildings fairly and comparably, but not the

equipment inside them. Where additional building services are needed for the equipment in the building (rather than the people in the building), these can be excluded from the analysis as they effectively become part of the Tenant Improvements.

For example, a data centre requires considerable extra power cabling and HVAC equipment to power and cool the computers inside the data centre. The HVAC equipment and power cabling beyond that required to run the core building services (for the offices and common areas) can therefore be excluded from *Green Star Design & As Built NZv1.1*. Only the HVAC equipment and power cabling needed for a comparably sized warehouse-type building would need to be included in the Calculator.

Note that this exemption does not apply to the *Net-Zero Upfront Carbon Standard*, where all permanently installed equipment must be included.

3.5.3 External Works

Some external works are excluded from the scope of analysis. These are:

- Soft landscaping
- External fixtures
- Fencing, railings, and walls
- External services

3.5.4 Non-Physical Items

Non-physical elements are excluded from the scope of analysis as their environmental impacts occur outside of the mandatory system boundary set by EN 15978. Based on the categories in RICS Elemental Standard Form of Cost Analysis, 4th Edition (RICS, 2012), these non-physical elements are:

- Employer's Requirements
- Main Contractor's Cost Items
- Main Contractor's Overheads
- Main Contractor's Profit
- Consultant's Fees
- Main Contractor's Pre-Construction Fees
- Main Contractor's Design Fees
- Other Development/Project Costs
- Design Development Risks
- Construction Risks
- Employer Change Risks
- Employer Other Risks

4 WHEN TO USE THE CALCULATOR

The Calculator can be used for:

- Credit 19.1 Upfront Carbon Reduction Assessment of *Green Star – Design & As-Built NZv1.1*.
- Credit 19.3 Long-term Carbon Storage of *Green Star – Design & As-Built NZv1.1*.
- NZGBC's *Net-Zero Upfront Carbon Standard*.

The Calculator cannot be used for Credit 19.2 Comparative Life Cycle Assessment. A third-party LCA tool must be used instead.

The Calculator should be used more than once where:

- Both a Proposed Building and a Reference Building are assessed to calculate a percentage reduction.
- When the *Net-Zero Upfront Carbon Standard* is being applied but there are significant differences in the inclusions and exclusions between the Upfront Carbon credit of *Green Star – Design & As Built NZ v1.1* and the *Net Zero Upfront Carbon Standard*.

4.1 Use of the Calculator Through the Design Process

For compliance with *Green Star – Design & As-Built NZv1.1* and the *Net-Zero Upfront Carbon Standard*, the carbon footprint must be calculated following practical completion of the project.

However, given that both programmes require upfront carbon reduction targets to be met, Projects are strongly encouraged to use the Calculator at early design stages so that upfront carbon can be assessed early and tracked against targets. A projected assessment using the Calculator could be based on quantities from a previous building and/or estimates from architects/engineers/surveyors.

4.2 Occupancy and Allocation

Projects must disclose whether the project is the sole occupant of a site (Sole Occupant Site) or part of a larger, shared site (Shared Site). This information shall be used to identify which shared building elements must be included within the scope of assessment.

Where a building is part of a Shared Site, shared elements must be apportioned (allocated) to the building under study in a way which reflects their use of these shared elements. Floor area – either Gross Floor Area (GFA) or Net Lettable Area (NLA) – should be used as the default method of allocation, unless there is a good reason to use a different method. All buildings within the Shared Site applying for ratings to the NZGBC must use the same allocation method for each shared element for consistency.

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 floor area of 1,000 m² NLA. It is part of a retail precinct with 100,000 m² of total NLA and 140,000 m² total GFA.
- The retail store should be allocated 1% (=1,000/100,000) of the shared services of the precinct. NLA 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.

4.3 Upfront Carbon in *Green Star Design & As-Built NZv1.1*

The Calculator returns the results of the upfront carbon assessment, but not the Green Star points. To calculate the points achieved for *Green Star – Design & As Built NZv1.1*, copy the 'Results for Green Star' section from the 'Results' sheet of the Calculator (Table 2) and paste this into the 'Upfront Carbon' sheet of the *Life Cycle Impacts Calculator NZv1.1*. When using the Reference Building approach, you will need to run the Calculator twice (once for the Reference Building and once for the Proposed Building) and paste in two sets of results tables.

Table 2: Summary results to be copy-and-pasted for the points calculation

Results for Green Star (kg CO ₂ e)			
Result (kg CO ₂ e)	Absolute	Per m ²	Credit
Upfront carbon footprint (A1-A5) inside the drip-line	203,560	170	19.1
Upfront carbon footprint (A1-A5) outside the drip-line	5,710	5	n/a
Upfront long-term stored carbon	-73,204	-61	19.3
Demolition carbon footprint that must be offset	162,902	136	19.1
Whole of life embodied carbon (A-C) [EN 15804+A2]	305,655	255	n/a
Whole of life embodied carbon (A-D) [EN 15804+A2]	234,662	196	n/a
Whole of life embodied carbon (A-C) [EN 15804+A1]	251,103	209	n/a
Whole of life embodied carbon (A-D) [EN 15804+A1]	180,110	150	n/a

4.4 Net-Zero Upfront Carbon Standard

Projects pursuing the *Net-Zero Upfront Carbon Standard* can use the Calculator to display conformance. Projects shall demonstrate:

1. Total (gross and net) projected upfront carbon emissions.
2. Total (gross and net) upfront carbon emissions at practical completion of project.
3. Reductions in upfront carbon emissions that comply with relevant reduction targets.

A minimum reduction in upfront carbon is required to achieve certification against the standard.

Projects are required to select and disclose the scope of building elements included within their application:

- **Whole-building certification.** Projects must calculate and offset upfront emissions for all building elements included within the base building and tenant improvements.
- **Base-building certification.** Projects must calculate and offset upfront emissions for all building elements included within the base building (warm shell).
- **Tenant improvements.** Projects must calculate and offset upfront emissions for improvements conducted by, or on behalf of tenants within their contracted area. This incorporates any permanently installed building elements which are not included in the scope of base building certification and relevant to the tenant's space.
 - Wherever non-generic items that are not included within the tenant improvements sheet are incorporated into tenant improvements, applicants shall agree with Green Star Assessor as to the appropriate approach taken, aligning with guidance set out in section 6.4 "Adding Custom".

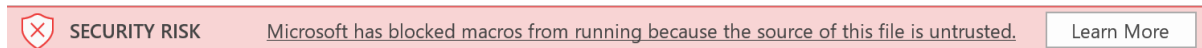
5 OVERVIEW OF CALCULATOR

5.1 Opening the Calculator File

The Calculator is a macro-enabled Excel file. The use of macros (VBA code) can trigger a security warning in Excel which may prevent the file from being opened or which may allow the file to be opened with macros disabled. If the file can be opened with macros disabled, it will still function; however, this will disable the protection of editable cells, allowing you to accidentally cut-and-paste or drag-and-drop cells which may lead to calculation errors within the file.

Depending on your operating system and version of Excel, you may need to follow different steps to get the file to open with macros enabled:

1. If you see a red “Security Risk” message upon opening the file for editing in Excel,



right-click on the file and choose “Properties”. In the “General” tab, check “Unblock” next to the security message “This file came from another computer and might be blocked to help protect this computer.” See Figure 2 below.

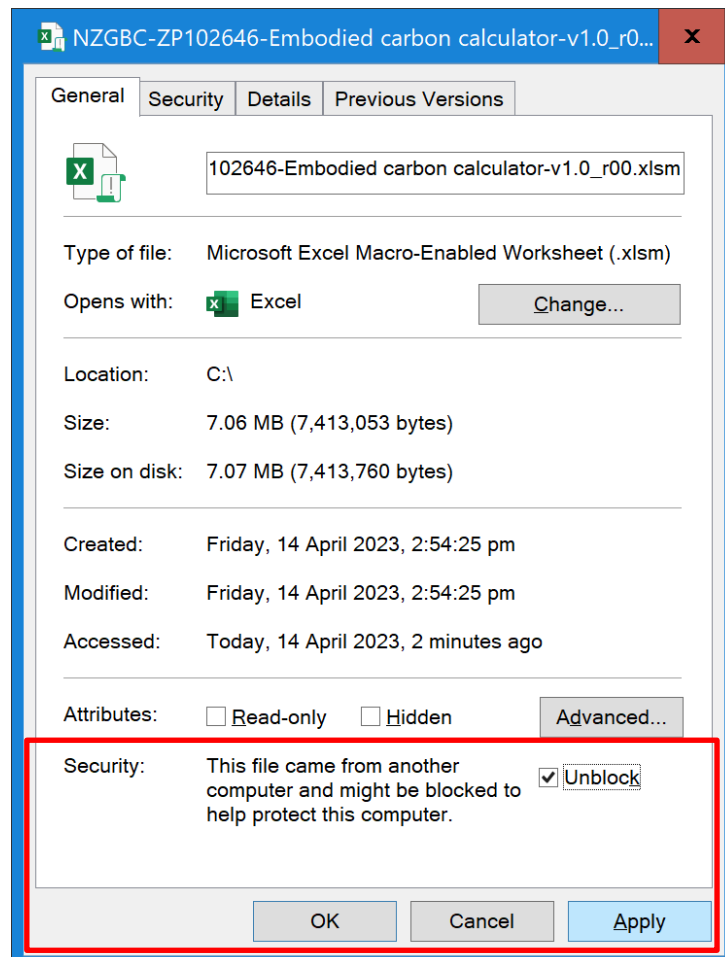
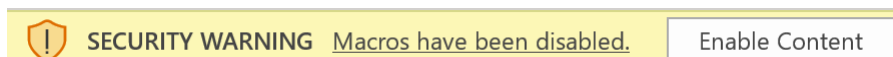


Figure 2: Unblock the file

2. If you see a yellow “Security Warning” message upon opening the file in Excel,



click “Enable Content” to enable macros within the file.

3. If you see a “Microsoft Excel Security Notice” pop-up box in Excel,

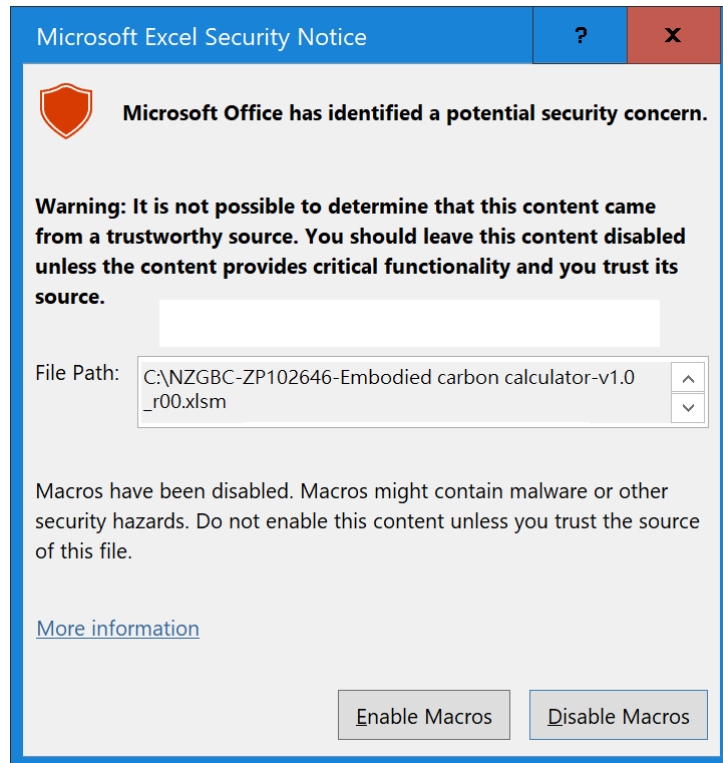


Figure 3: Enable macros

click “enable Macros” (Figure 3).

NZGBC can supply a version of the Calculator without macros if your organisation blocks them. However, this file cannot block the use of cut-and-paste or drag-and-drop automatically, meaning that it will be possible for you to break the formulas in the file accidentally.

5.2 Colour Coding

The first sheet of the Calculator, ‘Read Me’, describes how the Calculator should be used. The colour coding in Figure 4 indicates optional and required data inputs. A cell with a red marker in the top-right corner indicates that a comment is available.

Required inputs
Optional inputs
Contains instructions or note
Contains formula - Do not touch

Figure 4: Colour coding of optional and required data inputs

All sheets that take data inputs (quantities) have the prefix ‘Q_’. Exceptions are the ‘Custom_EFs’ and ‘Assemblies’ sheets as these are not required to complete calculations but allow the user to expand on the Calculator’s database and aggregate multiple materials where commonly used assemblies are identified within the building.

Additionally, sheets are colour-coded as shown in Figure 5 below:

Results
User inputs
Information
Locked datasets
Open datasets - Can be added to

Figure 5: Colour coding of sheets

Only the orange colour sheets are required for the calculations. Sheets with the suffix '(NZUC)' are only required when following the *Net-Zero Upfront Carbon Standard*.

The outputs of the Calculator are displayed as different categories of carbon footprint / climate change as described in section 2.5 and section 2.6. Outputs are displayed per phase of construction and dependent on the input data provided by the user, with modules derived from EN 15978:2011 and EN 15804+A2:2019.

5.3 Progress Bar

The progress bar shown in Figure 6 appears on all data input tabs. This shows the upfront carbon footprint at both the whole building level and per square metre of gross floor area. The graph then shows the contribution of the current module (e.g., the substructure) to the upfront carbon footprint.

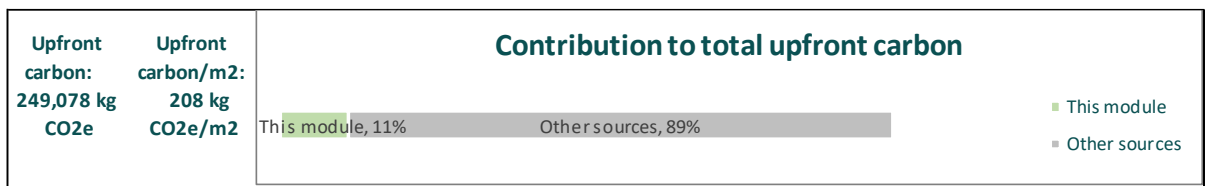


Figure 6: Progress bar

5.4 Calculation Methodology

5.4.1 Modules A1-A3 (Upstream Emissions of Materials)

Upstream emissions of materials (modules A1-A3) are based primarily on data from the BRANZ CO₂NSTRUCT Database, though the Calculator also includes custom data (largely from EPDs) supplied by NZGBC and thinkstep-anz. Users can also enter their own data in the 'Custom_EFs' sheet.

Carbon footprint results are split into the following four indicators (defined in section 2.6):

- Climate change potential – Total (GWPT) [kg CO₂ eq.]
- Climate change potential – Fossil (GWPF) [kg CO₂ eq.]
- Climate change potential – Biogenic (GWPB) [kg CO₂ eq.]
- Climate change potential – Stored (GWPS) [kg CO₂ eq.]

5.4.2 Upstream Transport

Upstream transportation is calculated based on data provided in the 'Nearest city' and 'Distance from city' fields in the 'Metadata' along with the chosen location selected in the 'Source' column in the material's row. The Calculator automatically determines the necessary travel distances by sea and road, multiplies it with the given tonnage of the material, and matches the tonne-km values with appropriate emission factors.

For the upstream transportation calculations to function properly, you must have filled in the 'Nearest city' and 'Distance from city' fields in the 'Metadata' sheet.

5.4.3 Replacement Over Building Service Life

Replacement of materials is calculated based on data on replacement rates per material group, sourced from BRANZ LCA datasheets. These datasheets provide data on typical service life (in years) per material group used in the building. Materials with a service life shorter than that of the building's service life stated will be modelled with the necessary number of replacement cycles to cover the entire service life of the building. This will be rounded to whole number replacements. For example, if a material is calculated as being replaced 2.5 times, 3 replacements will be applied. Replacements are calculated covering the end-of-life stage of replaced components as well as the full upstream stage of the new components.

The following fields in the 'Metadata' sheet must be filled in for the replacement calculations to function properly:

- Building design life
- Estimated envelope life
- Estimated building service replacement cycle
- Estimated fixed interior replacement cycle

Note: Material replacement is not part of the upfront carbon calculation or the points calculation for Green Star Design & As Built NZv1.1.

5.4.4 Deconstruction

Deconstruction emissions are calculated using the average emissions per kg of deconstruction from Stevenson's EPD No. S-P-03727 (Stevenson Concrete, 2022). This is applied to all materials. This functionality requires no data entry beyond that of upstream material data.

5.4.5 Transport to Waste Processing

All materials are assigned emissions from 50 km of road transport to end-of-life irrespective of end-of-life treatment(s). A Technical Question may be raised should a project provide evidence that transport is closer than 50 km to end-of-life treatment and this is important to the final carbon footprint. However, this choice will generally not have a significant impact on the carbon footprint of the building.

5.4.6 Waste Processing/Disposal/Recycling

There are no data entry requirements beyond that of upstream material data, as Whole-of-Life Embodied Carbon is used as a check rather than as the main output from the Calculator.

End-of-life scenarios are based on typical end-of-life fates from BRANZ's LCA datasheets. BRANZ's datasheets indicate a percentage split between landfill, recycling, incineration/energy recovery, and reuse per material type, also accounting for different uses in the building.

The end-of-life fates from BRANZ are then combined with end-of-life data from EPDs to calculate the relevant emissions.

5.5 Scaling by Estimated Completeness

Buildings are complicated and it will not be possible to include all elements within the Calculator. As such, the user must input the estimated coverage of each major part of the building (substructure, superstructure, envelope, etc.) in the 'Completeness' sheet. For any part of the building where the estimated completeness is less than 100%, its emissions are scaled up to ensure full coverage.

Completeness is judged by the percentage of material cost covered within the Calculator versus the actual (or estimated) project cost per major part of the building. This cost should be for the building products only, excluding transport to site, labour costs and subcontractor profit margins as these items are either modelled separately (transport to site) or excluded from the Calculator (labour and profits).

This scaling approach is applied to increase completeness where modelling cannot fully capture all the items in major part of the building. While this may be less needed for items with relatively few large components (e.g., the substructure), it becomes increasingly important for the envelope, fitout, and services where the variety and number of materials is much larger.

For the minimum coverage required to achieve a rating, please see section 6.2.1.

5.6 Use of Excel

The Calculator uses many dropdown menus within Excel. You can expand the dropdown menu by first selecting the desired cell and then either left-clicking the down arrow with your mouse or pushing Alt + Down Arrow on your keyboard.

6 SELECTING DATA

6.1 Types of Data Needed

Two types of data are needed to complete a carbon footprint of a building project (Figure 7):

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. The Calculator contains a database of emission factors, based largely on BRANZ's CO₂NSTRUCT Database.

NZGBC encourages use of the Calculator throughout the building design and development process to help minimise the carbon footprint of the project.

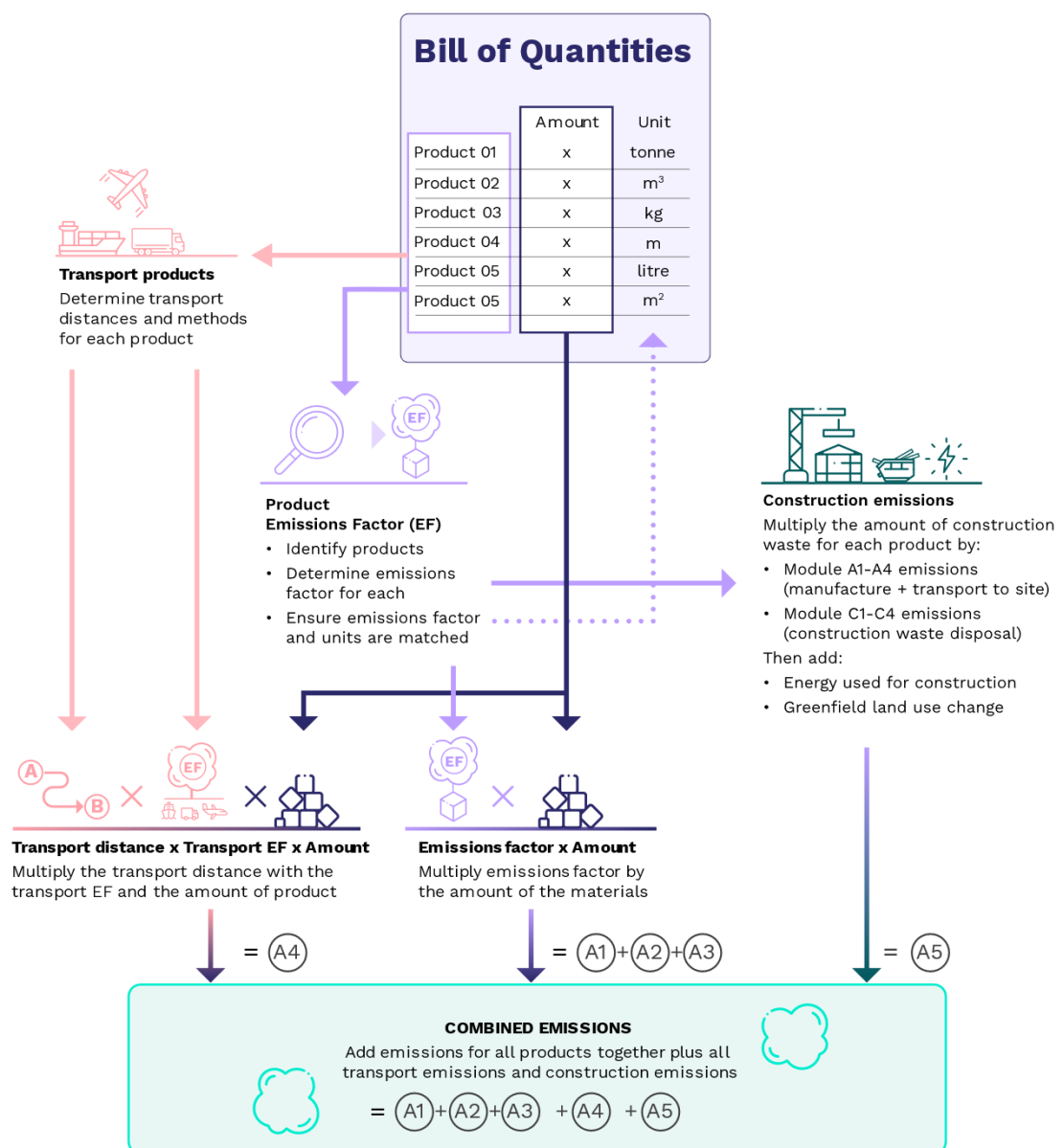


Figure 7: Calculating upfront carbon from building quantities and emission factors

6.2 Data Quality

6.2.1 Building Quantities

The following minimum data quality is required to achieve a rating:

- ≥80% as-built information for *Green Star – Design & As Built NZv1.1*.
- ≥95% as-built information for *Net Zero Upfront Carbon Standard*.

6.2.2 Emission Factors

Data quality is assigned automatically for the data built into the Calculator, though it must be defined manually for custom data inputs (see next section).

There is no minimum requirement to achieve a rating 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). While the Calculator does calculate a data quality score automatically, this is just used as a sense-check. A weighted quality score of 6 (medium data quality) or below (see Table 3 on page 25) is considered good, while a weighted quality score of 2 or below is considered excellent. This score is calculated by multiplying the quality score for each emission factor used (Table 3) by its contribution to the final Upfront Carbon of the building project.

6.3 Built-in Emission Factors, Replacement Cycles and End-of-Life Data

The Calculator draws on the BRANZ CO₂NSTRUCT Database for most material emission factors. Accompanying the CO₂NSTRUCT database are BRANZ's publicly available data on construction site waste, building materials replacement cycles, and building end-of-life. All additional datasets are mapped using the material categories from the CO₂NSTRUCT Database.

Fuels and transport calculations rely on Manatū Mō Te Taiao's (Ministry for the Environment's) publicly available emission factors from 2022.

Data inputs will be updated annually to maintain accuracy and relevancy.

End-of-life calculations predominantly use end-of-life emissions intensities from representative EPDs, supplemented with more generalised calculations to fill gaps.

6.4 Adding Custom Emission Factors

6.4.1 How to Choose Data

The following preference hierarchy must be applied when choosing emission factors:

- **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:
 - **Producer specific**
 - The emission factors 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.
- **Independently verified**, following either of the following two approaches:
 - Environmental Product Declarations (EPD) 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 (see section 4.1.1 of the *Embodied Carbon Methodology*). Only product carbon footprints can be accepted, not organisational carbon footprints.
 - Life Cycle Assessments, compliant with EN 15804+A1, EN 15804+A2 or ISO 21930.
- **Generic value built into the Calculator.**
- **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 3 shall be applied as follows:

Working from the top to the bottom of Table 3 (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 recognised in the *Embodied Carbon Methodology*.
 - Generic data, e.g., AusLCI, ecoinvent, GaBi Databases. A good central repository is the Global LCA Data Access (GLAD) network: <https://www.globalcadataaccess.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. For guidance, see section 3.2.1 of the *Embodied Carbon Methodology*.
- 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 value to the lower quartile, forming a lower fence, and to the upper quartile, forming an upper fence. All values below the lower fence and above the upper fence can be excluded from the dataset.

- Take the following value and use this as the proxy within the Calculator:
 - For the Proposed Building, use the highest GWP-total.
 - For the Reference Building, use the median GWP-total.

Table 3: Emissions factor data quality hierarchy¹

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) 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 section 4.1.1 of the *Embodied Carbon Methodology*. 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, can 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 follow EN 15804 or ISO 21930.

6.4.2 How to Input Custom Data

Data should be entered in the sheet 'Custom_EFs' (Figure 8). Please add a new row for each custom material.


		
Green Star Embodied Carbon Calculator		
Component name ▼	Material ▼	Category ▼
Concrete surface finishing	Concrete	Substructure
Propping	Steel	Substructure

Figure 8: Data entry for custom emission factors

The following data must be entered:

- **Component name:** This is the name that will appear in the dropdown menus throughout the Calculator.
- **Material:** This is a material type grouping, e.g., concrete or steel.
- **BRANZ material class:** This class defines which construction and demolition waste statistics will be applied to the custom material. Please choose the closest matching category.
- **Origin:** Please enter the location where the last major manufacturing step occurs. E.g., if you buy the product from a New Zealand wholesaler, but it is manufactured in China then enter China in this box. If the country of supply is not in the list, please choose the country or region that is geographically closest to your supplier as this field is used for transport distances.
- **Waste:** This is the typical waste produced when installing this type of product. Common values are between 0% and 10%.
- **Replacement frequency (years):** This is the expected life of the building product before it needs to be replaced. This will be used in calculating whole-of-life embodied carbon. For structural elements, please enter a number between 50 and 100 years.
- **Unit:** This is functional or declared unit that the carbon footprint data is declared in, e.g., kilograms, tonnes, metres, square metres or cubic metres.
- **GWP-t (kg CO₂e):** This is the total carbon footprint, which is GWP-f + GWP-b + GWP-l. It might be reported as 'GWP-total' or 'Climate change – total', or sometimes simply as 'GWP' or 'Climate change'. In some studies, this is the only carbon footprint value reported. Depending on the standard followed, it may include or exclude GWP-b.

- **GWP-f (kg CO₂e):** This is the fossil carbon footprint. It might be reported as 'GWP-fossil' or 'Climate change – fossil'. It can be entered directly if it is separated (as required by EN 15804+A2:2019 and ISO 14067:2018). If it is not separated:
 - If the product is *not* from a biogenic source, assume $GWP-f = GWP-t$.
 - If the product is from a biogenic source (e.g., wood or paper) and you think it is unlikely that stored carbon is included within GWP-t (e.g., because GWP-t from A1-A3 is positive and not close to zero), assume $GWP-f = GWP-t$.
 - If the product is from a biogenic source (e.g., wood or paper) and you suspect that stored carbon is included within GWP-t (e.g., because GWP-t from A1-A3 is negative), first remove GWP-s and then assume the remainder is GWP-f, i.e., $GWP-f = GWP-t - GWP-s$.
- **GWP-b (kg CO₂e):** This is the biogenic carbon footprint. It might be reported as 'GWP-biogenic' or 'Climate change – biogenic'. It can be entered directly if it is separated (as required by EN 15804+A2:2019 and ISO 14067:2018). If it is not separated:
 - If the product is *not* from a biogenic source, assume $GWP-f = GWP-t$.
 - If the product is from a biogenic source (e.g., wood or paper) and you know it to be sustainably managed, assume $GWP-b = GWP-s$ (see below for a calculation).
- **GWP-l (kg CO₂e):** This is the carbon footprint from land use and land use change (LULUC). It might be reported as 'GWP-luluc', 'Climate change (LULUC)' or 'Climate change – land use and land use change'. It can be entered directly if it is separated (as required by EN 15804+A2:2019 and ISO 14067:2018). If it is not separated, assume it is zero.
- **GWP-s (kg CO₂e):** For products made from fossil fuels and/or mined minerals, $GWP-s = 0$. For products that contain bio-based materials (e.g., wood and paper), this is biogenic carbon stored in the building product itself. 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. Where GWP-s is unknown, calculate it as $(1 - \text{water content}) * (\text{biogenic carbon content of dry matter}) * (-44/12)$. The biogenic carbon content of dry wood (0% water) 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 $-1.65 \text{ kg CO}_2\text{e/kg} = (1-0.1)*(0.5)*(-44/12)$. 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.
- **Density (kg/m³):** Density is required when the **Unit** is volume (cubic metres).
- **Area density (kg/m²):** Area density is required when the **Unit** is area (square metres).
- **Mass per m (kg/m):** Linear density is required when the **Unit** is length (metres).

Note: if you are intending to enter quantities in multiple different units for the same dataset, make sure to fill in the relevant conversions e.g., 'area density', 'density', or 'mass per metre'.

To use your new materials in the Calculator, select 'Custom_material' within the 'Material type' dropdown menu on most of the 'Q_...' sheets.

6.5 Adding Custom Assemblies

Custom assemblies are reusable building elements that aggregate multiple materials together. This could be one m² of internal walls, for example. This can then be scaled up as needed.

When used in a material input sheet, this will be treated as a single row, scaled by the input amount.

The input structure and data requirements are aligned with the regular material input sheets for ease of use. Additionally, the assembly sheet includes the 'Assembly unit' column, allowing the user to specify the unit type for the assembly – such as m² or kg.

Important:

Where the assembly sheet differs from the material input sheets is that assemblies are comprised of multiple rows. Every row with the same name in 'Assembly name' will be treated together when used. This means that any number of rows can be combined by giving them the same name, but please make sure to copy/paste the name to avoid spelling mistakes – otherwise this could cause the assemblies to miss rows during use.

7 THE 'METADATA' SHEET

This sheet of the Calculator gathers data used for the following functions:

- Information required for Green Star submissions.
- Data required for general calculations.
- Data used for benchmarking and validation.

The input fields are a mix of open data inputs and dropdown menus.

As with all sheets, the colour coding defined in section 5 applies.

Fields of particular importance are:

- **Nearest city:** This controls transport distances and emissions in module A4.
- **Stage of design:** This affects the data entry requirements (which will update the colour coding accordingly). Indicating a design stage model will allow you to utilise the Calculator without inputting project data required for benchmarking and validation. This is intended to allow for exploring general trends in generic designs during the design phase of building planning. However, it should be noted that you may not submit a model that is in the design stage for certification.
- **Is this a reference building?** This field controls how general emission factors are selected when you specify a material category but not a specific material within the Calculator:
 - 'No' (i.e., the Proposed Building): The Calculator will automatically select the worst value in a specific class of values. For example, if you select Concrete > 40 MPa but do not select a specific concrete mix, the Calculator will select the *highest carbon* 40 MPa concrete (per kilogram of concrete). This is to encourage the project team to get better quality information and, ultimately, to choose a lower carbon alternative.
 - 'Yes' (i.e., the Reference Building): The Calculator will try to model market-average performance rather than worst-in-class performance. For example, if you select Concrete > 40 MPa but do not select a specific concrete mix, the Calculator will select the 40 MPa concrete with the *median* carbon footprint per kilogram of concrete.
- **Gross Floor Area (GFA):** This controls emissions calculations per square metre of floor area. Please see the definition of GFA within the *Embodied Carbon Methodology*.
- **Was there an existing building on the site?** and **Age of previous building.** These two fields control whether carbon offsetting of a previous building is required. If there was a previous building that was demolished and it was under 50 years old then a full or partial offset for that building's embodied carbon emissions will be required.

8 THE 'LAND' SHEET

The 'Land' sheet is for GWP-LULUC, which is the carbon footprint due to land use and land use change. This sheet is only mandatory for greenfield developments where there is land use change. It does not need to be completed for brownfield developments since there is no land use change.

In general, land use change will only have a material impact on the carbon footprint results if a forest (plantation or natural) is cleared to build the building. Other forms of land use change are less significant because greenhouse gas modelling in New Zealand assumes that 'Settlement' (which is the default land use type for buildings, lawns, parking etc.) is equivalent to grassland/pasture.

When entering data:

- Area 1 is for land within the building's drip-line. This is the only land area which is included within the upfront carbon calculations.
- Areas 2-5 are for land use change that occurs on the site outside of the building's drip-line. These land use changes do not count for upfront carbon under *Green Star Design & As Built NZv1.1* but do count for *Net-Zero Upfront Carbon*.

The crop area is the age of the crop on the site. For example, for a 30-year-old forest, enter 30 years. The older the crop, the more carbon will be stored in that crop.

9 THE 'COMPLETENESS' SHEET

This function of this sheet is to calculate the completeness of each building module and to enable the Calculator to extrapolate the missing cost coverage by scaling the associated emissions. It is therefore very important to fill in the 'Estimated percent of budget (%)' column as accurately as possible. Importantly, this only refers to the cost of materials. All other costs (e.g., labour, transport to site, subcontractor's profit margin) should be excluded from the calculation, as they are either included elsewhere within the Calculator (transport) or not part of the scope of assessment (labour and subcontractors' profit margins).

10 THE 'C_ENERGY' SHEET

The 'C_Energy' sheet of the Calculator gathers aggregated energy and fuel data to calculate the emissions from site preparation and the construction process (module A5). These items are not split out following the Bill of Quantities / Cost Plan (e.g., as the amount of soil excavated) but are instead grouped together on this sheet.

Please enter data for *all fuels and electricity used on-site* in the construction and installation process. This data may be difficult to source as it must include fuel and electricity data from all trades and sub-trades in the construction process. Please *exclude* all fuel and energy used off-site, e.g., transporting staff to and from site, and energy used in the offices and vehicles of professional services firms.

If aggregated information for all contractors is not available, please *either* fill any gaps in your own data with conservative approximations *or* use the following default values:

- Diesel: 4.5 L/m²
- Petrol: 0 L/m²
- Electricity (grid): 37 kWh/m²
- Electricity (on-site renewables or green power): 0 kWh/m²
- Natural gas: 0 kWh/m²

These default values come from One Click LCA and have been used in a range of other studies, e.g., (Arup & WBCSD, 2021).

Note: A later sheet 'NZUC_Construction' is also provided for users of the Net-Zero Upfront Carbon Standard. This allows additional energy required for tenant improvements (which are not part of the scope of Green Star – Design & As Built NZv1.1) to be included. This sheet has the same structure as 'C_Energy'.

11 THE 'C_WASTE' SHEET

This sheet calculates the cumulative proportions of construction waste that are destined for the different available end-of-life options per material category. This then allows the user to review the data and potentially override these proportions with their own waste data on a per-material category basis.

Note: You must document any reasoning for overriding these values as they are based on common practice in New Zealand and should only be replaced by data with higher accuracy. Documentation should be provided with relevant and adequate references (e.g., a site waste report based on weighed waste quantities per material type).

12 MATERIAL INPUT ('Q_') SHEETS

This guidance covers the general function of the following sheets:

- 'Q_SitePrep.'
- 'Q_Substructure'
- 'Q_Superstructure'
- 'Q_Envelope'
- 'Q_Fitout'
- 'Q_Services'
- 'Q_Formwork'
- 'Q_Ext.Works'
- 'NZUC_Improvements'
- 'NZUC_Ext.Works'

This chapter provides detail on how to input data to the input sheets above. Each sheet follows a similar structure, as shown in Figure 9. These sheets are designed for you to enter as many rows as necessary to cover each category of materials in the given building module. The label 'NZUC' indicates that a sheet is intended for compliance with the *Net-Zero Upfront Carbon Standard* only and is not needed for Green Star.



Green Star Embodied Carbon Calculator

Substructure

Category	Assembly name / notes	Component name
Slabs	Foundation - Ground beam	Concrete
Slabs	Foundation - Ground beam	Reinforcing

Figure 9: Example material input sheet (Substructure pictured)

12.1 The 'Category' Column

Please select a category from the drop-down menu. This column relates the specific row towards one of the sub-classifications of the building module within the 'Results' tab. E.g., in the 'Substructure' module, the available sub-classifications are 'Slabs', 'Piles', 'Retaining walls', and 'Other'.

12.2 The 'Assembly name / notes', and 'Component name' Columns

These columns are of do not have a function within calculations. They are intended to be used as follows:

- The 'Assembly name / notes' column is intended to be used where one entry spans more than one row. In this case, please enter the same assembly name in several rows (see e.g. Figure 10).
- The 'Component name' column is intended for the name/ID of an item within the assembly.

Using these columns will assist both the user and reviewer to keep track of what each row represents.

Category	Assembly name / notes	Component name	Material type	Subtype	Matching material - (Dependent on 'Material Type' selection)	Amount Unit
Slabs	Ground beam	Concrete	Concrete	30_MPa	Concrete, 30 MPa, in-situ, no reinforcement, (OPC)	10 m3
Slabs	Ground beam	Reinforcing	Steel		Steel reinforcement, primary, bar (Pacific Steel)	1,500 kg

Figure 10: Example entry for reinforced concrete

12.3 The 'Material type', 'Subtype', and 'Matching material' Columns

These columns are used to select the most representative emission factor per modelled item.

The 'Material type' and 'Subtype' columns are used to pick a category of materials, or to select custom input emission factors and assemblies. The effect of selecting these (sub)types in the dropdown menus is to select a subset of data to be displayed in the 'Matching material' dropdown menu.

Not all materials have a 'Subtype'. If the 'Subtype' dropdown menu is empty, please move to the 'Matching material' column and select your desired material.

If your selection in the 'Material category' column is related to custom assemblies, only assemblies classified as belonging to your current building module will be available. See section 6.5 for information regarding the 'Custom assemblies' sheet.

Note: If you choose a 'Subtype' and/or a 'Matching material' and then later change the 'Material type', the old 'Subtype' and 'Matching material' will remain and will not be cleared automatically. To replace an existing row, you can either delete the row (right-click on the row to be deleted and select 'Delete > Table Rows'.

In this case, please proceed through the menus from left to right to override the old values, starting by selecting 'Material type' then 'Subtype' then 'Matching material'. The 'Unit' may also need to change

12.4 The 'Amount' and 'Unit' Columns

These columns are used to input the quantity of your material used. Make sure that the 'Unit' column dropdown reflects the quantity you are inputting in 'Amount'.

While some datasets contain conversions for different units (allowing for entry of different units), there are exceptions within the database. If your chosen unit does not have an available conversion factor, the unit selection will turn red, prompting you to select a different unit. E.g., conversions are not available when selecting 'unit' or 'linear metre' as your unit when having selected a concrete material.

12.5 The 'Source' Column

This column is used to indicate where your material/product was sourced from. Please choose the location that the last major manufacturing step takes place. For products that are imported into New Zealand, please enter the location of the original manufacturer, not the location of their local representative's warehouse. In the context of Green Star, packaging does not count as a manufacturing step. E.g., if a product is manufactured in China, but shipped in bulk to New Zealand and then individually wrapped in Auckland, please enter 'China' as the source.

Please note:

- 'Local' should be used for products that are manufactured in the city where the building is constructed.
- Please select the geographically closest alternative if the required country/city is not available in the dropdown menu. E.g., if your material was sourced from Uruguay, please select Brazil as the geographically closest alternative. Use of proxy locations can be documented using a

note in Excel; however, transport distances will generally not have a significant impact on the building's overall carbon footprint when using sea, rail or truck freight.

12.6 The 'Waste % input' Column (Optional)

While this column is not a required input, it will allow you to specify the construction waste per line-item. If this column is left empty, a default construction waste figure from BRANZ's LCA datasheets will be used in its place.

This percentage is:

- Additional to the amount you entered.
- Calculated as a percentage of the output amount, not the input amount.
- Counted in module A5, not module A1-A3, in line with EN 15804 and EN 15978.

For example, 10 tonnes of concrete with 10% waste input would be calculated as 10 tonnes of concrete in module A1-A3 plus 1 tonne of concrete waste in module A5, totalling 11 tonnes of concrete manufactured.

13 OTHER DATA INPUT SHEETS

13.1 The 'Q_Services' Sheet

Building services are difficult to model due to a lack of available data. The Calculator contains several in-built services carbon footprints that can be used in place of real data. The use of these datasets is strongly encouraged while carbon footprint data on building services improves.

To find these datasets, select "Building_services" from the "Material type" drop-down menu. You will see the following three options:

- Building services, low-rise residential (proxy)
- Building services, mid-rise and high-rise (excl. vertical transport) (proxy)
- Building services, warehouse and industrial (excl. vertical transport) (proxy)

Please select the appropriate option for your project. Assuming that your building can solely be grouped as one of the categories above, please enter the total floor area of the building in the "Amount" column (which can also be entered as "=A_GFA") and select the "Unit" to be "m²". An example is shown in Figure 11 below where the building can best be represented by three different types of building services, each of which covers 1,000 m² of gross floor area.

Material type	Subtype	Matching material - (Dependent on 'Material Type' selection)	Amount	Unit	Emission factor used (GWP fossil)
Building_services		Building services, low-rise residential (proxy)	1,000	m ²	40.000 kg CO ₂ e/m ² (selected EF) - 25.81% of module.
Building_services		Building services, mid-rise and high-rise (excl. vertical transport) (proxy)	1,000	m ²	75.000 kg CO ₂ e/m ² (selected EF) - 48.39% of module.
Building_services		Building services, warehouse and industrial (excl. vertical transport) (proxy)	1,000	m ²	40.000 kg CO ₂ e/m ² (selected EF) - 25.81% of module.

Figure 11: Example of selecting generic building services emission factors

It is important to note that these general building services factors exclude:

- Vertical transport services, such as elevators and escalators.
- On-site photovoltaic installations.

These should be modelled separately and added on top of the general building services figure above.

For projects wanting to model building services in detail, please refer to CIBSE's TM65ANZ standard for guidance (CIBSE, 2022a) and the related DT65ANZ Embodied Carbon Calculator (CIBSE, 2022b).

The generic factors for building services should only be replaced where the project can ensure that it models at least 80% of the mechanical, electrical and plumbing services (by material value) and uses a scaling factor in the 'Completeness' tab to quantify any missing portion.

13.2 The 'Q_Formwork' Sheet

This sheet behaves in the same way as the other 'Q_' sheets with two important differences:

- The 'Uses' column allows you to enter the number of use cycles for the formwork. For single-use items, please enter a value of 1. Where you do not have specific data, please use:

- Timber formwork (light duty): 1 use cycle
- Timber formwork (heavy duty): 3 use cycles (Laleicke, et al., 2015)
- Steel scaffolding: 10 use cycles (Laleicke, et al., 2015)
- Bamboo scaffolding: 3 use cycles (Laleicke, et al., 2015)
- All transport distances are multiplied by 2 when the use cycles exceed 1. This accounts for the return transport leg, assuming a return-to-base (rather than peer-to-peer) transport model.

13.3 The 'Q_Ext.Works' Sheet

This sheet is designed to enter information about the trafficable surfaces (carparks, driveways, hardstands, etc.). While this information is not within the dripline of the building and therefore not strictly within the scope of assessment, it is included for reporting purposes given that some building types (e.g., retail) will almost always include vehicle parking spaces or hardstands.

This information is mandatory to allow NZGBC monitor if there are any trade-offs between trafficable surfaces inside the dripline of the building (e.g., covered carparks in the basement of a multi-storey building) versus those that are outside of the dripline (e.g., uncovered carparks).

13.4 The 'Carbonation' Sheet

This sheet is designed to allow the user to enter any carbon dioxide removed from the atmosphere during concrete carbonation, either during the building's life or at the end of the building's life. The carbon dioxide stored should be calculated separately and then copied into this sheet. Appropriate documentation must be supplied to support the numbers entered.

13.5 The 'ExistingBuild' Sheet

For all projects in which there is already an existing building, this sheet allows the user to calculate the mandatory offsets associated with the demolition and/or reuse of (parts of) the existing building.

The emissions associated with the demolition of the existing building is calculated through approximated quantities of selected materials combined with their proportions to end-of-life fates. The sheet is already set up with all required materials and should therefore not be modified beyond adding quantities and end-of-life data. Please also ensure that the proportions to end-of-life scenarios adds up to 100% exactly. Non-empty proportions that do not add up to 100% are highlighted with red text.

14 RESULTS

Two sheets are provided for the LCA results:

- 'Results'
- 'Results_Detail'

14.1 The 'Results' Sheet

The main results of the Calculator are presented in the 'Summary results' table (Figure 12):

- **Upfront carbon footprint (A1-A5):** This is used to award points for Credit 19.1 of *Green Star – Design & As Built NZv1.1*. Credit 19.1 only accounts for upfront carbon within the drip line.
- **Upfront long-term stored carbon:** This is used to award points for carbon storage following Credit 19.3 of *Green Star – Design & As Built NZv1.1*.
- **Demolition carbon footprint to offset:** If there was an existing building on the site that was younger than 50 years at the time of demolition, this is the carbon footprint that must be offset, either fully or partly depending on building's age.
- **Whole-of-life embodied carbon footprint (A-C):** This is used as a sense-check to help ensure that burdens have not been shifted from upfront carbon to whole-of-life. It includes EN 15804 modules A, B and C (i.e., it excludes credits from reuse and recycling). It is not part of the points calculation for *Green Star – Design & As Built NZv1.1*.
- **Whole-of-life embodied carbon footprint (A-D):** This is used as a sense-check to help ensure that burdens have not been shifted from upfront carbon to whole-of-life. It includes EN 15804 modules A, B, C and D (i.e., it includes credits from reuse and recycling). It is not part of the points calculation for *Green Star – Design & As Built NZv1.1*.



Green Star Embodied Carbon Calculator

Summary Results

Results for Green Star (kg CO ₂ e)			
Result (kg CO ₂ e)	Absolute	Per m ²	Credit
Upfront carbon footprint (A1-A5) inside the drip-line	203,560	170	19.1
Upfront carbon footprint (A1-A5) outside the drip-line	5,710	5	n/a
Upfront long-term stored carbon	-73,204	-61	19.3
Demolition carbon footprint that must be offset	160,318	134	19.1
Whole of life embodied carbon (A-C) [EN 15804+A2]	304,467	254	n/a
Whole of life embodied carbon (A-D) [EN 15804+A2]	225,222	188	n/a
Whole of life embodied carbon (A-C) [EN 15804+A1]	282,930	236	n/a
Whole of life embodied carbon (A-D) [EN 15804+A1]	203,685	170	n/a

Figure 12: Summary results table

The Calculator returns the results of the upfront carbon assessment, but not the Green Star points. To calculate the points achieved for *Green Star – Design & As Built NZv1.1*, copy the 'Summary results' section from the 'Output – Results' sheet of the Calculator and paste this into the 'Upfront Carbon' sheet of the *Life Cycle Impacts Calculator NZv1.1*. When using the Reference Building approach, you will need to run the Calculator twice (once for the Reference Building and once for the Proposed Building) and paste in two sets of results tables.

A greater level of results breakdown is provided in the 'Results for MBIE's Building for Climate Change' table (Figure 13). This table splits the results into greenhouse gas emissions (positive numbers) and greenhouse gas removals (negative numbers) for the stages that happen now (modules A1-A5) versus those that happen in the future (modules B-D), as per the current guidance from MBIE. This table may be revised as MBIE further clarifies its requirements for Building for Climate Change.

Results for MBIE's Building for Climate Change (kg CO ₂ e)		EN 15804+A2	
Life cycle module	GHG emissions	GHG removals	GHG total
A1-A3 (building products)	175,566	-73,204	102,362
A4 (transport of products to site)	8,688	0	8,688
A5 (construction)	19,306	0	19,306
B1 (direct emissions)	0	0	0
B3-B5 (materials replacement)	98,252	0	98,252
C1 (deconstruction/demolition)	65	0	65
C2 (transport of scrap off-site)	690	0	690
C3 (waste processing for recycling)	50,947	0	50,947
C4 (landfill and incineration)	24,157	0	24,157
D (benefits and loads beyond the system boundary)	2	-79,247	-79,246
Total upfront carbon (A1-A5)	203,560		203,560
Total embodied carbon (A-C)	377,671	-73,204	304,467
Total embodied carbon (A-D)	377,673	-152,451	225,222

Figure 13: Results for MBIE's Building for Climate Change

The Calculator also includes several charts to help visualise the results. An example is presented in Figure 14 below for upfront carbon.

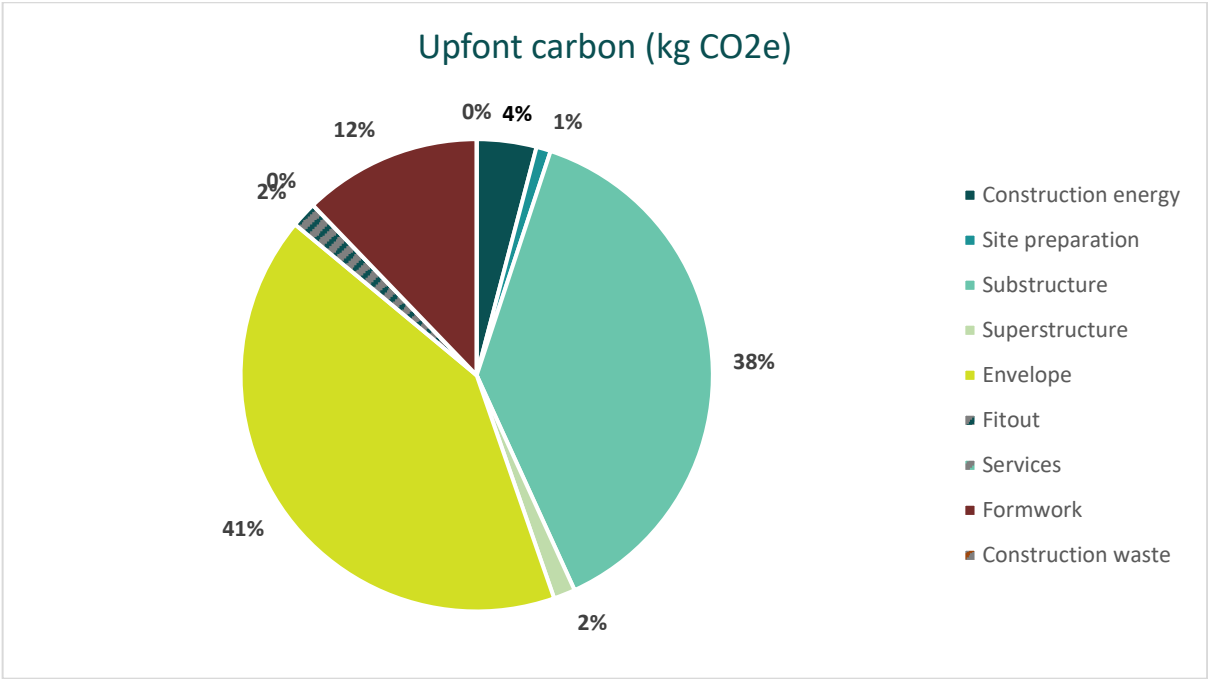


Figure 14: Chart showing contributions to upfront carbon

A detailed breakdown of carbon footprint results is available in Figure 15 below. The emissions breakdown has the following two axes:

- **Building modules** (rows) correspond to each of the major 'Q_*' sheets (substructure, superstructure, etc.), allowing the user to see which parts of the building are contributing the most towards the total carbon footprint.
- **Life cycle modules** (columns) correspond to the life cycle modules defined in section 2.4. The results are summarised in the 'Upfront carbon' and 'Embodied whole-of-life' columns to the right, with one set showing whole-building and the other set showing per m² results.

Climate Change - Upfront Carbon (kg CO2e)					
Green Star	A1-A3	A4	A5	Absolute	Per m ²
Construction energy			19,306	19,306	16
Site preparation	7,873	874		8,747	7
Substructure	18,750	5,801		24,551	20
Superstructure	5,200	1,709		6,909	6
Envelope	95,742	304		96,046	80
Fitout	0	0		0	0
Services	48,000	0		48,000	40
Formwork	0	0	0	0	0
Construction waste			0	0	0
Total	175,566	8,688	19,306	203,560	170

Net-Zero Carbon	A1-A3	A4	A5	Absolute	Per m ²
Construction energy	0	0	0	0	0
External works	0	0	0	0	0
Tenant improvements	0	0	0	0	0
Construction waste	0	0	0	0	0
Additional	0	0	0	0	0
Total	175,566	8,688	19,306	203,560	170

Figure 15: Detailed upfront carbon results per life cycle stage and module, for both Green Star and Net-Zero Upfront Carbon

14.1 The 'Results_Detail' Sheet

The 'Output – Additional results' sheet provides an additional level of breakdown to split the carbon footprint by the major source of emissions: GWP-fossil, GWP-biogenic, GWP-luluc and GWP-total. GWP-stored is also included. Figure 16 shows the GWP-total results as an example.

EN15804+A2: Climate Change - Total (kg CO ₂ e)										
Green Star	A1-A3	A4	A5	B1	B3-B5	C	D	Upfront carbon	Embodied whole of life (A-C)	Embodied whole of life (A-D)
Construction energy			19,306					19,306	19,306	19,306
Site preparation	-57,081	874		0	0	65,665	-14,158	8,747	9,458	-4,700
Substructure	18,750	5,801		0	0	306	-7,344	24,551	24,857	17,513
Superstructure	-3,050	1,709		0	0	8,434	-1,178	6,909	7,093	5,915
Envelope	95,742	304		0	0	328	-56,565	96,046	96,374	39,809
Fitout	0	0		0	0	0	0	0	0	0
Services	48,000	0		0	98,252	1,126	0	48,000	147,378	147,378
Formwork	0	0	0					0	0	0
Construction waste			0					0	0	0
Recarbonation				0		0	0	0	0	0
Total (inside the drip-line)	102,362	8,688	19,306	0	98,252	75,859	-79,246	203,560	304,467	225,222
External works	5,710	0		0	0	2,045	-39	5,710	7,754	7,716
Land use change outside the drip-line	0			0				0	0	0
Total (including external works)	108,071	8,688	19,306	0	98,252	77,904	-79,284	209,269	312,222	232,937

Figure 16: Detailed whole-of-life carbon results per life cycle stage and module

15 CALCULATING POINTS

The results from the *Embodied Carbon Calculator* must be pasted into the *Life Cycle Impacts Calculator* to calculate the points achieved under Green Star. Please use the tab “Credit 19.1 and 19.3”. The initial view of the *Life Cycle Impacts Calculator* is shown in Figure 17.

Result	Unit	REFERENCE		PROPOSED		IMPROVEMENT	
		Absolute	Per m ²	Absolute	Per m ²	Absolute	Per m ²
Upfront carbon footprint (A1-A5) inside the drip-line	kg CO ₂ e					0%	0%
Upfront carbon footprint (A1-A5) outside the drip-line	kg CO ₂ e					0%	0%
Upfront long-term stored carbon	kg CO ₂ e						
Demolition carbon footprint that must be offset	kg CO ₂ e						
Whole of life embodied carbon (A-C) [EN 15804+A2]	kg CO ₂ e					0%	0%
Whole of life embodied carbon (A-D) [EN 15804+A2]	kg CO ₂ e					0%	0%
Whole of life embodied carbon (A-C) [EN 15804+A1]	kg CO ₂ e					0%	0%
Whole of life embodied carbon (A-D) [EN 15804+A1]	kg CO ₂ e					0%	0%

Figure 17: Blank results table where results should be pasted

When using a reference building, paste the results from the *Embodied Carbon Calculator* into the left two blue columns, as shown in Figure 18.

Result	Unit	REFERENCE		PROPOSED		IMPROVEMENT	
		Absolute	Per m ²	Absolute	Per m ²	Absolute	Per m ²
Upfront carbon footprint (A1-A5) inside the drip-line	kg CO ₂ e	8,983,993	898			100%	100%
Upfront carbon footprint (A1-A5) outside the drip-line	kg CO ₂ e	53,444	5			100%	100%
Upfront long-term stored carbon	kg CO ₂ e	50,042	5				
Demolition carbon footprint that must be offset	kg CO ₂ e	0	0				
Whole of life embodied carbon (A-C) [EN 15804+A2]	kg CO ₂ e	10,780,792	1,078			100%	100%
Whole of life embodied carbon (A-D) [EN 15804+A2]	kg CO ₂ e	8,999,787	900			100%	100%
Whole of life embodied carbon (A-C) [EN 15804+A1]	kg CO ₂ e	10,123,423	1,012			100%	100%
Whole of life embodied carbon (A-D) [EN 15804+A1]	kg CO ₂ e	8,798,977	880			100%	100%

Figure 18: Results table after entering data for a reference building

Next, paste the results for your proposed building's *Embodied Carbon Calculator* output to the right two blue columns, as shown in Figure 19.

Result	Unit	REFERENCE		PROPOSED		IMPROVEMENT	
		Absolute	Per m ²	Absolute	Per m ²	Absolute	Per m ²
Upfront carbon footprint (A1-A5) inside the drip-line	kg CO ₂ e	8,983,993	898	7,988,998	799	11%	11%
Upfront carbon footprint (A1-A5) outside the drip-line	kg CO ₂ e	53,444	5	53,444	5	0%	0%
Upfront long-term stored carbon	kg CO ₂ e	50,042	5	852,500	85		
Demolition carbon footprint that must be offset	kg CO ₂ e	0	0	0	0		
Whole of life embodied carbon (A-C) [EN 15804+A2]	kg CO ₂ e	10,780,792	1,078	9,187,348	919	15%	15%
Whole of life embodied carbon (A-D) [EN 15804+A2]	kg CO ₂ e	8,999,787	900	7,923,424	792	12%	12%
Whole of life embodied carbon (A-C) [EN 15804+A1]	kg CO ₂ e	10,123,423	1,012	8,135,353	814	20%	20%
Whole of life embodied carbon (A-D) [EN 15804+A1]	kg CO ₂ e	8,798,977	880	6,871,429	687	22%	22%

Figure 19: Results table after entering data for both a reference building and the proposed building

The Green Star points for Credit 19.1 and Credit 19.3 will be calculated below the table, as shown in Figure 20.

Points Awarded For	Points Awarded
Mandatory achievement met?	YES
Points awarded for Credit 19.1	6
Points awarded for Credit 19.3	0
Innovation points for going beyond Credit 19.3	0

Figure 20: Green Star points calculation

16 ALTERNATIVE TOOLS

NZGBC's intention is to approve alternative tools that meet the requirements of the *Embodied Carbon Methodology*. As the *Embodied Carbon Methodology* and Calculator were developed in parallel, no alternative tools were approved as at the time of launch. Priority will be given to approve those tools that are already widely used within Green Star, such as BRANZ LCAQuick, eTool and One Click LCA.

17 OFFSETTING DEMOLITION WORKS

To offset the carbon embodied in a previous building (or buildings) that is (are) demolished:

- Sufficient carbon offset units must be purchased to offset the demolition works, as calculated within the 'ExistingBuild' sheet of the *Embodied Carbon Calculator*.
- All carbon offset units must have a vintage year later than 2012.
- All carbon offset units must be cancelled in a public registry in the name of the project (i.e., the building's address or building's name) and *not* the name of the construction company or building owner. This is to prevent double counting of offsets across projects.

Offsets may be claimed through any of the programmes listed below:

- Toitū
- Ekos
- Climate Active

Offsetting can also be done by the project itself or through another third party through the use of voluntary carbon offsets provided that only eligible offset units are used, namely:

- Certified Emissions Reductions (CERs) issued as per the rules of the Kyoto Protocol from Clean Development Mechanism projects, except for:
 - Long-term (ICERs) and temporary (tCERs), and
 - CERs from nuclear projects, the destruction of trifluoromethane, the destruction of nitrous oxide from adipic acid plants or from large-scale hydro-electric projects not consistent with criteria adopted by the EU (based on the World Commission on Dams guidelines).
- Removal Units (RMUs) issued by a Kyoto Protocol country for land use, land-use change and forestry activities under Article 3.3 or Article 3.4 of the Kyoto Protocol.
- Verified Emissions Reductions (VERs) issued by the Gold Standard, noting that:
 - Abatement recognised by the Gold Standard may be subject to the possibility of double counting; for example, where the abatement occurs in a host country or region that is affected by international or national emissions trading, cap and trade or carbon tax mechanisms. Please see the Gold Standard's Double Counting Guideline for full details.
 - Where the additionality of a VER is ensured through the cancellation of an Eligible Cancellation Unit (as defined by the Gold Standard), that VER is only eligible for use where the applicable Eligible Cancellation Unit would itself have been eligible.
- Verified Carbon Units (VCUs) issued by the Verified Carbon Standard.
- New Zealand emissions units (NZUs) from the New Zealand Emissions Trading Scheme (NZ ETS), provided that:
 - Only NZUs issued for permanent forestry are surrendered. No other type of NZU may be used.
 - All NZUs are voluntarily surrendered. NZUs that must be surrendered for a company to meet its obligations under the NZ ETS cannot be claimed.

This list of eligible carbon offset units comes from the *Climate Active Carbon Neutral Standard for Buildings* (Climate Active, 2022) with additions from Toitū (Toitū, 2022). As per the *Climate Active*

Carbon Neutral Standard for Buildings, this list may be updated as new information and new offset units become available. This may result in the addition of new offset units or the removal of existing offset units.

18 REFERENCES

- Arup & WBCSD. (2021). *Net-zero buildings: Where do we stand?* Geneva: World Business Council for Sustainable Development.
- BRANZ. (2021). BRANZ CO2NSTRUCT v2.0. Porirua, NZ: Building Research Association of New Zealand.
- CEN. (2011). *EN 15978:2011 Sustainability of construction works. Assessment of environmental performance of buildings*. Brussels, Belgium: European Committee for Standardization.
- CEN. (2013). *EN 15804+A1:2013 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products*. Brussels, Belgium: European Committee for Standardization.
- CEN. (2014). *EN 16449:2014 - Wood and wood-based products*. Brussels, Belgium: European Committee for Standardization.
- CEN. (2019). *EN 15804+A2:2019 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products*. Brussels: European Committee for Standardization.
- CEN. (2019). *EN 15804+A2:2019: Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products*. Brussels: European Committee for Standardization.
- CEN. (2021). *prEN 15978-1:2021 Sustainability of construction works - Methodology for the assessment of performance of buildings*. Brussels, Belgium: European Committee for Standardization.
- CIBSE. (2022a). *TM65ANZ: Embodied carbon in building services: A methodology for ANZ*. London: The Chartered Institution of Building Services Engineers.
- CIBSE. (2022b). *DT65ANZ Embodied Carbon Calculator: Australia and New Zealand (beta v1)*. London: The Chartered Institution of Building Services Engineers.
- Climate Active. (2022). *Climate Active Carbon Neutral Standard for Buildings*. Climate Active, Commonwealth of Australia.
- ISO. (2006). *ISO 14044 Environmental management — Life cycle assessment — Requirements and guidelines*. International Organization for Standardization.
- ISO. (2006). *ISO 14040 Environmental management — Life cycle assessment — Principles and framework*. International Organization for Standardization.
- Laleicke, P. F., Cimino-Hurt, A., Gardner, D., & Sinha, A. (2015). Comparative Carbon Footprint Analysis of Bamboo and Steel Scaffolding. *Journal of Green Building*, 10(1), 114–126.
- MBIE. (2022). *Whole-of-Life Embodied Carbon Assessment: Technical Methodology*. Ministry for Business, Innovation and Employment.
- RICS. (2012). *Elemental Standard Form of Cost Analysis. Principles, Instructions, Elements and Definitions. 4th (NRM) Edition*. London, UK: Building Cost Information Service, The Royal Institution of Chartered Surveyors.
- Stevenson Concrete. (2022). *Stevenson Concrete – Ready-mix Concrete, EPD*. Registration No: S-P-03727.
- Toitū. (2022, May 5). *Explainer Series | A comparison of voluntary carbon markets and the New Zealand emissions trading scheme*. Retrieved from Toitū: <https://www.toitu.co.nz/news-and-events/news/carbon-credits/voluntary-carbon-markets-and-the-new-zealand-emissions-trading-scheme-a-comparison>
- World Green Building Council. (2019). *Bringing embodied carbon upfront*. London: WorldGBC.

