LIFE CYCLE IMPACTS CALCULATOR GUIDE

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This guide is to be used for Credit 19 Life Cycle Impacts in Green Star – Design & As-Built NZ v1.1.

greenstar

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

Change Log

Release	Date	Description of changes
V1.0	01/05/2023	Initial release

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1 INTRODUCTION

This document provides guidance for:

- Use of the *Life Cycle Impacts Calculator*. This tool calculates points awarded for the Credit 19, 'Life Cycle Impacts' within *Green Star – Design & As-Built NZv1.1*. It can also be used to assess if the reduction targets have been met for NZGBC's *Net-Zero Upfront Carbon Standard*.
- The application of Credit 19.2 Comparative Life Cycle Assessment within *Green Star – Design & As-Built NZv1.1*.

This document also refers to NZGBC's *Green Star NZ Embodied Carbon Methodology* (the 'Embodied Carbon Methodology'). While this document refers to environmental indicators other than carbon, many elements of the *Embodied Carbon Methodology* are shared for full Life Cycle Assessment (LCA) and the *Embodied Carbon Methodology* provides more detail than is included within this document.

1.1 Credit 19.2 Comparative Life Cycle Assessment

All projects are encouraged to conduct a peer reviewed whole-of-life whole-building comparative LCA (modules A – D), in conformance with the calculation rules of EN 15978.

This study must be conducted by a Competent LCA Practitioner (as defined in section 2.3).

There are a total of three points which are available for the demonstration of reductions in life cycle impacts of the project building:

- 10% improvement – 1 point total
- 20% improvement – 2 points total
- 30% improvement – 3 points total

The percentage improvement is calculated based on the weighted difference in environmental impacts between the Proposed Building and the Reference Building (see definition in section 2.1). The method by which points the percentage improvement is calculated is explained in section 4.5.

NZGBC's *Embodied Carbon Calculator* cannot be used for compliance with Credit 19.2 since it focuses on carbon footprint only and does not assess other environmental impacts. Instead, Credit 19.2 can only be met with a third-party LCA tool (e.g., BRANZ LCAQuick, eTool, One Click LCA).

The only pathway available for achievement of Credit 19.2 is to compare a Proposed Building and a Reference Building (see definitions in section 2.1). This is unlike upfront carbon (Credit 19.1), where NZGBC's goal is to move towards a fixed benchmark approach (i.e., kg CO_2e/m^2 GFA) over time.

It is crucial that the project team uses identical assumptions (in the life of the building, in replacement cycles, in end-of-life rates, etc.) for both the Proposed Building and the Reference Building to ensure a fair comparison. The choice of Reference Building is also important so that it represents what would likely have otherwise been built had the project team not sought out a Green Star rating.

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.

Practical Completion: The point in time at which major construction works are completed and the building can be occupied for its intended purpose.

2.2 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.

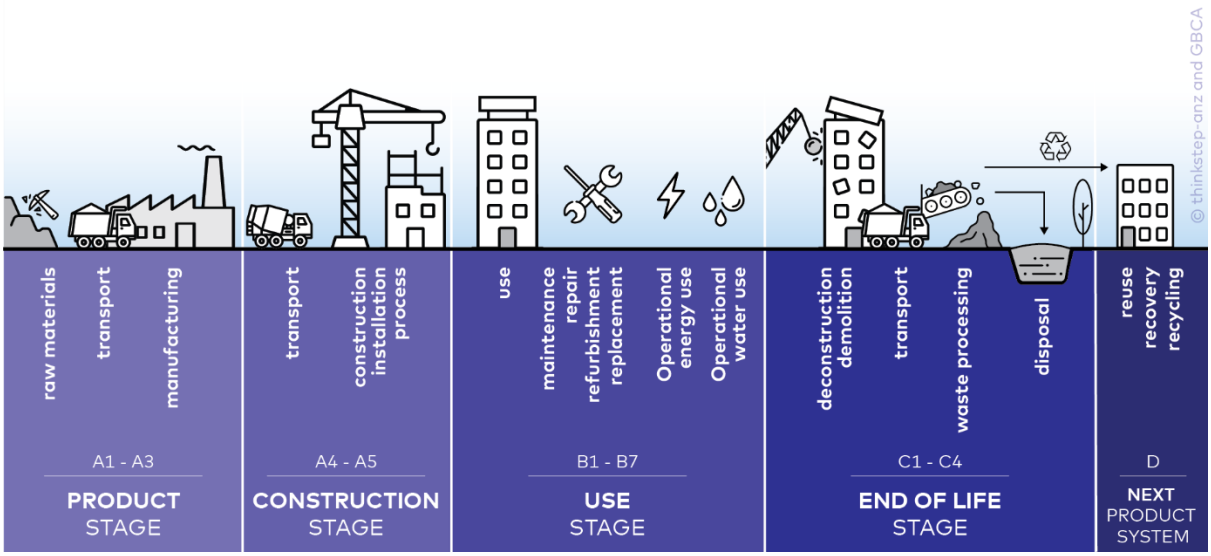

Figure 1: Stages of a building's life cycle (as per EN 15978)

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.

2.3 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 LCANZ, 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.

2.4 Environmental Impacts of Products

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 life cycle modules **must be included**:

- **A1-A3:** Production of building materials and building products.
- **A4:** Transport of materials to the construction site.
- **A5:** Construction of the building, including site clearing, groundworks, erecting the building, and the manufacture and disposal of materials which leave the site as construction waste.
- **B3-B5:** Repair, replacement and renovation.
- **B6:** Operational energy use.
- **B7:** Operational water use.
- **C1:** Deconstruction and demolition.
- **C2:** Transport of waste materials off-site for processing.
- **C3:** Processing of waste materials for recycling.
- **C4:** Disposal of those materials that are not recycled or reused.
- **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.

The following life cycle modules **should be included if relevant**:

- **B1:** Direct emissions to the environment, such as emissions from refrigerants.
- **B2:** Building maintenance, including washing and repainting.

In this document, 'relevant' is defined as being above the cut-off criteria (see section 3.4).

The following activities should be **excluded**:

- Manufacture of machinery and other capital goods (unless these are likely to be above the cut-off criteria), such as:
    - Manufacture of earthmoving equipment and cranes used for construction.
    - Manufacture of trucks used for transportation.
    - Manufacture of machinery used to manufacture building products.
    - (In all cases, emissions from operating machinery and vehicles must be included.)
- Transport of staff to and from the construction site.
- Energy used off-site for professional services.
- Any benefits or loads from electricity exported from the building.

This system boundary follows EN 15978:2011 (CEN, 2011), prEN 15978-1:2021 (CEN, 2021a) and EN 15804+A2:2019/AC:2021 (CEN, 2021b).

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.

Table 1: Building elements in scope

Building element	Included?
Facilitating Works	**Yes**
Substructure	**Yes**
Superstructure	**Yes**
Internal Finishes	**Yes**
Fittings, Furnishing, and Equipment	**No**
Services	**Yes** (see Appendix A of the *Embodied Carbon Methodology*)
Prefabricated Buildings and Building Units	**Yes**
Work to Existing Buildings	**Yes** (see Appendix A of the *Embodied Carbon Methodology*)
External Works	**No**

For more detail, see:

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

3.3 Demolition and Reuse of Existing Building(s)

Demolition is considered part of the previous building's life cycle. The start of the system boundary for the new building as the point where the previous building has already been demolished or disassembled and the materials are separated for disposal or recovery. Land clearing or groundworks that are required for the new building are part of the new building's system boundary.

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.

3.4 Cut-off Rules

This methodology follows EN 15978:2011 (CEN, 2011), prEN 15978-1:2021 (CEN, 2021a) and EN 15804+A2:2019/AC:2021 (CEN, 2021b). These standards require that data which are available must be included in the study. Where there are data gaps, up to 5% of each module (A1-A3, A4-A5, B1-B5, C1-C4 and D) may be excluded, as measured by mass or energy.

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

- Individual screws, nails and other fasteners that are not part of delivered building products.
- Glues, sealants, caulking compounds and filling compounds used in small quantities throughout the building and not part of delivered building products. (Sealants used in membrane roofs applied on-site must be included in the study.)
- Doorknobs, door hinges, 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

- Embodied carbon for additional building services (e.g., additional power cables) installed in the building to operate the equipment in the building (e.g., servers, medical equipment) should be excluded because they are not required to operate the building itself.
- Electricity required for electric vehicle charges should be excluded from module B6 (provided this is possible), given that this electricity is not required for building operation.

4 CALCULATION RULES

4.1 Core Methodology

Project teams may choose to follow *either:*

EN 15978:2011 (CEN, 2011) and EN 15804+A1:2013 (CEN, 2013)

or:

prEN 15978-1:2021 (CEN, 2021a) and EN 15804+A2:2019/AC:2021 (CEN, 2021b).

The same methodology must be applied for both the Proposed Building and the Reference Building.

4.2 Environmental Indicators

4.2.1 EN 15978:2011 and EN 15804+A1:2013

If following EN 15978:2011 and EN 15804+A1:2013, all life cycle impact assessment indicators must be reported and used in the points calculation, as listed in Table 2 below.

Table 2: Environmental indicators to be declared if following EN 15978:2011 and EN 15804+A1:2013

Environmental indicator	Unit
Climate change	kg CO_2 equivalent
Stratospheric ozone depletion potential	kg CFC 11 equivalent
Acidification potential of land and water	kg SO_2 equivalent
Eutrophication potential	kg PO_4^{3-} equivalent
Photochemical ozone creation potential	kg C_2H_4 equivalent
Mineral depletion	kg Sb equivalent
Fossil fuel depletion	MJ net calorific value

4.2.2 prEN 15978-1:2021 and EN 15804+A2:2019/AC:2021

If following prEN 15978-1:2021 and EN 15804+A2:2019/AC:2021, all life cycle impact assessment indicators (both core and additional) must be reported and used in the points calculation, as listed in Table 3 below.

Table 3: Environmental indicators to be declared if following prEN 15978-1:2021 and EN 15804+A2:2019/AC:2021

Environmental indicator	Unit
Climate change – total	kg CO_2 equivalent
Climate change – fossil	kg CO_2 equivalent

	Climate change – biogenic	kg CO_2 equivalent
	Climate change – luluc	kg CO_2 equivalent
	Ozone depletion	kg CFC 11 equivalent
	Acidification	mol H^+ equivalent
	Eutrophication aquatic freshwater	kg P equivalent
	Eutrophication aquatic marine	kg N equivalent
	Eutrophication terrestrial	mol N equivalent
	Photochemical ozone formation	kg NMVOC equivalent
	Depletion of abiotic resources – minerals and metals	kg Sb equivalent
	Depletion of abiotic resources – fossil fuels	MJ, net calorific value
	Water use	m^3 world equivalent deprived
	Particulate matter emissions	Disease incidence
	Ionizing radiation, human health	kBq U235 equivalent
	Eco-toxicity (freshwater)	CTUe
	Human toxicity, cancer effects	CTUh
	Human toxicity, non-cancer effects	CTUh
	Land use related impacts	dimensionless

Note:

- The same environmental indicators must be applied for both the Proposed Building and the Reference Building.
- All requirements from the *Embodied Carbon Methodology* apply for the carbon footprint / climate change environmental indicators.
- Only “Climate change – total” is used in the points calculation.

4.3 Design of the Reference Building

The design of the Reference Building is critical to ensure that the points awarded under Credit 19.2 are fair. The Reference Building aims to reflect the building that would have otherwise been built had the project decided not to opt to pursue a Green Star rating. Detailed requirements for the design of the Reference Building are set out in section 8.2 of the *Embodied Carbon Methodology*. These requirements also apply to this guide.

4.4 Results Calculation

Results should be calculated relative to two declared units:

- Total impacts for the project.
- Impacts per square metres of Gross Floor Area (GFA).

Only impacts per square metre need to be entered into the *Life Cycle Impacts Calculator*.

4.5 Points Calculation

All points calculations for Credit 19.2 are based on a comparison in environmental impacts between the Proposed Building and the Reference Building. The calculated results for each building per square metre of gross floor area (per m^2 GFA) must be entered into either the "Credit 19.2 EN15804+A1" or the "Credit 19.2 EN15804+A2" tab of the *Life Cycle Impacts Calculator*, depending on which methodology you have applied in your study.

The *Life Cycle Impacts Calculator* calculates a weighted single score by first dividing each impact by a normalisation factor (to get dimensionless numbers that can be more fairly compared) and then multiplying by a weighting factor (to judge relative significance). The normalised and weighted results per indicator are then summed together to calculate a total environmental score for each building.

4.5.1 EN 15978:2011 and EN 15804+A1:2013

If following EN 15978:2011 and EN 15804+A1:2013, the normalisation and weighting factors in Table 4 apply. The normalisation factors are based on per person global emissions calculated from total global emissions in the year 2000 from (CML, 2013). The weighting factors are based on the Australian version of Green Star Buildings, with an adjustment to remove water use since it is not an environmental impact assessment indicator and due to its lower relevance to the New Zealand market. (Water use is included for EN 15804+A2 since this standard includes a scarcity-weighted water indicator that measures the potential impact of water use rather than solely the amount of water used.)

Table 4: Normalisation and weighting factors for EN 15978:2011 and EN 15804+A1:2013

Indicator	Unit	Normalisation factor	Weighting factor
Climate change	kg CO_2 equivalent	6800	25%
Stratospheric ozone depletion potential	kg CFC 11 equivalent	0.0368	0%
Acidification potential of land and water	kg SO_2 equivalent	38.9	15%
Eutrophication potential	kg PO_4^{3-} equivalent	25.75	15%
Photochemical ozone creation potential	kg C_2H_4 equivalent	5.99	15%

Mineral depletion	kg Sb equivalent	0.0340	15%
Fossil fuel depletion	MJ net calorific value	61800	15%

4.5.2 prEN 15978-1:2021 and EN 15804+A2:2019/AC:2021

If following prEN 15978-1:2021 and EN 15804+A2:2019/AC:2021, the normalisation and weighting factors in Table 5 apply. These factors are based on the global average from (EPLCA, 2023).

Table 5: Normalisation and weighting factors for prEN 15978-1:2021 and EN 15804+A2:2019/AC:2021

Indicator	Unit	Normalisation factor	Weighting factor
Climate change - total	kg CO_2 equivalent	8100	21.06%
Ozone depletion	kg CFC 11 equivalent	0.0536	6.31%
Acidification	mol H^+ equivalent	55.6	6.20%
Eutrophication aquatic freshwater	kg P equivalent	1.61	2.80%
Eutrophication aquatic marine	kg N equivalent	19.5	2.96%
Eutrophication terrestrial	mol N equivalent	177	3.71%
Photochemical ozone formation	kg NMVOC equivalent	40.6	4.78%
Depletion of abiotic resources - minerals and metals	kg Sb equivalent	0.0636	7.55%
Depletion of abiotic resources - fossil fuels	MJ, net calorific value	65000	8.32%
Water use	m^3 world equivalent deprived	11500	8.51%
Particulate matter emissions	Disease incidence	5.95E-04	8.96%

Ionizing radiation, human health	kBq U235 equivalent	4220	5.01%
Eco-toxicity (freshwater)	CTUe	42700	1.92%
Human toxicity, cancer effects	CTUh	1.69E-05	2.13%
Human toxicity, non-cancer effects	CTUh	2.30E-04	1.84%
Land use related impacts	dimensionless	8.19E+05	7.94%

4.5.3 Improvements From Reducing Operational Energy

Reductions in operational energy use are already rewarded through other credits within *Green Star – Design & As Built NZ v1.1*. As such, a maximum of 1 point is awarded to savings made from operational energy use within Credit 19.2.

4.5.4 Indicators Cannot Worsen by More Than 10%

The intention of multi-indicator LCA is to prevent burden shifting (i.e., not to shift environmental problems from one place to another, from one time to another, or from one type of environmental harm to another). As such, the project is not eligible for any points if any environmental indicator worsens by more than 10% when comparing the Reference Building to the Proposed Building (the '-10%' rule).

NZGBC recognises that there are some design changes which do result in trade-offs against one or more environmental indicators, but significant improvements in other indicators. As such, project teams can submit a Technical Question for an exemption for certain design changes.

Exemptions pre-approved from previous Technical Questions are listed below.

Any project team may use one of the pre-approved exemptions below without submitting a Technical Question provided they can demonstrate that the building would have met the '-10%' rule without the specific design change. Put another way, the exemption shall be used for the specific design change(s) below and not be used to hide trade-offs in other parts of the building. Note that these exemptions only apply to the '-10%' rule. They do not apply to the points calculation.

One way that a project team can demonstrate that the building would have otherwise met the requirement is to compare the results for the relevant indicator(s) for the element or group of elements that are affected by this change. For example, if the design change affects several elements in the superstructure, the project team could show that it is the superstructure only that is causing the '-10% rule' to be broken and that all other parts of the building (substructure, envelope, etc.) meet the '-10%' rule if treated in isolation.

4.5.4.1 Photovoltaic Installations

The installation of solar photovoltaic (PV) systems can cause projects to increase Abiotic Depletion Potential (ADP). This category is known as ADPE (ADP elements) under EN 15804+A1 and ADPm&m (ADP minerals & metals) under EN 15804+A2. This issue occurs because of the materials used in the systems, such as copper in cabling and inverters, rare earths and other materials in batteries, etc. These materials drive a higher ADP score due to their relative scarcity compared to the relatively abundant metals and minerals used in the building itself (such as iron in steel, aluminium, etc.)

An exemption is granted for ADPE / ADPm&m to break the '-10%' rule for building projects that have on-site solar PV systems, provided they can demonstrate that the building would have met the requirement if it did not have the solar PV system.

4.5.4.2 Engineered Wood Products

Significant use of engineered wood products – primarily Cross-Laminated Timber (CLT), Laminated Veneer Lumber (LVL) and Glue-Laminated Timber (glulam or GLT) – can cause projects to increase summer smog. This category is known as Photochemical Ozone Creation Potential (POCP) under EN 15804+A1 and Photochemical Ozone Formation Potential (POFP) under EN 15804+A2.

An exemption is granted for POCP / POFP to break the '-10%' rule for building projects that use engineered wood products as major structural elements, provided they can demonstrate that the building would have met the requirement if it did not have these engineered wood products.

5 GUIDANCE PER LIFE CYCLE MODULE

5.1 Modules A1-A3

Module A1-A3 reports the impacts of manufacturing building materials and products from “cradle to gate”, i.e., from raw material acquisition (mining, extraction, recycling, reuse) to the manufacturer’s outbound gate where the final product is ready for distribution to a customer.

Two types of data are needed to complete a building LCA:

(1) Building quantities: The quantities of materials used in the building itself. These quantities are often known as the activity data. Building quantities may be based on estimates in early design stages but should be based on as-built data for the final LCA to the greatest extent possible. A minimum of 80% as-built data (verifiable by invoices) must be used for the final as-built rating.

(2) Emissions factors: The potential environmental impacts per unit of material, energy or waste. Emission factors may be product-specific, come from a generic database, or be proxies selected to fill data gaps. Emission factors should be selected following the data quality hierarchy set out in the *Embodied Carbon Methodology*, section 6.3. This provides the following preference hierarchy:

1. Verified EPD for specific product with the specific country of manufacture reflecting the product installed in the building.
2. Verified EPD for sector average product with the specific country of manufacture reflecting the product installed in the building.
3. Verified EPD for the specific product (specific or sector average) with a different country of manufacture to the product installed in the building.
4. Peer reviewed LCA for the specific product (specific or sector average), regardless of country of manufacture, not published by an independent programme operator
5. Verified EPD for a similar product (specific or sector average) to the product installed in the building regardless of country of manufacture
6. Peer reviewed LCA for a similar product (specific or sector average), regardless of country of manufacture, not published by an independent programme operator
7. Unreviewed LCA 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. Unreviewed LCA 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. Input-output LCA or hybrid LCA data, either for New Zealand or for a country that has significant manufacturing capacity for this product type.

When using EPD data, the EPD you select should cover the environmental indicators appropriate to the method you have selected for your building LCA. Since 2022, all EPDs produced to EN 15804 must follow EN 15804+A2; however, there are still many historic EPDs published that follow EN 15804+A1. The two versions of EN 15804 use different characterisation models and different units for many of the environmental indicators, meaning they are not interchangeable.

Where a product-specific emission factor or an appropriate generic value from your LCA tool’s database is not available, the project team should apply the procedure outlined as “Generic value from global literature scan” within section 6.3 of the *Embodied Carbon Methodology*.

5.2 Module A4

Module A4 reports the emissions produced to transport building products to site. For large, heavy components (ready-mix concrete, steel beams, windows and doors, curtain wall, etc.), distances should either be provided by the supplier or calculated using mapping software (e.g., Google Maps for truck freight, sea-distances.org for sea freight). When calculating distances, use the last major manufacturing step as the point of origin, not the local warehouse.

For smaller components, blanket assumptions can be made as they will not affect the results. E.g., an approximate distance of 10,000 km by sea and 100 km by truck can be applied for smaller components that are likely to be sourced from Asia.

When using an LCA software tool, please ensure the underlying assumptions are representative of New Zealand conditions. BRANZ provides data for transportation in its module A4 datasheet which can be used to validate (and, if possible, correct) these underlying assumptions.

5.3 Module A5

Module A5 includes:

- **Construction energy:** Diesel burnt in construction machines, diesel burnt in earthmoving equipment, electricity used in cranes, electricity used for site office on-site (if relevant).
- **Construction waste:** This includes the environmental impacts of manufacturing, transporting and disposing of all materials which are wasted on-site (e.g., offcuts, breakages, over-orders that are disposed of). For typical wastage rates, please apply BRANZ's module A5 datasheet, as used in the *Embodied Carbon Calculator*.
- **Land use and land use change impacts:** Please use the *Embodied Carbon Calculator* to calculate climate-related land use change impacts.

5.4 Module B1

Module B1 includes:

- **Fugitive emissions** of refrigerants from air conditioning systems / heat pumps.
- **Direct emissions** to the environment (e.g., run-off from lead or zinc roofs).
- **Removals from the atmosphere**, e.g., uptake of CO_2 through carbonation of concrete during the building's operating life. Carbonation can only be applied for exposed concrete.

Module B1 can be excluded if it is likely to fall below the cut-off criteria defined in section 3.4.

5.5 Module B2

Module B2 includes the emissions from cleaning, repainting and other minor maintenance. BRANZ provides a B2 worksheet which can be used for default assumptions. In general, emissions in B2 will be small and can be excluded if they are likely to fall below the cut-off criteria defined in section 3.4.

5.6 Module B3-B5

Module B3, B4 and B5 include all emissions associated with replacement, repair and refurbishment over the life of the building. By default, a building life of 50 years should be assumed, in line with the New Zealand Building Code. BRANZ provides a datasheet of default values for replacement for module B4 which can be applied for modules B3, B4 and B5 collectively.

5.7 Module B6

Module B6 covers operational energy, specifically the use of electricity and any direct use of fossil fuels on-site for heating. The values used should align with those used in the Green Star *Greenhouse Gas Emissions Calculator* for the project. Deviations must be justified.

Where a building uses on-site renewables, the embodied carbon in these renewables (e.g., in photovoltaic panel installations) must be accounted for in modules A1-A5. All direct use of these renewables can be assumed to replace grid electricity 1:1. Where a portion of the electricity is fed into the grid and then returned for use by the building, a 20% loss factor (accounting for transmission and storage losses) shall be assumed following (RICS, 2023). Where feasible, the embodied emissions in grid generation and transmission should also be accounted for following for all exported and returned energy (RICS, 2023). Grid electricity must be assumed to meet the balance of the energy not met by on-site renewables that are either used directly or exported to the grid and then re-imported.

Electricity for car charging should be excluded where possible as this is not building-related usage.

5.8 Module B7

Module B7 covers operational water and wastewater treatment. The water values should align with those used in the Green Star *Potable Water Calculator*. Deviations must be justified.

5.9 Modules C1-C4 and D

Modules C1 to C4 cover:

- **C1:** Demolition or deconstruction activities, particularly energy used in machinery.
- **C2:** Transport of waste, materials or products off-site for further processing.
- **C3:** Preparation of materials for recycling or reuse (if recycled or reused).
- **C4:** Disposal of materials that cannot be recycled or reused, e.g., in landfill.
- **D:** Avoided impacts (or additional impacts) from not needing to produce primary materials through recycling and/or reuse of a building's materials at end-of-life.

End-of-life is typically modelled at the material category level rather than product-by-product. Default assumptions for end-of-life rates are provided by BRANZ in their C1 datasheet. Alternative assumptions from an LCA software tool can be used provided that they are justified and are applied consistently for the Reference Building and the Proposed Building.

6 QUALITY ASSURANCE

The LCA study and LCA report must 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 ISO 9001.
- **Option B:** The report is produced by an Experienced Individual and is peer reviewed by an LCA Certified Practitioner or independent Experience Individual. For definitions of these terms, please see section 2.3.

For Option B, the aim of the peer review is to provide a third-party opinion on how the LCA was conducted and whether the results are acceptable to demonstrate credit compliance. The peer reviewer must issue a peer review statement which confirms that:

- The LCA conforms to the requirements and intent of Credit 19.2, including (but not limited to) appropriateness of scope.
- The Interpretation section of the LCA report explains the validity of any claims of LCA consideration in the design and construction of the building.
- The methods used to carry out the LCA are consistent with ISO 14040 and 14044 (ISO, 2006a; ISO, 2006b).
- The methods used to carry out the LCA are scientifically and technically valid.
- The data used are appropriate and reasonable in relation to the goal of the LCA.
- The interpretations reflect the limitations identified and the goal of the LCA.
- The LCA report is transparent and consistent.

This statement must also confirm that the LCA report that has been reviewed is the same LCA report (including any revisions) that has been provided for assessment.

7 CALCULATING POINTS

The results from your LCA tool must be pasted into the *Life Cycle Impacts Calculator* to calculate the points achieved under Credit 19.2.

Results should be pasted per square metre of Gross Floor Area (GFA). Results should be split per life cycle module (A1-A3, A4, A5, B1, B2, B3, B4, B5, B6, C1, C2, C3, C4 and D).

Please use either the “Credit 19.2 EN15804+A1” tab or the “Credit 19.2 EN15804+A2” tab depending on which life cycle indicator set you have selected.

The initial view of the *Life Cycle Impacts Calculator* is shown in Figure 2. The “Credit 19.2 EN15804+A1” tab is used as an example. Figure 2 shows the Reference Building results table only, but there is one table for the Reference Building and one table for the Proposed Building.

	Please enter LCA results per m^2 of GFA		Materials and Construction Modules A1 to A5			
			Product	Transport	Construction	Use
	Impact Category	**Unit**	**A1-A3**	**A4**	**A5**	**B1**
REFERENCE	Climate change	kg CO_2 equivalent				
	Stratospheric ozone depletion potential	kg CFC 11 equivalent				
	Acidification potential of land and water	kg SO_2 equivalent				
	Eutrophication potential	kg PO_4^{3-} equivalent				
	Photochemical ozone creation potential	kg C_2H_4 equivalent				
	Mineral depletion	kg Sb equivalent				
	Fossil fuel depletion	MJ net calorific value				

Figure 2: Blank results table where results should be pasted

If your project has an exemption (either via a Technical Question or one of the pre-approved exemptions in section 4.5.4), please enter "YES" alongside the appropriate environmental indicator, as shown in Figure 3. This will zero out the results for that indicator, removing it from the "-10%" rule and the points calculation.

		All Modules					
Impact Category	**Unit**	**Reference**	**Proposed**	**Improvement**	**Exemption?**	**Pass?**	
Climate change	kg CO_2 equivalent	0.0465	0.0376	19%	NO	YES	
Stratospheric ozone depletion potential	kg CFC 11 equivalent	0	0	0%	NO	YES	
Acidification potential of land and water	kg SO_2 equivalent	0.0290	0.0245	15%	NO	YES	
Eutrophication potential	kg PO_4^{3-} equivalent	0.0282	0.0225	20%	NO	YES	
Photochemical ozone creation potential	kg C_2H_4 equivalent	0.0308	0.0246	20%	NO	YES	
Mineral depletion	kg Sb equivalent	0	0	0%	YES	YES	
Fossil fuel depletion	MJ net calorific value	0.0279	0.0244	13%	NO	YES	
		Total Impact Reduction		**18%**			
						Theoretical Points Awarded Excluding Module B6	

Figure 3: Example of entering an exemption

The Green Star points for Credit 19.2 will be calculated below the table, as shown in Figure 4.

Points Awarded For	Points Awarded
Points awarded for module B6	**1**
Points awarded excluding module B6	**0**
Total points awarded	**1**

Figure 4: Green Star points calculation

8 REFERENCES

CEN. (2011). *EN 15978:2011 Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method.* Brussels: European Committee for Standardization.

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CML. (2013, 04). *CML-IA Characterisation Factors (2013 version)*. Retrieved from Institute of Environmental Sciences (CML), Leiden University: https://www.universiteitleiden.nl/en/research/research-output/science/cml-ia-characterisation-factors

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