# Materials Life cycle Impacts

## Aim of Credit

Assess and reduce the environmental impacts of building materials for the whole building over its entire life cycle.

## Credit Criteria

| | | |
|---|---|---|
| **1** | **Comparative Life Cycle Assessment** | Up to 5 points are available where a whole-of-building whole-of-life (cradle-to-grave) life cycle assessment (LCA) is conducted for the project and a reference case. Points are awarded based on the extent of environmental impact reduction against six environmental impacts categories when compared to the reference case. |
| **2** | **Additional Life Cycle Impact Reporting** | 1 additional point is available where the LCA conducted by projects includes reporting of five impact categories in addition to those required under the whole-of-building whole-of-life methodology. |

## Compliance Requirements

## 1. Comparative Life Cycle Assessment

To comply with this credit, projects shall demonstrate the reduction of environmental impacts when compared with a reference building using a life cycle assessment.

The life cycle assessment shall comply with the following sections of the compliance requirements:

1.1 Whole of Building, whole of life LCA Methodology
1.2 Appropriate definition of Reference Case
1.3 Peer reviewed by Independent LCA Practitioner

Both the LCA and the peer review shall be carried out by a competent LCA practitioner as defined in:

1.4 Competent LCA Practitioner

Points will be awarded according to an Impact reduction Calculation. The maximum 6 points will be awarded when a cumulative impact reduction of 100% is achieved according to the method described in:

1.5 Impact Reduction Calculation

Projects that demonstrate smaller impact reductions between 5% and 100% will be rewarded points on a linear scale between 1 and 6.

# 1.1 Whole-of-building, whole-of-life LCA methodology

Scope
Whole-of-Building as defined in EN 15978. In particular, refer to section 7.5 'The Building Model'.

System Boundary
Cradle to grave including all life cycle modules (modules A to D) and scenarios as detailed in EN 15978.

Functional Unit
One square metre (m2) project floor Gross Floor Area (GFA)

Service Life
The service life required by the client or through regulations. If no required service life is defined, a default service life of 60 years is to be applied.

Impact Categories
Projects are to assess the impact of the following six categories:

| **Impact Category** | **Unit** | **Characterisation Methods** |
|---|---|---|
| Climate change | Kg $CO_2$ equivalent | IPCC AR4 |
| Stratospheric ozone depletion potential | Kg CFC 11 equivalent | WMO 1999 |
| Acidification potential of land and water | Kg $SO_2$ equivalent | CML |
| Eutrophication potential | kg $PO_4$ equivalent | CML |
| Tropospheric ozone formation potential | Photochemical Ozone Creation Potential (POCP) [Ethylene equivalents] | CML |
| Mineral and fossil fuel depletion (abiotic depletion) | Kg Sb equivalent | CML |

Data Quality
Selection of data to be based on EN 15978. Data quality to be reported and is subject to peer review.
Use of Australian data should take precedent over imported data where available. Where imported data is used this must be adapted for relevance to Australian conditions (for example transport distances and modes) and documented to show how the data was adapted.

Inputs from Green Star Submission
When conducting the LCA for the project, the following Green Star based inputs shall be used:

- Reference case operational energy benchmarks as used in the Greenhouse Gas Emission Calculator for the project;
- Standard Portland cement content in concrete as benchmarked in the Green Star Concrete credit; and
- Product specific and industry wide Environmental Product Declarations submitted in response to the Environmental product Declarations credit.

## 1.2 Definition of Reference Case

Two options are available for comparison to the project's life cycle assessment

- **Standard Practice Reference Case**

A hypothetical building that represents standard contemporary and construction practices

- **Actual Reference Case**

A building constructed in the last five years and is similar to the in use, construction and operation to the project.

### 1.2.1 Standard Practice Reference Case– Specific Guidance

The reference case is to be agreed through consultation with structural, mechanical, electrical and architectural professionals.

The standard practice reference case and project must have the same:

- Structural requirements
- Scale
- Function
- Location
- Tenant requirements
- Aesthetics
- Site conditions including underlying geology
- Planning constraints
- Orientation
- Season of construction



Materials

The standard practice reference case is to be defined using conventional materials predominant for the building or fitout type and deemed compliant to current National Construction Codes (NCC), as detailed in the Building Code of Australia (BCA). Building fabric must be compliant with BCA Section J DTS requirements.

Energy

Modelled energy consumption of the standard practice reference case must be based on BCA Section J deemed to satisfy (DTS) compliance. Maximum permissible lighting levels in line with BCA must be used. Heating and cooling appliances must comply with efficiencies

which meet the latest Minimum Energy Performance Standards (MEPS) and where relevant BCA Section J DTS requirements.

Documentation required to demonstrate the Standard Practice reference case are included in 'Submission requirements'

### 1.2.2 Actual Reference Case – Specific Guidance

This reference case is only applicable where data for a suitable existing building available to projects. The building must have been constructed in the past 5 years.

The age of the reference case is measured between the project registration for Green Star certification and the date of occupancy certificate for the reference case.

The actual reference case and project must have the same:

- Structural requirements
- Scale
- Function
- Location
- Site conditions including underlying geology

Where possible, the actual reference case and project should have similar:

- Planning constraints
- Orientation
- Season of construction
- Tenant requirements
- Aesthetics

Where there is no actual reference case building that has the same scale as the project, it is acceptable to adjust data to an actual reference case building to represent the scale of the project.

Documentation required to demonstrate the Actual reference case are included in 'Submission requirements'

## 1.3 Peer Review

The aim of the peer review is to provide a third party opinion on how the LCA was conducted and whether the results are to be accepted to demonstrate credit compliance.

The LCA must be peer reviewed by an independent agent as stated in ISO 14044 6.1 and 6.2.

The ISO 14044 standard requires critical LCA reviews to be performed; this provides an assurance of the credibility of the LCA and therefore the results. In general the peer review will investigate whether the

- the methods used to carry out the LCA are consistent with ISO 14040 and 14044,

- 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 study,
- the interpretations reflect the limitations identified and the goal of the study, and
- the study report is transparent and consistent.

The peer review statement must also confirm that the LCA report that has been reviewed is the same LCA report (including revision) that has been provided the GBCA for assessment.

## 1.4 Competent LCA Practitioner

The LCA practitioner and peer reviewer competencies to undertake LCA must be established.

For the purpose of this credit, and whilst an Australian LCA practitioner accreditation system does not exist, an LCA practitioner is an individual or organisation who have produced, co-produced and/or independently peer reviewed at least five LCA studies in the past three years.

Projects are required to submit a competencies statement from the practitioners undertaking the LCA and the peer review. This statement shall include reference to five studies. Any building, product or service LCA study is acceptable.

Prior experience in building LCA may be an advantage to the practitioner but is not required. The credit requires building parameters for the model and reference case to be agreed by architects and engineers

## 1.5 Impact Reduction Calculation

Points are awarded based on a cumulative percent reduction; this is the sum of all impact category reductions and increases between the project and the reference case

Impact categories reductions are unweighted. Increases are subtracted from the cumulative sum.

Where one of the impact categories is increased by more than 10%, no points may be claimed for this credit.

For example the following project outcomes are summed as a cumulative reduction of 90%.

| **Impact category** | **Reference Case (per $m^2$ NLA)** | **Project (per $m^2$ NLA)** | **Percentage change (+/-)** |
|---|---|---|---|
| **Climate change (Kg CO2 equivalent)** | 62925 | 5200 | 21 |
| **Stratospheric ozone depletion potential (Kg CFC 11 equivalent)** | 20 | 22 | -10 |
| **Acidification potential of land and water (Kg SO2 equivalent)** | 922 | 726 | 27 |

| | | | |
|---|---|---|---|
| **Eutrophication potential (kg PO4 equivalent)** | 3.5 | 3 | 17 |
| **Tropospheric ozone formation potential (POCP Ethylene equivalents)** | 0.98 | 0.8 | 23 |
| **Mineral and fossil fuel depletion (abiotic depletion) (Kg Sb equivalent)** | 698 | 623 | 12 |
| **Total cumulative reduction (%)** | | | 90 |

One point may be claimed for every 20% cumulative reduction, or fraction of, to a maximum of 5 points (a 100% cumulative reduction). The final score is rounded to include one decimal point.

For example, a 90% cumulative reduction results in 4.5 points, calculated as 90% divided by 20.

## 2. Additional Life cycle Impact reporting

This criterion rewards the reporting of the following five impact categories in addition to those required under the whole-of-building whole-of-life methodology.

| **Impact Category** | **Unit** | **Characterisation Methods** |
|---|---|---|
| Human Toxicity | Kg 1,4 DB equivalent | DALY |
| Land use | Land Transformation m2 | UNEP/SETAC Land Use Indicator Value Calculation in Life Cycle Assessment |
| Resource depletion - water | m3 water use related to local scarcity of water | Water Stress Indicator |
| Ionising Radiation | kg U-235 equivalent to air | Human Health Effect model |
| Particulate Matter | kg PM2.5 equivalent | RiskPoll |

The additional impact categories should be reported for the project only, not the reference case

Changes to the whole-of-building whole-of-life methodology
EN 15978 scope in relation to operational energy excludes in-use appliances IT and other often tenant installed uses, the methodology may be changed to require these energy uses are accounted for in the LCA in addition to the scope of EN 15978 in certain circumstances.

Impact Categories
The number of impact categories to be reported as part of the methodology based on credit use and national or international developments in LCA.

## Guidance

**Standards noted in this credit**
EN 15804 Sustainability of Construction Work - Environmental Product Declarations - Core Rules for the Category of Construction Products.

EN 15978 Sustainability of Construction Works – Assessment of environmental performance of buildings - Calculation method.

ISO 14040 Environmental management - Life cycle assessment - Principles and framework

ISO 14044 Environmental management - Life cycle assessment - Requirements and guidelines

**References**
Athena Sustainable Materials Institute 2013, 'Athena publishes first North American building declaration to EN 15978', http://www.athenasmi.org/

EeBGuide 2013, various document found at http://www.eebguide.eu.
Grant, P. And Peters, G. (2008) 'Best Practice Guide for Life Cycle Assessment in Australia', Australian Life cycle Assessment Society.

Eurime 2012 'Analysis of five approaches to environmental assessment of building components in a whole building context', thttp://www.eurima.org

Ignacio Zabalza Bribián, ,Antonio Valero Capilla, Alfonso Aranda Usón (2011), 'Life cycle assessment of building materials: Comparative analysis of energy and environmental impacts and evaluation of the eco-efficiency improvement' Building and Environment Volume 46, Issue 5, May 2011, Pages 1133–1140,
http://www.sciencedirect.com/science/article/pii/S0360132310003549

**Definitions**
Life Cycle Assessment (LCA)
An evaluation of the environmental effects of a product or activity holistically, by analysing the entire life cycle. The LCA consists of four complimentary components: goal and scope definition, inventory analysis, impact assessment and interpretation. Further definitions can be found in ISO 14040 and ISO 14044.

Climate change
Climate change is defined as the impact of human emissions on the radiative forcing of the atmosphere with its adverse impacts on ecosystem health, human health and material welfare. The major climate gases are carbon dioxide (CO2) and methane (CH4).

Stratospheric ozone depletion
The thinning of the stratospheric ozone layer as a result of anthropogenic emissions.

Acidification potential of land and water
Acidification potential quantifies acidifying pollutants and their wide variety of impacts on soil, groundwater, surface waters, biological organisms, ecosystems, materials and buildings. The major acidifying pollutants are sulphur dioxide (SO2), nitrogen oxide (NOx) and reactive nitrogen (NHx).

Eutrophication potential
Eutrophication potential quantifies compounds with high nutrient content released into water sources. Eutrophication is a natural, process for a water body, but human activity such as material extraction, processing, manufacturing, construction and maintenance procedures can greatly speed up the process. This impact is measured in kilograms phosphate equivalents (kg PO4 eq).

Tropospheric ozone formation potential
Tropospheric ozone potential quantifies the formation of reactive chemical compounds such as ozone (O3) by the action of sunlight on certain primary air pollutants.

Mineral and fossil fuel depletion
This metric is related to extraction of scarce minerals and fossil fuels. This is generally based on remaining reserves and rate of extraction. This impact is measured in kilograms Antimony equivalents (kg Sb eq). this impact category ius also known as abiotic depletion.

Human Toxicity
Human toxicity is an indication of the risk to human health based on material concentrations tolerable to humans.

Land Use
Land use refers to transformation of land through use in human activities.

Water Depletion
Water depletion refers to scarcity of water.

Ionising Radiation
Ionising radiation refers to radiation resulting from nuclear reaction.

Particulate Matter
Particulate matter is defined as a mixture of solid and liquid particles of organic and inorganic substances resulting from human activities and suspended in the atmosphere.

# Documentation Requirements
# 'Design Review' Submission (Optional)

**Submission Template**

- Points Claimed
- Description of the building
- Indicating whether an Actual Reference Case or Standard Practice reference case has been used.
- Description of the reference case building
- Summary of the impact reducing initiatives that have been included in project design
- LCA results for the reference case and the project, reporting on all six impact categories. LCA results shall be reported per $m^2$ of net lettable area, and where appropriate, per expected occupancy hour
- Where the Additional Life Cycle Impact Reporting criterion is claimed, the results for the additional five categories

Project teams are required to provide documentation supporting credit compliance. The following documents may be used to demonstrate compliance:

- **LCA Report**
  The LCA report is to be presented in accordance with ISO 14044. The LCA report must confirm the whole-of-building whole-of-life methodology of the credit has been followed and that no impact increases by more than 10% when compared to the reference case score. The peer review statement, comments of the practitioner and any response to recommendations made by the reviewer shall be included in the LCA report.
- **Peer Review Statement**
  A peer review statement is a summary of the peer review findings signed by the peer reviewer, it must be clear that the peer reviewer statement refers to the final LCA report for the project, the same report which is submitted for this credit, by reference to specific document versions, dates or other means.
- **LCA practitioner competencies statement** for practitioner and peer reviewer
- **Documentation Required for Actual Reference Case**
  To ensure the reference case is appropriate, projects are required to submit the following:
  - Signed declarations from the principal architect and engineer for the project, confirming and demonstrating how the reference case meets the specific guidance above.
  - As-built drawings pertaining to the reference case;
  - Quantity Surveyor bill of quantity pertaining to the reference case;
  - LCA impact categories results for the reference case.

- **Documentation required for Standard Practice Reference Case**
  To ensure the reference case is appropriate, projects are required to submit the following
  - Signed declarations from the principal architect and engineer for the project, confirming the reference case was constructed in accordance with the specific guidance above. Also confirming the reference case design, technologies and construction are true representation of contemporary practice for the type and function of the project.
  - LCA impact categories results for the reference case

**Please provide your feedback on the technical content of this credit:**