MATERIALS LIFE CYCLE IMPACTS

Points available: 6

INNOVATION CHALLENGE SUMMARY

Use of life cycle assessment (LCA) is gaining greater recognition in sustainability assessment. Currently, products and materials are often compared like-for-like, not holistically and as assembled and used in the building or fitotut works.

This Innovation Challenge aims to encourage project teams to perform whole-of-building whole-of-life life cycle assessments of their project, and to demonstrate that their project performs better in most impact categories without any negative tradeoffs.

This Challenge also aims to increase demand and availability of life cycle data and to build the capacity of industry to perform life cycle comparisons of projects.

ELIGIBLE RATING TOOLS

- Green Star rating tools for Design & As Built
- Green Star - Interiors

TO CLAIM THIS INNOVATION CHALLENGE

To claim this Innovation Challenge your project team must:

- Conduct a whole-of-building, whole-of-life life cycle assessment for the project; and/or
- Compare the results of the life cycle assessment to a reference case over six environmental impact categories, and show that the project performs better in most, and no worse in any category.

NEXT STEPS

1. Review the credit as outlined below.
2. Sign up for this Innovation Challenge using the Green Star Project Manager.
3. Receive approval from GBCA to use Innovation Challenge.
4. Submit documentation with Round 1 or Round 2 assessment submission.
5. Provide feedback to GBCA on the application of the Innovation Challenge to their project. This feedback is to be provided to the GBCA in written format to help inform improvements to the content of the Innovation Challenge.

   It is expected that 500 to 1000 words would suffice and the feedback must include:

   a) The name of the Innovation Challenge claimed;
   b) The time period related to the implementation of the Innovation Challenge (how long it took to implement);
   c) The type of development the Innovation Challenge was applied to (NCC building class or building use);

d) The perceived or demonstrated benefits to the owner and project team. This should form the core of the feedback provided. Qualitative and quantitative information may be used.
e) The perceived or demonstrated difficulties with implementing the Innovation Challenge and suggestions for improvements. Qualitative and quantitative information may be used.

AIM OF CREDIT

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

CREDIT CRITERIA

Three criteria are available only two criteria can be claimed by projects to a total of six points. This means either the ‘Project LCA’ or the ‘Reference Case Comparative LCA’ criteria, and the ‘Additional Life cycle Impact Reporting’ criterion.

Project LCA	One point is available where a whole-of-building, whole-of-life (cradle-to-grave) life cycle assessment (LCA) is undertaken for the project in accordance with the whole-of-building whole-of-life methodology detailed in Compliance Requirements.
Reference Case Comparative LCA -	Up to five 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.
Additional Life cycle Impact Reporting	An additional one 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 of the credit.

COMPLIANCE REQUIREMENTS

Whole-of-building whole-of-life methodology

Scope	Whole-of-Building as detailed in EN 15978 (in particular see 7.5 'The Building Model'.)
System Boundary	Cradle to grave including all life cycle modules (including module D) and scenarios as detailed in EN 15978.
Functional Unit	One square metre (m^2) project floor area (GDA, GFA, GLAR, NLA or GLA) as relevant to the Green Star rating tool to which the project is registered. Gross Dwelable Area (GDA) – Green Star – Multi Unit Residential Gross Floor Area (GFA) – Green Star – Education, Green Star - Healthcare and Green Star – Public Building Gross Lettable Area – Retail (GLAR) – Green Star - Retail Gross Lettable Area (GLA) – Green Star - Industrial Net Lettable Area (NLA) – Green Star – Office Design and As Built, Green Star – Office Interiors and Green Star – Interiors PILOT.
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

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

Under the Additional Life Cycle Impact criteria of the credit, a further one point is available where the LCA conducted by projects includes reporting of a further five impact categories. See 'Additional Life cycle Impact Reporting' guidance.

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.

Definition of Reference Case

Two options are available for comparison to the projects life cycle assessment.

- Standard Practice Reference Case – A hypothetical building that represents standard contemporary construction practices
- Actual Reference Case – A building constructed in the last five years and is similar in use, construction and operation to the project.

The following provides guidance to the Reference Case Comparative LCA criterion, unless stated as 'specific' to either the standard practice or actual reference case scenarios.

Standard Practice Reference Case– Specific Guidance

The reference case is to be designed using conventional materials predominant for the building or fitout type deemed compliant to current National Construction Codes (NCC), as detailed in the Building Code of Australia (BCA).

Modelled energy consumption 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. Building fabric must also be compliant with BCA Section J DTS requirements.

Both the reference case and project must have the same structural requirements, scale, function and location, tenant requirements, aesthetics, site conditions including underlying geology, planning constraints, orientation and assumed to be constructed at the same season. The reference case is to be agreed through consultation with structural, mechanical, electrical and architectural professionals.

To ensure the reference case is appropriate, projects are required to submit 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.

Actual Reference Case– Specific Guidance

This criterion of the credit is only available where data for a suitable existing building or fitout is available to projects; this data is the basis for the reference case. This entails an actual building or fitout constructed in the last five years.

The age of the reference case is measured between the project registration for Green Star and the date of occupancy certificate for the reference case. This applies equally in a Design or As Built situation. A Design registration date shall take precedent where a project undergoes both a Design and As Built assessment.

Both the reference case and project must have the same structural requirements, scale, function and location, including underlying geology. Where possible the two buildings also have a similar orientation, and season of construction. In light of the possible difficulty in finding a reference case of exactly the same scale as the project, it is acceptable to adjust data for an existing reference case to represent the scale or other parameters of the project.

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; and
- Quantity Surveyor bill of quantity pertaining to the reference case;

Where such documentation is not available the actual reference case scenario cannot be used.

Green Star based inputs

When conducting the LCA 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.

Peer Review

The LCA must be peer reviewed by an independent agent as stated in ISO 14044 6.1 and 6.2, it must be clear that the LCA report submitted by the project is the same LCA report to which the peer reviewer has provided a favourable opinion. This should include a reference to the report name and date by the peer reviewer that corresponds with the LCA report submitted.

The aim of the peer review is to provide a third party opinion on how the LCA was conducted and the validity of the result. The peer review will also comment on whether the whole-of-building whole-of-life methodology of this credit has been followed.

LCA Practitioner competencies

The LCA practitioner and peer reviewer competencies to undertake LCA must be establish. 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 includes reference to five studies. LCA studies conducted by the practitioner do not necessarily need to relate to buildings or building products, any product or service LCA is acceptable.

Prior experience in building LCA may be an advantage to the practitioner but the credit requires building architecture and engineering for a reference case to be agreed by architects and engineers.

Documenting LCA results

The project LCA report is the main deliverable from the LCA practitioner to the project and the main item of documentation for this credit. 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 of 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.

A peer reviewer 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.

The short report must includes summary of all results, as follows:

- LCA result for the reference case and the project reporting on all impact categories, LCA result shall be presented as one meter square of the relevant unit (see whole-of-building whole-of-life methodology), in addition the following must also be presented:
    - per expected occupant hour (occupancy pattern); and
    - where the Additional Life Cycle Impact Reporting criterion is claimed including additional five categories

The As Built submission LCA report and result are to be adjusted by the LCA practitioner based on changes to materials selection or design between the design and the final constructed project, if no changes are made the architect statement is to be reissued to also confirm this. Any changes between the project as-built LCA and design LCA report shall be subject to peer review.

Benchmarking points

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.

One point may be claimed for every 20% cumulative reduction, or fraction of, to a maximum of five 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 90/20, see Guidance for a worked example.

ADDITIONAL LIFE CYCLE IMPACT REPORTING

This criterion encourages 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	USEtox
Land use	Land Transformation m^2	UNEP/SETAC Land Use Indicator Value Calculation in Life Cycle Assessment
Resource depletion - water	m^3 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.

The Additional Life cycle Impact Reporting criterion is aimed at encouraging development of relevant characterisation methods for impact categories that are underdeveloped in LCA and/or to test relevance of impact categories to the system (Building or fitout projects). Reporting against such impact categories may result in incorporation of a wider range of impact categories within the whole-of-building whole-of-life methodology of this credit.

GUIDANCE

Standards noted in this credit

Standards for this credit include:

- 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.*

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.

LCA terms, frameworks and standards – it is beyond the scope of the credit to introduce the reader to many LCA terms, frameworks and standards used or referenced within this document. Further reading may be necessary.

Climate change – 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 (CO_2) and methane (CH_4).

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

Acidification potential of land and water – 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 (SO_2), nitrogen oxide (NO_x) and reactive nitrogen (NH_x).

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 PO_4 eq).

Tropospheric ozone formation potential - formation of reactive chemical compounds such as ozone (O_3) by the action of sunlight on certain primary air pollutants.

Mineral and fossil fuel depletion – 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 is also known as abiotic depletion.

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

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

Water depletion – refers to scarcity of water.

Ionising radiation – refers to radiation resulting from nuclear reaction.

Particulate Matter – mixture of solid and liquid particles of organic and inorganic substances resulting from human activities and suspended in the atmosphere.

Peer review – 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 wether the:

- methods used to carry out the LCA are consistent with ISO 14040 and 14044,
- methods used to carry out the LCA are scientifically and technically valid,
- data used is appropriate and reasonable in relation to the goal of the study,
- interpretations reflect the limitations identified and the goal of the study, and
- study report is transparent and consistent.

Notice of upcoming revisions

This credit will be subject to change over time. Changes will be determined based on the extent of use of the credit and ongoing need for further guidance and clarifications. The following details three changes that may be considered in future.

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

Changes to benchmarking

The initial benchmarks of the credit, one point for every 20% cumulative reduction to a maximum of five points, will be changed over time based on rate of submissions, and points claimed from Green Star projects using this credit. We expect revisions to benchmarks will occur annually or biannually.

Worked Example

The following is a worked example of documented outcomes for the Reference Case Comparative LCA criterion of the credit. In this example, a 90% cumulative reduction was achieved resulting in 4.5 points, calculated as 90/20.

Impact category	Reference case (one m2 NLA)	Project (one m^2 NLA)	Percentage change (+/-)
Climate change (Kg CO2 equivalent)	6295	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 (Kg Sb equivalent)	698	623	12
		Total cumulative reduction (%)	90
		Points generated	4.5

DOCUMENTATION REQUIREMENTS

DESIGN AND AS BUILT

- ☐ Submission Template
- ☐ Peer reviewed LCA report
- ☐ LCA practitioner competencies statement

Where the Reference Case Comparison LCA criterion is claimed

- ☐ Reference case documentation

Submission Template:

- the credit criteria and points claimed
- the LCA result for the reference case and the project

- referencing documentation submitted
- a brief discussion on how LCA was used as a design decision making tool and resulting material selection, project design or other project features.

Peer reviewed LCA report as requirement by the credit Compliance Requirements.

LCA practitioner competencies statement from both the practitioner(s) undertaking the LCA for the project and the peer reviewer.

Reference case documentation as required for a standard practice or actual reference case (see compliance requirements - specific guidance).

REFERENCES

Athena Sustainable Materials Institute 2013, 'A Grander View The Enermodal Engineering Office Building Kitchener, ON An Environmental Building Declaration According to EN 15978 Standard', http://www.athenasmi.org/wp-content/uploads/2013/06/EnermodalEnvironmentalDeclaration.pdf.

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