



# **GBCA Consultation Paper: Life Cycle Assessment in Green Star Edge Environment Response**

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This note provides Edge Environment's response to the GBCA consultation paper on "Life Cycle Assessment in Green Star", responding directly to the questions posed. The questions posed are shown in grey text, Edge Environment's response is shown in blue text (with a quotation reproduced from the BP LCI Protocol shown in green text)

## **1. Summary of Questions**

**The Green Building Council of Australia invites feedback from stakeholders on undertaking a project aimed at introducing LCA based assessment in the Green Star Materials category. You may need to read the entire paper before you can answer these questions.**

- Is it appropriate for the GBCA to undertake this project or would any other organisation be better placed to do it. If yes, which organisation?

Edge Environment applaud GBCA taking this step toward a more comprehensive and meaningful assessment of the environmental impact arising from materials used in building products within the Green Star suite of Building Rating tools.

We believe that GBCA have the trust and engagement of stakeholders from government and both the supply and demand side of the Property industry whilst maintaining independence from any particular interest. GBCA are the only organisation that can do this for Green Star.

Equally, GBCA make reference to many other organisations and activities in the design of their credits – the energy credits require BESTEST accredited modelling tools, Forest Certification and other Stewardship schemes are recognised, Ecospecifier and GECA ecolabels are, or have been recognised within credits.

In developing LCA based credits for Green Star it may be appropriate to recognise ALCAS member companies or accredited practitioners and ALCAS registered product certification schemes since these will all be subject to expert scrutiny by ALCAS as the learned body for LCA in Australia.

National Standard's is also developing a suite of product criteria reports (PCR's), with engagement of industry, government and other interested stakeholders and to which GBCA has an open invitation to participate. These build from the work of BPIC members developing the Building Products Life Cycle methodologies, protocols and consistent datasets (121 published product production processes) to establish baseline generic average industry data for over 99% of the mass of all buildings in Australia. These establish the criteria for Environmental Product Declarations (EPD's) compliant to ISO14025 and the thresholds for environmentally preferable performance required by ISO14024 compliant ecolabels. National Standards is seeking ABSDO accreditation as an Australian standard writer for this work and the resulting PCR's and ecolabel criteria

will be available to any organisation to adopt and use. This initiative may also provide a valuable basis for Green Star materials credits.

- Is the Australian market ready for LCA as a tool for assessing the environmental impact of materials? If no, in how many years time do you think the market would be ready?

The Australian market will never volunteer to be ready for LCA, but meanwhile the international market, particularly in Europe is driving forward with LCA based EPD's and ecolabels being recognised in regulations and legislation. Australian industry needs to catch up. The UK BREEAM rating system has had LCA-based credits since 1998 and the Code for Sustainable Homes effectively embeds them into regulation. This approach is being replicated in other European countries.

The Building Product Life Cycle Inventory project has achieved a hard-won cross-sector consensus to establish the baseline methodologies, protocols, impact assessment method and weightings and compile the key baseline data for 121 materials/products. These have already been used in the design of materials and resources credits for the Australian Green Infrastructure Council's recently launched "Infrastructure Sustainability"(IS) rating tool. (Edge Environment were authors of these credits and developed the Materials Calculator used as the basis for credit). The BP LCI has also been used by Edge Environment as the basis for the Australian and NZ transport authorities Greenhouse Gas Assessment Workbook for Road Projects, in Green Tag ecolabel submissions, in the NSW transport project sustainable procurement guidelines, and numerous product and building LCAs.

- What do you see as the main barriers to implementing LCA as an assessment methodology for materials in Green Star?

We believe that two types of credit are needed for buildings:

- Firstly for the design of whole buildings where complex trade-offs occur between material/product choices and operational performance. An intermediate solution is needed (BREEAM uses the Green Guides to Specification for example). A long term solution may be in the form of dynamic whole building design tools. BRE in the UK and Edge Environment in Australia have proven this concept through the ENVEST LCA tool which assist design teams to make the best informed choices right from inception of the design where the key decisions are made about a building for the next 100 years of its life.
- Secondly in the specification and procurement of specific proprietary products for the construction of the building. At this stage we would envisage ecolabels as the most potent way of recognising environmentally preferable products.

As a result, the main barriers to implementing LCA as an assessment methodology for materials/products in Green Star is the availability of proven and accepted LCA based design tools and the availability of ISO14024 compliant and cost-effective ecolabels. (Global Mark are establishing such an ecolabel and this will use the National Standards' PCR's to be launched shortly).

- If the GBCA decided to introduce the methodology described in this paper, how much notice would you recommend the GBCA give to the market?

Edge Environment believe that this consultation has put the industry on-notice and it will take perhaps 12-24 months to progress through and pilot the approach for LCA

based material/product credits which should provide enough time for the market to prepare.

- The list of inclusions may be expanded in the future, is it appropriate to start with a limited scope of assessment in order to simplify the LCA?

Limiting the physical scope of the assessment to the building structure, core services and façade materials could significantly reduce the time and cost of an assessment but significantly reduce the reliability of the assessment – see below

- Please provide feedback on the list of inclusions and exclusions.

“building structure” would need to include ground and upper floors, foundations, roof and any internal structural walls if it were to capture most of the initial embodied impacts.

Omitting floor finishes would be problematic for a reliable assessment - these may double the materials impacts of a whole building over its life because they are high impact and replaced many times over the life of a commercially tenanted building. Internal partitions and wall and ceiling finishes (including suspended) are also significant contributors. (Precious Joules, Howard and Sutcliffe, Building 18 March 1994)

- Are there additional materials should be addressed by the inclusions and exclusions?

What matters here is not materials but elements - we believe that surface finishes and internal partition should be included in an LCA based credit assessment for this to be sufficiently comprehensive. Use of, default ratios of internal partition to floor area and default floor finish assumptions could standardise assumptions and make this practical and cost –effective. More about this below considering functional unit for fit-out.

- Is the use of a ‘cradle to constructed, sealed and serviced’ building approach appropriate?

We agree with GBCA that limiting the temporal scope to ‘cradle to grave’ and ‘cradle to gate’ would be too limited to reliably rate LCA based environmental performance.

The proposed scope of ‘cradle to constructed, sealed and serviced’ has some merit, but would still miss out on key embodied impacts in fit-out elements as above

- Is it practical to make qualified assumptions about the origin and the distances that material must be transported in a Green Star design submission, i.e. at a tender stage when some the specific materials are unknown?

For most high impact products, the transport assumption is not a significant proportion of the total embodied impact and generic assumptions can be used. However, for some materials/products it is significant – in particular the large mass materials (e.g. aggregate and fill materials, concrete).

Also, LCA has shown that some recycled materials are more damaging to the environment than virgin sourced material because of increased transport. Recycled content is not a reliable proxy for low impact for many products.

Qualified assumptions can be made about the origin and transport distances for most materials and products for a Green Star design submission, but for the large mass of low impact materials and for reused and recycled materials, origin, distance and transport mode are often significant and should be taken into account.

- Is 1m<sup>2</sup> of GFA an appropriate unit?

We believe that per m<sup>2</sup> of GFA is the best unit to use for a new commercial/mixed use building and that by analogy, per m<sup>2</sup> of NLA is the best unit for tenanted space if a rating tool is addressed to tenancies only.

- Are there constraints to using this unit?

Any functional unit is a compromise between thoroughness (where everything is a special case) and practicality – we consider this the best unit provided it is related to the mix of uses of the building and provided the scope addresses how materials and products integrate and perform with the energy, water and waste systems (which are addressed by other credits within the rating systems).

- If there are constraints or reservations about the proposed functional unit, what are the alternatives?

We would ideally prefer that this were per m<sup>2</sup> over a 50year life cradle to grave and incorporating all operational energy, water and waste aspects measured comparably to avoid perverse outcomes.. Since 1998, BREEAM has also measured the likely transport implications of buildings based on location in a way that is also compatible with the energy and materials embodied impacts.

- Is it appropriate to limit the number of environmental impact categories to six?

No, the main time taken and costs incurred in compiling the LCA for a building lies in estimating materials quantities, lifetimes of components, cleaning and maintenance implications etc. for the scope. Impact assessment is automated within LCA software – there is no need to limit the impact categories.

Leading international midpoint impact assessment methods (e.g. CML, ReCiPe, IMPACT 2002+, TRACI, SETAC) use a large set of midpoint impact categories, typically between 12 and 18.

Normalisation and possibly weighting of the individual impact categories are the appropriate approaches to determine which impacts matter, not *a priori* exclusion or prioritisation. Use of limited impact categories have repeatedly been demonstrated to lead to perverse outcomes and misleading results.

- If more categories are to be included, which categories do you recommend be included? What method should be applied to determining the impact categories the LCA will take into account?

The BP LCI categories appear to be misquoted in the consultation document, listing all of the categories investigated rather than the ones recommended for use. (Internal Environment is not assessed by LCA currently). We would recommend the following BPIC categories at present:

Global warming: characterised in 100 year global warming potential factors (GWP100) for carbon dioxide equivalents (kg CO<sub>2</sub>-eq).

Abiotic resource depletions (excl. water): CML 2 baseline 2001 relative characterisation factors for abiotic resource depletion potential renormalised to be measured in oil equivalents (kg oil-eq) for non-renewable fuel depletion and iron equivalence (kg Fe eq) for mineral depletion.

Land transformation and use: characterised in hectare years (ha.a).

Water resource depletion: characterised using total freshwater consumed (kL water).

Eutrophication: CML 2 baseline 2001 characterisation factors in phosphate equivalents (kg PO<sub>4</sub> eq).

Acidification: ReCiPe global (H) midpoint characterisation factors in sulphur dioxide equivalents (kg SO<sub>2</sub> eq).

Eco-toxicity: characterisation based on Potentially Affected Fraction (PAF) of species, based on Lundie et al (2007) for marine aquatic, freshwater aquatic and terrestrial eco-toxicity.

Photochemical smog: ReCiPe (H) global midpoint characterisation factors in non-methane VOC equivalents (kg NMVOC eq).

Ozone depletion: WMO method for characterisation in Chlorinated Fluorocarbon 11 equivalents (kg CFC-11 eq).

Ionizing radiation: ReCiPe (H) global midpoint characterisation factors in Uranium 235 equivalence (kg 235U eq).

Human toxicity: Lundie et al (2007) characterisation factors in Disability Affected Life Years (DALY) for carcinogenic and non-carcinogenic effects.

Particulates: IMPACT 2002+ expressed in particulates with a diameter of 2.5 µm equivalence (kg PM<sub>2.5</sub> eq)

Impact categories are being continuously researched internationally. The next ones to be refined for Australia should be water and land use.

- If fewer categories are to be included which categories do you recommend be removed?

We have described inclusions.

- If six impact categories are appropriate, are the six categories above the most appropriate?

The BPIC impact assessment research identified 12 impact categories, building mostly on international scientific methods, with the exception of eco-toxicity and human toxicity where Australian specific research and adaptations have been made.

- Is it appropriate to refer to the AusLCI impact categories? Is there an alternative which should be used? Why?

The impact categories quoted seem to be from the BP LCI. These nonetheless draw from and extend the AusLCI Impact Assessment Working Group's work. There are many possible permutations and combinations of impact assessment methodology – the

corrected set above does have the advantage of support from the BPIC members representing the material and product suppliers in Australia.

- Is it appropriate to reference the BC LCI weightings? If not, what should be used instead?

The methodology used and results obtained have a long pedigree (since 1997 UK) and have proved consistent between countries (UK, US, NZ, AU 11 Cities), between demographic groups and different stakeholders (with similar profiles of stakeholder opinion between countries). Edge Environment strongly recommends the methodology and the weightings to GBCA for the material/product assessments,

- Is it appropriate to have separate credits for each of the environmental categories or should the total score be weighed together and assessed in one credit?

Edge Environment believes that this is a moot question. If each of the categories is separately scored then the number of credits given to each category will become an implicit weighting. It is far more justifiable, transparent and credible to explicitly use the weightings to combine the scores into one credit. The impact assessment can be readily automated to reduce the time and cost of documentation and assessment

- Is it practical to establish a standard practice reference case for low-rise, mid-rise and high-rise buildings of different classes? If not, what other methods could be used to establish a reference case?

Edge Environment staff have considerable experience of credits and assessments based on reference cases (from BREEAM UK and LEED US) and would not recommend this approach. Project teams will, in their submissions, show great creativity in gaming the reference case to high impact so that their actual project appears to perform well. This results in considerable costs and contention to document both the reference and actual design and then to appraise both the reference and actual for the award of credit.

In addition, for consistent assessment, presumably GBCA will need to standardise many design and specifications aspects between the reference and actual which may be a constraint to design team ingenuity. The more aspects that are standardised, the less the gaming and the more consistent the assessment between projects, but also the greater the constraint on design innovation.

We do not believe that there needs to be a differentiation between low-rise, mid-rise and high rise buildings – the LCA results per m<sup>2</sup> of GFA should be similar for similar mixes of use (substructure is usually a small proportion of total embodied impacts especially over the full life).

We would not recommend this approach – please see below.

- Should the reference case distinguish between new building on a green field site, refurbishment of existing buildings and fitouts? How can an equitable system be developed which acknowledges the advantages of the options from an environmental impact perspective?

We believe that a single absolute metric threshold would be appropriate for all cases (see below) because what matters at the end is the quantity of floorspace provided to meet the required functions that the building serves. Where a development reuses parts of an existing structure this deserves the commensurate reward of avoiding the use of



materials and products that the Greenfield development must consume. Equally, new-build on a Greenfield site is less constrained, may be more efficient and benefit from new materially efficient structural systems etc. We believe that it is fair to compare them on the same basis irrespective of the starting point.

- If the reference case is constructed in a similar manner to that described above, would you be able to provide your interpretation of how this may operate in practice?

We would not recommend this approach

- Can LCA methodology in the Green Star Materials category operate without a reference case? If so, how do you see this working?

We believe that it is quite possible to define absolute threshold criteria for credits in weighted overall Au Ecopoints per m<sup>2</sup> of Gross Floor area.

The threshold should be based on a wide range of building use mixes, building sizes, shapes, specifications of all major elements, with a range of fit-out alternatives and mixes of open plan to cellular office space. From such a “histogram” the thresholds can be set at any desired level of credit ambition (% of designs likely to achieve any particular Ecopoint/m<sup>2</sup> threshold). This can also be done for any sub-set of the 12 BPIC impact categories.

We would strongly recommend this approach which has been proven through the UK Green Guides to Specification and which can be cost-effectively and transparently modelled using Edge Environment’s ENVEST tool

- Is it practical to conduct two iterations of the LCA with different inputs for the project?

Yes this is definitely possible (but not our recommendation).

- How much additional time would it take to do the second iteration of the LCA having completed the first one? Is it 25% more, 50% more, 100% more etc?

This depends on the amount of latitude given to the design team for variation between the reference and the actual design. The more the team are constrained to a standardised set of specifications the closer to 25% addition, the more the reference and design differ and the closer the cost addition would approach 100%. In addition, the costs to document and for Green Star assessment would also increase commensurately.

- Does the intended content of Table 1 include enough data to determine the input parameters for the standard practice case LCA? If not, what is missing?

Table 1 would not be at all sufficient to define the reference structure. Comprehensive specification/design details and dimensions would be needed for every component for this to provide a consistent reference case. It is also somewhat unclear how this would be used – in particular what aspects must remain common between the reference and actual designs – definitely m<sup>2</sup> GFA, but what about shape, number of stories, window areas/orientations? Every item that remains common improves the consistency of the assessment but is removed from the designers palette to innovate for credit. Our recommended approach has none of these limitations.

- What would be the best way to determine the rules for the input parameters in Table 1?

This would require an expert committee to deliberate for a considerable period to find the right balance and would be very complex and costly to administer and audit. Once again, we would not recommend this approach. Far better in our view to compile a histogram of building impacts from which to determine the credit thresholds. We anticipate that there would be little difference between the results for low, medium and high-rise and that just one set of absolute criteria could be used for all.

- Is it appropriate to nominate ISO 14025 as the reporting mechanism?

We do not think that ISO14025 is the best choice for a reporting mechanism. This standard is primarily for making validated Type III Environmental Product Declarations (EPD's) for proprietary products. The resulting EPD's comprise a list of declared parameters (the criteria) about the product together with a similar list of impact performances. It is analogous to a food nutrition label as opposed to a final performance assessment like an Energy Star label. It is hard to see how GBCA would interpret the list of results into performance based credit outcomes in Green Star.

- Is there an alternative that is preferred or should be considered?

ISO14024 however is for ecolabels which provide a final assessment of performance, which could in this case be the numbers of Green Star credits directly. To comply with the ISO14024 standard, GBCA would still have to research the range of LCA based performance achieved by a broad range of building designs and publish the report as the basis for giving credit. We do not believe that a reference building approach could be used compliant to either the ISO14025 or ISO14024 standards because it will not be possible in advance to publish unambiguous criteria (because the reference will be different in every case).

- Is percentage reduction in impact an appropriate way to award points for improvement?

We would not recommend the reference building approach but rather award points on the basis of direct absolute Ecopoint / (m<sup>2</sup> GFA) thresholds at different levels for different levels of credit. We do not expect these to need to be different for low, medium and high-rise buildings, but this would need confirmation across a broad range of design alternatives.

If the reference building is chosen then % improvement seems appropriate.

- Is it appropriate to have separate credits for each of the environmental categories or should the total score be weighed together and assessed in one credit?

As above, we consider this a moot question – whether the credits are assigned against individual impact categories or rolled up into a final result, the numbers of credits assigned to each category amount to a weighting – in our view better to explicitly declare the weighting and roll up the scores into a single measure of credit in Ecopoints / (m<sup>2</sup> GFA).

- Should the Aus LCI Building Product inventory dataset be used in a LCA methodology within Green Star rating tools?

Currently, there is no building product data in the AusLCI database – the main source of data is the BP LCI which comprises 121 LCI datasets spanning all of the major



construction materials (estimated to span more than 99% of the mass of almost every building). The data does not comprehensively cover fit-out materials however but these can be obtained from other sources).

The BP LCI methodologies, protocol, impact assessment methods, weighting factors and replacement life data have been agreed by all major industry product sectors, they are publicly available, the data has been compiled to be consistent with the methodology and hence consistent and comparable for Australian industry. BPIC members have committed to keep the data updated. The BPIC LCA Protocol incorporates a hierarchy of datasources to be used as follows:

“In order to compile the inventory for an LCA, data will need to be compiled for all of the inputs and outputs from the system boundary defined in the goal and scope phases of the project. This data must be sourced in priority order as follows, starting from the top of the list:

1. From the BPIC/LCI database (this data will comply with the BPIC/LCI *Methodology Guidelines*).
2. From AusLCI (this data will comply with the AusLCI Data Guidelines and be highly compatible with BPIC/ICIP data).
3. From other acknowledged Australian data sources (documented for source, age, representativeness and data quality assessment).
4. From other authoritative sources (e.g. Ecoinvent, USNLCI) adapted for relevance to Australian conditions (energy sources, transport distances and modes and so on, and documented to show how the data is adapted for relevance in Australia).
5. From other sources with sensitivity analysis reported to show the significance of this data for the results and conclusions drawn.

In using data from other sources, the practitioner should make every practical effort to adapt and model the data to be compatible with the BPIC/LCI *Methodology Guidelines* and this Protocol. Any deviation from the BPIC rules must be documented with reasons for deviation and attempts made.”

We believe that this is a world leading achievement by BPIC and we would recommend GBCA to adopt both the underpinning methodology and the data hierarchy from the Protocol.

- Should a European LCI be used?

European data would not be correct for the large mass of low impact materials and should not be used. For high impact materials (where the transport component is a small proportion – e.g. for metals, plastics etc. it can be used appropriately). We would recommend the BPIC LCA Protocol hierarchy above for consistency.

- Are penalties needed?

Penalties are not needed, GBCA need only award credits to LCA's that use data compliant with the hierarchy – for limited scope assessments this will be very straightforward.

- What data sources would be acceptable for a credible LCA to be conducted.

Those described by the BPIC LCA Protocol hierarchy of data sources above.

- Is it appropriate to exclude fitouts based on the lack of an agreed functional unit for fitout items?

We believe that fit-out should be included as described above – in particular floor finishes, ceiling finishes and partitioning should be included. The functional unit is no

more contentious for fit-out than for whole building and can be the same – m2 GFA. For specific versions of Green Star targeted at tenancy then the analogous unit would be m2 NLA.

- Will the proposed LCA methodology accommodate existing LCA systems and tools?

Yes, the GBCA should also consider “Earthster” as a future source of open-source LCA data and tools.

- What constitutes an LCA practitioner, what qualifications should be required, and should the system ALCAS are developing be referenced?

The data available internationally lacks consistency in quality and reveals that many LCA practitioners do not have sufficient grounding in chemistry and thermodynamics. To-date we are aware of only one accreditation system for LCA practitioners internationally operated by the American Center for Life Cycle Assessment. There have been calls for such accreditation in Europe to improve the quality of data and ALCAS is developing an Accreditation programme and publishes a list of members and member companies. We would tentatively recommend the ALCAS system, but real experience and a portfolio of prior peer reviewed projects would currently be the best indicator of competence.

- How much would you estimate it would cost to complete the assessment outlined in this paper? And how does that cost compare to the cost of demonstrating compliance with the current Materials Category in Green Star?

The cost of an LCA for a whole building depends on the complexity of the building and the quality and relevance of the data provided by the design/development team or owner and would range \$30,000 to \$100,000, with the majority lying in the \$30,000-\$50,000 range for practitioners specialised in buildings’ LCA. With our ENVEST tool, Edge Environment can quickly complete assessments of complex mixed-use buildings for \$2,000-\$10,000.

- Is the requirement to adhere to international standards necessary?

ISO14040/4 is the main standard for LCA. We consider this a bare minimum standard for consistent LCA and hence the need to reinforce this with the BP LCI Guidelines for building products and buildings. We believe that only adherence to the BP LCI Guidelines can provide a credible basis for consistent LCA applied to buildings in Australia (and this guarantees compliance with ISO14040/4).

The purpose of International Standards is to enable international comparison and confer credibility internationally. In the case of buildings, the need for comparison is quite local and, as for the whole of Green Star, there is no need to comply with an international standard. GBCA and Green Star have the credibility and trust of the markets that they act within.

- Which are the relevant standards that Green Star related LCAs should adhere to?

We believe that the underlying LCA and specific product assessments (especially where the supplier exports) need to comply with BP LCI (and hence also comply with ISO14040/4) but GBCA need not adhere to ISO14024 (or ISO14025) for Australian buildings.

- Is the requirement to use recognised software necessary?

We believe that LCA is aided by purpose built software, but this is not essential and does not need to be a requirement. In our work we find that the recognised software is not very well suited to building assessments and we need to use a mix of software tools.

- Should the GBCA recognise particular softwares?

GBCA should not recognise any particular LCA software. However, if the GBCA requires compliance with either AusLCI or BPIC Guidelines the software used must permit practitioners and GBCA auditors to scrutinise the upstream unit processes to ensure that all data in the supply chain are consistent to the methodology. This is not currently possible with GABI for example.

- Which software should be recognised, and why?

None

- The requirements of the Energy category within Green Star rating tools, stipulate that any energy simulation software used are BESTEST compliant.

LCA software handles large quantities of data but the manipulations that the software does are not complex. Energy modelling by contrast is much more with different approaches and algorithms used to translate theory and empirical data into energy performance. BESTEST compliance is needed for Energy Modelling but the equivalent is not needed for LCA software.

Does equivalent software exist for LCA?

No

- Is the requirement for peer review necessary?

In LCA, it is the underlying methodology and data that needs to be verified rather than the software. The key issues are scope, boundaries, product and functional unit definition, co-product and recycled material impact allocation, upstream and downstream data modelling. Expert or panel peer review conventionally provides the mechanism for this data quality assurance and details of the peer review are provided with the data.

- What other requirements are necessary to ensure best practice LCA modelling?

Edge Environment believes that the BP LCI tool kit of LCA resources provide comprehensive requirements and guidelines for level-playingfield LCA for the Australian construction sector. The BP LCI toolkit is the key enabler for bringing LCA into practical tools such as ecolabels, EPDs, design guidelines, and rating and design tools. Many of these tools (AGIC IS, ENVEST, National Standard PCRs, the Greenhouse Gas Assessment Workbook for Road Projects) are already launched or close to launch for wide industry use and benefit. Edge Environment's ENVEST tool would provide considerable benefit in many aspects of a proposed credit system for Green Star and may also be of interest to the USGBC for future LEED credits. (Brendan Owens – LEED Development Director - USGBC January 2012)