A FRAMEWORK FOR UNDERSTANDING THE ENVIRONMENTAL IMPACT OF BUILDINGS IN AUSTRALIA

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Summary

A major barrier to realising dramatic improvements in the environmental performance of buildings' structures is the inability to accurately quantify the environmental impacts of design alternatives. This paper presents a framework for determining the environmental performance of building materials and assemblies in Australia.

Presently being developed under the working title of "Building Assemblies and Materials Scorecard (BAMS)", this project aims to establish a method and reporting format to assess the environmental performance of building materials and assemblies. Learning from international initiatives, BAMS uses life cycle assessment (LCA) to ensure consistent and science-based evaluation of construction options. The underlying LCA framework of BAMS is unique in that it combines a number of essential LCA ideas in one scheme. It is intended that in the short term BAMS will provide a common basis for materials assessment in a number of existing environmental building rating tools in Australia such as Green Star. The potential applications as a long term goal however, may be far more extensive.

1. Introduction

The relationship between global climate change and energy use is well documented (Garnaut 2008, IPCC 2007, OECD, 2002, 2003). Building construction, maintenance and operation is responsible for the bulk of energy consumption in the developed world, and increasingly so for the developing world (Bressand et al, 2007, Farrell et al 2008). In keeping with worldwide trends (World energy demand is expected to jump by 71% by 2030 (Huberman et al 2008), total energy consumed by Australian buildings is expected to grow, further contributing to greenhouse gas emissions and other environmental impacts (CSIRO 2008).

The environmental impacts of buildings can be divided into three life cycle stages: i) 'construction'; ii) 'operation'; and iii) 'deconstruction'. Construction being those impacts associated with producing the materials, transporting them to the site and the assembly of the building; operation being those impacts associated with energy use, water use and other activities such as maintenance over the building's life; and deconstruction being those impacts associated with disposal of the building at the end of its life, which may include some recycling. Traditionally, the operational impacts have tended to dominate the total environmental impact of a building over its life cycle.

This paper centres on the Building Assemblies and Materials Scorecard (BAMS) Project. Drawing from international experiences, this project aims to understand the environmental impacts of building assemblies and materials. The project received funding from the Victorian Sustainability Fund. The deliverable at the end of the first phase was to develop a proof of concept for the BAMS project. The founding partners included Victorian local and state government organisations and a national peak industry organisation. As the founding partners are many, the project brings together key tool-developing organisations and potential users to jointly develop and implement a common methodology.

This paper presents the development to date for the first stage of the BAMS project, addressing base building materials for residential and commercial applications. The focus is on the broader concept and the approach, rather than the technical detail in the development of the scorecards. The long term future includes setting up an operational BAMS governance and accreditation system, refinement of LCA data, increasing the number of assemblies, including branded products and integration with other developments as appropriate.

2. Aim of Building Assemblies and Materials Scorecard

The Building Assemblies and Materials Scorecard project was initiated and developed to:

- Provide a common basis for assessment and comparison of building materials environmental performance across a growing range of tools and approvals processes;
- Provide a basis for minimising the impacts and optimising the environmental performance of building products and materials over their life cycles through incorporation of an agreed method in a range of relevant tools and systems; and
- Generate increased awareness about the potential for the appropriate use of building materials to reduce the total environmental impact of the construction sector.

Specific deliverables were to:

- Prepare a State of Knowledge report outlining key issues and opportunities;
- Undertake stakeholder workshops as part of a needs analysis and stakeholder consultation process;
- Develop an LCA-based scoring methodology for a range of common building assemblies incorporating generic building products;
- Use the developed methodology to score a number of generic building assemblies; and
- Assist partners in implementing the scorecard in their respective contexts through training and workshops outlining the scorecard’s approach.

Strengths of the BAMS approach include:

- It is based on scientific life cycle data rather than qualitative estimates and is designed to support the National Life Cycle Inventory Initiative (auslci);
- It considers the whole of life performance, including construction, operation and deconstruction;
- It looks at environmental performance based on the application - where and how building products are used such as in a wall, or floor, or roof;
- It brings together key tool-developing organisations to jointly develop and implement a common methodology, offering for the first time a single reporting format for materials performance assessment;
- It helps manufacturers, suppliers and design teams respond proactively to growing interest in the environmental performance of building products and materials.

The stakeholders directly benefiting from BAMS include:

- Building rating tool users and industry professionals;
- Building rating tool owners and developers;
- Building materials and product manufacturers and representative organisations;
- LCA practitioners;
- Building and materials policy development professionals.

3. Research Design

A literature review provided an understanding of the state or play with regards to sustainable building material use in Australia and internationally. The literature review identified the following:

- Data on environmental impacts is currently generally insufficiently available or accessible.
- There is insufficient interoperability between existing tools and systems.

- Capabilities such as the Australian Life Cycle Inventory are still in development while others do not exist, such as an Australian damage indicator including effective biodiversity metrics.
- The high level of tool development (particularly at a local government level) has led to the multiplicity of overlapping approaches that are generating confusion and 'measurement fatigue'.
- International developments, in particular the development of ISO 21930 for Type III standards, have the potential to streamline the standardisation of environmental considerations into the Australian context and into Australian Standards.
- While Type III labelling provides a basis for reporting of environmental information, the standard was established on the basis that comparisons would not be made between products except on the basis of whole-of-life considerations. An additional step will be required to operationalise Type III results for decision-makers including specifiers, through an approach that takes an assemblage life cycle perspective.

To provide the capacity to address these issues, the BAMS project framework needed to enable a life cycle and assembly (rather than individual materials) approach to be taken, and create an effective platform for standardisation of approaches and growing interoperability in the Australian context. The framework also needed to allow for investigation of the possibilities and limitations of single-score weighting. Accordingly, Figure 1 illustrates the framework for activities and staging of the BAMS project.

The BAMS project considers the inputs into building construction, as well as operation and deconstruction scenarios. Building operational energy requirements (major drivers of operational environmental impacts) are addressed through a set of performance levels for energy efficiency as appropriate for the assemblage. For example, operational performance is critical for assessing the life cycle performance of cladding systems, however it is a less important consideration in cladding systems currently.

A range of environmental impact indicators were used, determined by the project partners. Generic building assemblies have been designed to be benchmarked on the basis of their life cycle performance, so that assessments can be made of relative performance against generic measures, such as standard performance and leading performance. Following the benchmarking exercise, a method of rating performance was devised, using a range of factors such as uptake, performance range and potential for future market transformation.

Consultation with stakeholders and the building industry as a whole indicated a strong preference for a single score output for BAMS. To achieve this single score, environmental impact indicators needed to be weighted. The project partners worked with the research team to build a shared understanding of opportunities and effective approach for weightings.

4. Development of the scorecards

The main phases that comprised the development of the scorecards were:

- data collection;
- method development;
- weighting process;
- life cycle impact assessment (LCIA);
- scoring process (develop scoring methodology, producing scorecards);
- peer review and stakeholder review.

The stipulations set out in ISO 14040:2006 were followed for data collection. The data categories used in the various life cycle stages included resource use, energy use, water use, land use, emissions to air, water and soil, and final waste. The quality of data complied with the data quality assessment method currently under development in the AusLCI project.

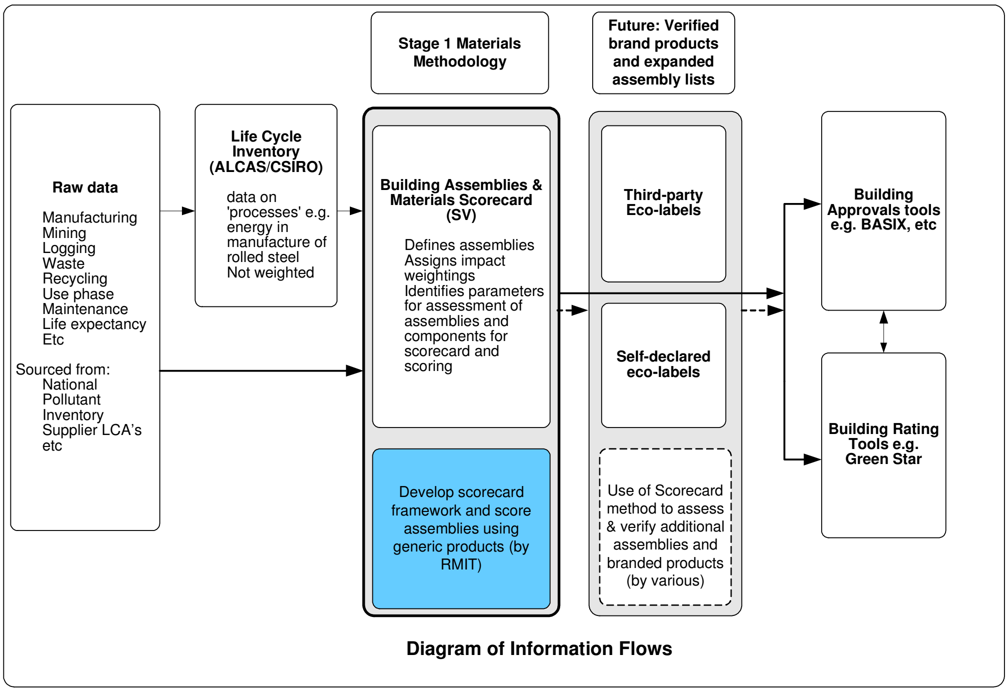

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Figure 1 BAMS Framework: Activities and information flows for the Building Assemblies and Materials Scorecard

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The methodology followed close parallels with the AusLCI project. However, since the method for BAMS was developed prior to the AusLCI project, it was agreed that the allocation rules follow the Dutch NEN 8006:2004 standards. Figure 2 shows the initial drafts of these scorecards.

The life cycle stages included in the BAMS project were:

1. Construction: extraction of raw materials; production of intermediate products; manufacture of assemblies; transport to the building site; building assembly on site .
2. Operation: energy consumption; maintenance and replacements.
3. Deconstruction: disassembly and waste treatment at the end of life cycle.

Transport between each of the stages is included in the LCA.

The five main indicators used for the BAMS project were:

- Resource use – measured as the additional energy required to extract future resources including fossil fuels and mineral resources.
- Water use – direct water extraction from the environment noting the water supply stresses in the location of the water extraction.
- Climate change – greenhouse effect based on fossil carbon dioxide equivalent emissions.
- Human health damage from pollution (excluding human health damage from climate change) – measure in WHO measure of death and morbidity (Disability Adjusted Life Years – DALYS).
- Land Use – measure of land occupation measured in area and time.

The environmental profile was calculated for each of the impact categories. Environmental impacts were checked to see if they were characterised. Normalisation and weighting followed next, leading to the scoring.

When the LCA of an assembly is completed, the result is expressed as a single indicator. It was anticipated that the user of the BAMS scorecard would like to make informed decisions regarding the sustainability of an assembly, when compared to its direct alternatives. The “BAMS score”, has been created to facilitate this decision by providing a relative environmental performance score of an assembly that is the result of directly comparing the performance of products providing similar functionality.

The scoring system was based on the BREEAM’s A-B-C system, where “A” represents best practice and “C” represents the worst. Therefore, “A” represents the most sustainable assemblies and “C” the least sustainable assemblies in their functional group. A separate set of BAMS-scores is determined for each group of assemblies. It is envisaged that for the Australian system, as “A” represents industry best practice, it may be incorporated into the leading best practice sustainability rating tool: the Green Star suite of tools, developed by the Green Building Council of Australia (GBCA). It is also envisaged that as “C” types of assemblies would represent minimum requirements, they would be equivalent to minimum standards set up by the Building Code of Australia (BCA).

It is important to note that the BAMS scores need to change over time. As new products are added to the group of assemblies and/or the environmental performance of existing products (assemblies) changes, the benchmark will change accordingly.

At every stage of the process, the project partners had opportunities to provide feedback. A peer review of the methodology was undertaken to ensure that the approach used for the BAMS project was robust and credible.

5. Conclusions

There is a rapidly expanding range of evidence demonstrating that environmental impacts are real and that significant steps are required to address them. The significant contribution of buildings to global environmental impacts, makes them an appropriate area for focus. Across the building life cycle, materials and assemblies can be significant contributors to total building performance, hence there is a need to optimise the selection of materials and assemblies in new designs to minimise environmental impact.

Furthermore, provided accurate and reliable information is available to decision makers regarding the environmental implications of different assemblages, and there is appropriate motivation to drive optimal environmental choices, significant reductions in the environmental impacts of buildings can be expected through the optimal use of materials and assemblies.

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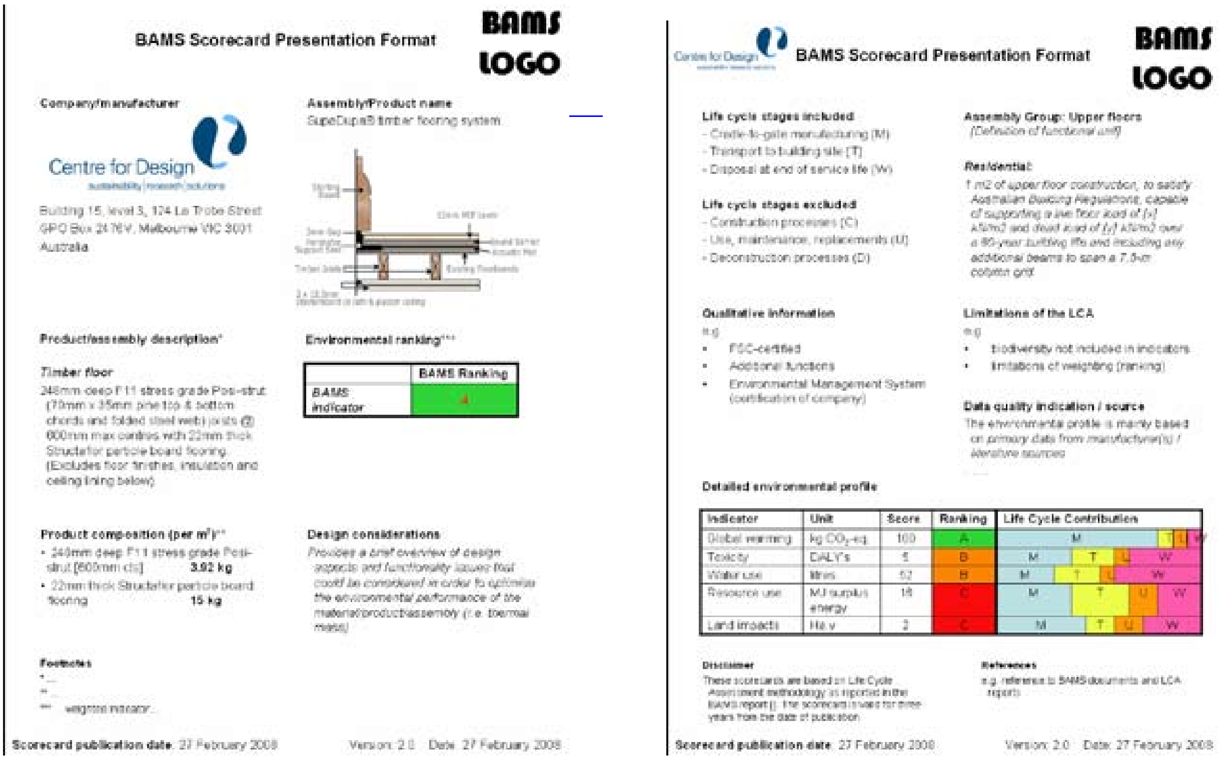

Figure 2 Draft concept of the presentation of the BAMS scorecards

Currently, the operational impacts of buildings are expected to dominate total environmental impacts over the building life cycle. However, as regulations dealing with energy efficiency, technical advancement in this area, rating tools and policies are developed to reduce energy consumption, the balance between operational and embodied (construction and deconstruction related) impacts is expected to shift. This shift in emphasis toward the embodied impacts of buildings will be expected to make projects like BAMS, which focus on materials and assemblies, even more important.

An initial analysis of barriers and opportunities showed that a broad range of stakeholders will benefit from the BAMS project, through provision of a valid, tested, publicly available method and protocol for building materials assessment. Stakeholder engagement is essential in ownership of the project and its process. Moreover, adoption and use, in concert with policy and market drivers, will lead to the significant environmental outcomes required as outlined above. The role of stakeholders in the project and in this endeavour is critical. It will ultimately assist in the uptake of BAMS and its sustainability outcomes.

6. Future Developments

The first phase of the BAMS project that has been described in this paper has concentrated on developing a proof of concept for Australia. Obviously, further work needs to be undertaken to move from the generic scorecards, to that of specific assemblies and materials from information provided by manufacturers.

Beyond this, however, there are a range of future developments that could flow from the development of the scorecard and methodology. These include:

- Development of a procedural manual for the method to allow certification of assessments to it by third parties (e.g. by Good Environmental Choice Australia (GECA) or others) or producing companies;
- Development of a procedural manual to allow peer-reviewing of scored assemblies and potentially products; and/or
- Lists of assemblages incorporating brand-specific products assessed either by third-party certifiers (e.g. GECA or other) or by supplying companies. Such lists could be used and facilitated by interested parties e.g. local governments and/or responsible authorities.

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