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Dear Committee Members

Thank you for the opportunity to comment on the matters relating to energy efficiency in Australia. Think Brick Australia has invested significantly in energy efficiency research over the past eight years through the University of Newcastle to understand how clay bricks – and thermal mass more generally – contributes to energy efficiency. The project was initiated in response to the inclusion of energy efficiency provisions with the Building Code of Australia (BCA) and has been used by the previous Australian Greenhouse Office to help calibrate early versions of the NatHERs software (ie AccuRate).

In addition to this, over the past two years Think Brick Australia has expanded its research program to include life cycle analysis and embodied energy. We have been involved in many different aspects of Life Cycle Analysis (LCA), including

- A total LCA of the Australian clay brick industry including 32 manufacturing plants and 39 clay pits representing 72% of the bricks produced in 2007/08
- The joint BPIC-ICIP project to develop the AusLCI (Australian Life Cycle Indicator) database of all Australian building materials 'metadata' for the completion of LCAs
- A total LCA on the 9 star demonstration house built by Right Homes and Designed by Jade Projects (in Perth)
- The peer-review of the Forest & Wood Products Australia full LCA on the impact of concrete slabs compared to suspended (timber) flooring systems
- A member of the National Standards Eco-labelling committee to develop a standard for the creation of product eco-labels (not just in the building products market)
- The joint development of an eco-labelling methodology specific to buildings with the Concrete Masonry Association of Australia (CMAA)
- The chair of the Australian Sustainable Built Environment Council's (ASBEC) Zero Emission Residential Task Group

The rationale for undertaking these projects and becoming involved in the various committees and groups undertaking LCA related projects was to

- ensure the fair, equitable and accurate treatment of clay brick
- better understand the topic, its urgency, the key stakeholders, and its relationship to future climate change, sustainability and energy efficiency policy
- take a leadership position in the building products market (beyond our BPIC involvement) on carbon related issues
- baseline the current industry position to demonstrate our improvements over the next 20 years, and to understand our position relative to competitors (where possible).

This work has provided Think Brick Australia with a very detailed knowledge of energy efficiency, life cycle assessment, thermal modelling and building sustainability rating issues. While the scope of the discussion paper is much broader than buildings and the built environment, this submission attempts to provide some insight into some of the issues that

need to be resolved before a more holistic sustainability framework (that incorporates energy efficiency) can be adopted in Australia to determine the performance of buildings.

Think Brick Australia believe significant work is required by Government in three areas:

- The use of thermal modelling to determine the energy efficiency and carbon liability of buildings
- The use of the life cycle methodology to underpin carbon and/or energy efficiency policy frameworks
- The difficulty in using 'eco-labels' to rate building materials.

Thermal modelling

Across the various projects undertaken multiple modelling tools were used, including AccuRate, BERS Pro, Design Builder, and an unreleased WA Department of Planning BASIX adaptation. In all cases, different results were noticed.

While Think Brick Australia has raised these issues before and ABSA (the group representing the Australian Building Sustainability Assessors) have undertaken work to demonstrate that the NatHERs software all perform within acceptable similar ranges, this work is not sufficient to help guide policy that attempts to significantly reduce the carbon associated with buildings.

While in most instances the trends observed by each tool when comparing alternatives were consistent across the set of tools, the magnitude of difference was enormous. Between Design Builder and AccuRate there was variation of ~ 390-470% (or 4 – 5 tonnes of C02-e per house). The comparison between Design Builder and the unreleased WA Department of Planning BASIX adaptation for a real house shows a variation of ~ 16-95% (or approximately 1 tonne of C02-e per house). On each occasion Design Builder had the higher numbers.

Design Builder is a United States Department of Energy tool that simulates the total energy loads required in a building. It was used by Energetics for the Think Brick Australia LCA because no equivalent, internationally accepted simulation tool exists to model all aspects of energy within a house. The Australian NatHERs software differs because it only determines heating and cooling requirements.

The WA Department of Planning BASIX tool models all energy requirements and is base-lined against actual WA consumption data for typical houses (the software was never released due to a change in direction from government). Based on data that could be determined as a proxy for actual energy consumption in real house, it appears that the results from the WA BASIX software is closest to actual energy consumption by a family of four people.

The concerns with the software is that there is substantial focus by various State and Federal departments on developing all sorts of software to quantify the energy and carbon 'liability' of buildings. This information will inform not only future changes to the BCA, but also future policy settings for carbon dioxide. These substantial differences could create the situation where carbon policies are initially set too low and major changes are needed within 10-15 years which will place un-due pressure on the industry, or conversely, that the policy settings are too hard and unnecessary pressure is applied now.

Unfortunately, from the work Think Brick Australia has done to date, it is almost impossible to determine which software is more accurate, however, part of the problem around determining software accuracy is the continued attempt to benchmark software against other software (Even the international standard to determine the efficacy of software, BEST TEST, uses Design Builder as its 'baseline' software). When the policy goal is only to determine if one building is better than the other a correlation between software under these conditions is sufficient, however, when major policy decisions will be made based on the outputs, the software needs to be calibrated against actual experimental data.

The work being undertaken by the University of Newcastle provides eight years of real experimental data for many different forms of typical Australian housing building construction. As part of the project the University has developed thermal modelling tools from first principles. The primary tool, NUMBERS, is a building modelling software capable of predicting the thermal

performance of a building envelop for a given set of climatic data, floor plan, walling construction and building orientation.

The software allows the user to construct a numerical representation of the actual building. This is achieved by putting together a number of walls to form one or more zones and then assembling the zone(s) to construct the building. NUMBERS can handle multi-zone and multi-story buildings by calculating the exchange of thermal energy between the zone(s) which is determined from the solution of conservation equation for mass and energy. The governing equations for each walling system and consequently zone can be obtained from the “Finite Volume method (FVM)”, “Conduction Transfer Function (CTF)”, or a hybrid approach (FVM+CTF) depending on the floor plan, building configuration, climatic data and boundary conditions.

NUMBERS can predict the energy consumption for air-conditioned buildings and the zone air temperature for free-floating buildings. For free-floating conditions the indoor air temperatures, time lags and decrement factors can be determined from NUMBERS while for air conditioned scenarios the energy consumption can be predicted. The window and door could be of any polygon shape and thermal radiation heat fluxes of the inner zone surfaces are determined by exchange areas with their view factors determined accurately by polygon-polygon view factor method. The open window/door between a zone and the outside air or between two zones can be modelled using NUMBERS. The main sub-models in NUMBERS include:

- The weather model which determines the heat flux of the exterior surfaces due to short/long wave length radiations.
- The wall model which presents a correlation of the heat fluxes and temperatures on both surfaces of the wall.
- The window model which predicts the sunshine area projected on the interior from windows.
- The ground model which characterises the thermal behaviour of the ground below the structure and determines the heat flux on the floor surface.
- The zone model which establishes the energy balance equation applied to the zone air.

In the weather model, the solar radiation heat fluxes upon the horizontal and vertical planes can be used to calculate the solar heat flux on walls at other orientation. The window sub-model also determines whether or not the wall is exposed to sunshine. If necessary, new functions could be added to the software depending on the building industry requirements.

By comparison, AccuRate predicts the energy consumption for air-conditioned buildings and the zone air temperatures for free-floating buildings. It allows for the comparison of the thermal performance of different styles and designs of buildings. It is an indicator of the energy needed to be added or removed to keep the conditioned floor area of the building comfortable. AccuRate assigns a star rating to a residential building based on its calculated annual heating and cooling energy requirements.

The software requires detailed information about the building such as orientation, construction type, insulation levels, window size and orientation, shading, overshadowing, ventilation, etc. The mathematical basis of the AccuRate software is the “Frequency Response” method in which the system (i.e. the building) inputs and outputs are viewed as being sinusoidal in time. The building is assumed to consist of a number of zones each comprised of elements, such as the floor, roof, ceiling, walls, windows, etc. Each building element is considered to be composed of a series of homogeneous (uniform in structure) layers, referred to as “slabs”. By combining the response of the individual slabs, the response of the building to a given input file can be determined. The input file is usually in the form of a weather data file, which is generally a year of data representing typical climatic conditions of a given geographical location. In the case of Newcastle for example, the year 1974 has been selected as a typical weather pattern for the Newcastle area. The input data for AccuRate cannot be changed by the user.

The model calculates heating and cooling energy data on an hourly basis over a period of one year. The output from the model is a simple report detailing the quantity of heating and cooling energy that would be required to maintain conditions within the building to the assigned comfort zone. A one-to-ten star rating is given to the building corresponding to the energy

performance with ten stars given to the most efficient building design. Star ratings correspond to different energy consumption rates depending upon the climate zone.

Think Brick Australia recommends a full review of thermal modelling software used in Australia be conducted in conjunction with the University of Newcastle. Think Brick Australia has discussed this with the research team at the University and they are willing and able to undertake such work in conjunction with CSIRO or other appropriate groups in conjunction with the relevant federal department.

Life Cycle Analysis and Embodied Energy

As stated in the issues paper:

> *"Energy use efficiency encompasses not only the energy used in operating a machine, or appliance or building; it also encompasses the 'embodied energy' consumed in making that product (from the mining and processing of natural resources to manufacturing, transport and product delivery).*
>
> *A life cycle approach to energy efficiency also incorporates the energy required to dispose of that product. Such an approach is critical to ensure that more energy is not used in producing a top-of-the-range 'energy efficient' product than can be saved over the effective lifetime of using that product."*

From Think Brick Australia's research, these statements are definitely true, however, caution should be exercised in how the life cycle analysis outcome is used.

Although there is an ISO standard governing LCAs, the standard does not provide the ability to compare different LCA results. Rather, the standard acts as a guideline for defining a tailored process based on specific outcomes sought. Historically LCA has been a decision support tool for individual organisations wanting to reduce the environmental impact of products. Prior to its use in policy frameworks a standardised methodology, set of assumptions, and data collection process is required. Think Brick Australia has developed a simple model (fig 1) to demonstrate how different 'ISO compliant' LCAs can produce different outcomes and ultimately not always provide meaningful information for the rating of buildings.

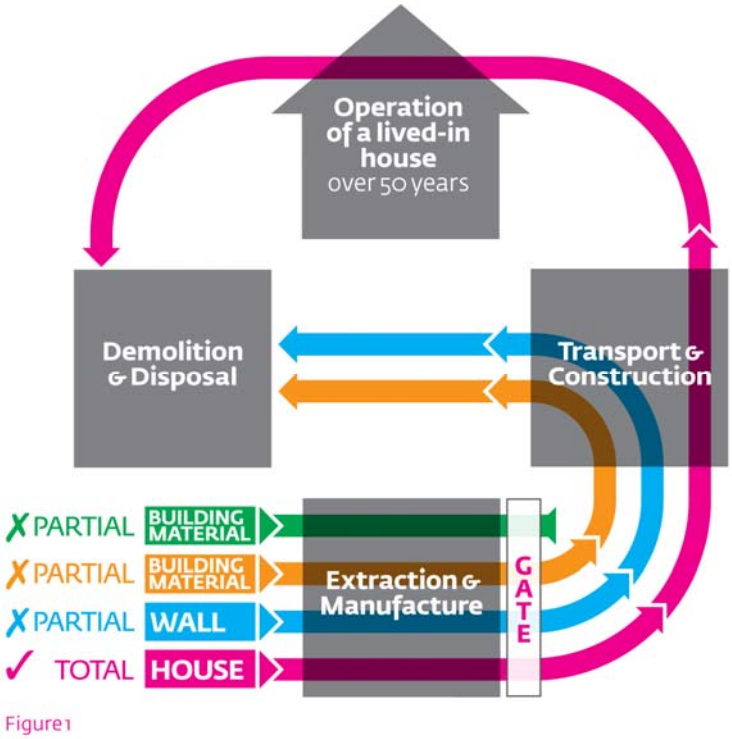

Figure 1

The benefit of developing a standardised methodology, set of assumptions, and data collection process is to manage the increasing number of sales and marketing claims supported by LCA-related research. Many companies are now undertaking LCAs in response to both consumer concerns and accusations of greenwashing, yet it has created a new challenge: ensuring customers, when comparing the LCA results from different products, are making like-with-like comparisons.

Similarly, in the education sector, students and academics alike are turning to LCA because of its 'objectiveness', without realising that the entire LCA methodology and governing standard is subjective.

Furthermore, LCA's don't only measure the carbon dioxide equivalents, they can include any

number of impact categories such as (but not limited to) Volatile Organic Compounds (VOCs), water consumption, land use or air pollutants. The significance and weighting of these other environmental impacts depends upon the intended use of LCA.

The BPIC-ICIP project included a specific sub-project to determine the relative importance of each of these other impact categories. This is an important component of LCA research, however, imposing a weighing upon the data may prove to be of little value if the intention is to provide a 'whole of building' rating for more than just carbon. Individual impacts such as VOCs or land use represent such a small component of the finished building, and even smaller when the building is considered over a life time of 50 years, that the outcome diluted.

For the purposes of Australian building ratings, the most value is likely to be achieved by selecting the big areas of concern (ie carbon dioxide, water, land use) and not weighting them, but rather displaying a score for each. The benefit of this is that one figure does not dilute another.

Further to this, many aspects of a detailed life cycle analysis are covered by other pieces of legislation (ie air & water pollutants), and care would be needed to ensure the use of LCA doesn't duplicate existing (and proposed) legislation. The most significant piece of proposed legislation – the Carbon Pollution Reduction Scheme – would unfortunately mean the use of LCA to improve the embodied energy (emissions) performance of buildings is duplication.

Given this, a clear distinction needs to be made between (a) reducing carbon pollution and improving energy consumption by manufacturers, and (b) providing market signals for consumers to assist their purchasing decisions.

Think Brick Australia recommends

- *reducing carbon pollution and improve energy consumption during the manufacturing process by using a broad-based emissions trading scheme with as few exemptions as possible*
- *providing market signals for consumers through an eco-labelling process that rates buildings against major areas of concern without weighting the results. At a minimum, buildings should use the figure 1 LCA methodology and have a single-figure carbon score.*

Eco-labelling

With the impending finalisation of the BPIC-ICIP AusLCI project, the past year has seen a renewed focus from green building professionals and standards organisations on eco-labeling of building products. One standards organisation – *National Standards* – has commenced significant work in the area, and *Good Environmental Choice Australia* (GECA) has made changes to its board, management team and has a new CEO in an attempt to expand its presence.

The increased activity of these and other eco-labelling groups has arguably been accelerated as a result of limited government leadership in this area. The vacuum caused by government has left the door open for these groups to create labels that are not necessarily accurate or helpful. Without an alternative, however, these eco-labels will continue to exist, and probably proliferate.

Almost all eco-label groups aspire to use "full Life Cycle Assessment" to underpin their declarations, however, in the best cases this only represents three of the four sections outlined in Figure 1. As no standard LCA methodology currently exists, eco-labels always exclude operational energy, and in many cases are limited to cradle-to-gate analysis (drawn in green in Figure 1) because of limited data for transport, construction, demolition and disposal.

While this type of eco-label is appropriate if consumers are only comparing equal and equivalent products (ie two different bricks), it is both unhelpful and misleading for consumers attempting to compare different products (ie bricks with timber). In the second instance, changing brick cladding for timber cladding has the potential to increase the total emissions from the house

because the timber-clad house is less energy efficient (see Think Brick Australia's LCA for more information, including the policy implications and a detailed description of the methodology used http://blog.thinkbrick.com.au/sustainability/lca/).

Furthermore, comparisons are not always helpful because the context is unknown. In our LCA we identified very similar embodied energy for timber weatherboard cladding and brick veneer cladding over the total house (approximately 5%), which was even less if operational emissions were included (<1%). Unfortunately, many of these issues are overlooked by the average consumer.

The types of eco-labels, combined with the number of organisations that produce them, are also confusing and at times misleading.

National Standards – often confused with *Standards Australia*, the official Australian standards body that develops and maintains Australian Standards – has applied to *Standards Australia* to be the sole developer of eco-labelling standards in Australia, yet even in the absence of the accreditation has commenced significant work on developing eco-labelling standards (Think Brick Australia is a member of the standards development committee). This work, although not technically wrong, will prove difficult to integrate with other similar organisations providing other eco-labelling products such as *Good Environmental Choice Australia* (GECA), *Ecospecifier* and even the *Green Building Council of Australia*.

GECA has provided eco-labels across a range of product categories since 2002. The label has been developed for "general compliance" to ISO 14 024 and is managed by a not-for-profit organisation utilising a national network of registered assessors. The program awards a mark of recognition for products and services that meet standards of environmental, quality and social performance within predefined product and service standards. The limitation of this eco-label is that if a product or service standard does not exist, then no GECA label can be awarded. This is currently the situation for clay bricks.

Even within standards there are often quite restrictive scopes which limit use by similar materials. For example, there is the 'Panel Boards' standard is limited to indoor use only, and similarly, the 'Building Insulation Materials' standard is only "applicable to bulk (resistive-type) thermal insulation materials for use in building applications. It does not include foils, lagging, sarking or specialty insulation materials."

GECA has created an 'Environmentally Innovative Products' standards in an attempt to capture areas not covered by other standards: "This Standard specifies environmental performance requirements for the award of the Australian ecolabel to products that may objectively be classified as environmentally innovative and are outside the scope of any other Good Environmental Choice Australia Standard."

Hebel panel systems and block have been awarded a GECA label under Environmentally Innovative Products standard and made their argument based on a comparison to concrete panels and clay bricks. This causes two problems for the clay brick industry: (1) clay bricks cannot fall under this standard because they are not new or innovative, and (2) future labels issued in this standard for cladding materials are likely to be compared to Hebel.

Ecospecifier aims to help building professionals and homeowners source environmentally friendly and healthy building materials. It provides "compelling and high-quality knowledge about innovative products that represent high value over their life - not only in the traditional sense, but also in the expanded sense of health, wellbeing and productivity of their total life, in the context of the people, buildings and systems they serve."

Ecospecifier is generally well regarded and does provide good, accurate (and generally fair!) commentary on clay bricks. *Ecospecifier* uses the work done by the University of Newcastle to support its judgement on the benefits of clay bricks, however, they do note that it is a poor insulator, the 4th largest source of embodied energy in domestic use and that high-strength Portland cement reduces the recyclability of the product.

Other groups to recently produce other types of eco-labelling or embodied energy calculators include the NSW Government land developer, Landcom, and Davis Langdon consultants. While all of this work by many different groups is useful to create interest and demand in more sustainable buildings, without the appropriate methodologies or rigour, much of this work will cause greater confusion and ultimately slow down greater take-up of energy efficiency and sustainable buildings.

Think Brick Australia recommends tighter controls on the use of eco-labels so as to not diminish or dilute their benefit.

Conclusion

Think Brick Australia is a wide contributor to the energy efficiency and sustainable buildings debate; our work is backed up by research and we provide practical tools and demonstration projects to support the industry (see www.designingforclimate.com.au or http://blog.thinkbrick.com.au for more information). This overview has been provided not so much to 'lobby' for any particular outcome, but rather to provide a 'lessons learned' perspective on some of the issues only briefly touched upon in the discussion paper.

Many of these issues are on the Government's agenda as part of the National Strategy for Energy Efficiency (NSEE), however, we believe the details and these 'lessons learned' are still to be seriously considered. We have raised them through this public consultation process to expand the number of people and committee's considering the issues.

If there are any further questions, or to discuss these matter further, please do not hesitate to contact me directly on the numbers provided below.

Yours faithfully,

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