ENERGY EFFICIENCY REGULATIONS AND RATING TOOLS FOR AUSTRALIAN BUILDINGS – AN OVERVIEW

CATHY INGLIS

Austral Bricks
Horsley Park, Australia
cathy.inglis@australbricks.com.au

SUMMARY

The Australian Government, in conjunction with the building sector, resolved to eliminate worst energy performance practices through a national standard approach to minimum performance requirements for buildings. Energy efficiency measures were introduced in January 2003, and the Building Code of Australia (BCA) has since been amended to include energy efficiency measures for all building classifications. The inclusion of energy efficiency measures in the BCA is part of a comprehensive strategy being undertaken by the Australian, State and Territory Governments to reduce greenhouse gas emissions.

In addition to the minimum performance requirements voluntary schemes encourage designers to achieve best practice. Rating tools such as NatHERS, AccuRate, Green Star and Energy Express have been introduced to promote the development of a sustainable property industry for Australia by encouraging the adoption of green building practices. This paper provides a background discussion on some of these rating tools. Finally, it looks at the impact of the energy efficiency regulations and rating tools on the brick industry.

INTRODUCTION

Global warming is a high profile public issue and there is no doubt that the Australian community expects and wants, effective action to combat the greenhouse effect. Each sector of the Australian economy can make an equitable contribution towards achieving the greenhouse gas emission reduction targets within the Kyoto Protocol. Although Australia did not sign the Kyoto Protocol, it agreed to limit the growth of its greenhouse gas emissions to 8 per cent above the 1990 level by the first commitment period, 2008-2012.

In March 1999 the Ministerial Council on Greenhouse and the building sector agreed upon a comprehensive strategy to make Australia's buildings more energy efficient. It was a dual approach, firstly, to eliminate worst practice through minimum performance in the Building Code of Australia, and secondly, to encourage best practice in building design, construction and operation. The introduction of energy provisions in the BCA is aimed at reducing greenhouse gas emissions from the building sector by defining an acceptable minimum level of energy

efficiency for new buildings throughout Australia. Such mandatory measures are intended to eliminate worst practice within the industry, rather than to drive best practice.

REGULATIONS

Baseline studies by the AGO projected levels of energy consumption and greenhouse gas emissions for the Australian residential and non-residential building sectors indicated the need for action to reduce emissions (see Table 1). Uniform energy efficiency regulations across Australia will deliver real benefits to owners of new homes and commercial buildings via reduced energy bills and real benefits to industry by avoiding multiple regulations that may vary between local government jurisdictions.

Table 1. Energy consumption and greenhouse gas emissions, 1990 and 2010 (AGO 1999)

	Energy Use (PJ/annum)			Greenhouse gas (CO_2-e)emissions (Mt/annum)		
	1990	2010	% Increase	1990	2010	% Increase
Residential	270	379	40	46.6	56.7	17
Non-residential	151	289	91	32.2	62.8	94

The introduction of energy efficiency provisions into the BCA will reduce energy consumption in buildings and building-related greenhouse gas emissions over the medium to long term. The proposed provisions will deliver substantial reductions in greenhouse gas emissions compared to forecast trends. These reductions will complement those being achieved through minimum energy performance standards for appliances and equipment and voluntary industry initiatives such as Window Energy Rating Scheme (WERS) and the Housing Industry Association Partnerships Advancing the Housing Environment (PATHE). As well as the direct impacts, the energy efficiency provisions will also change the perceptions of the general public over time. As developers see marketing advantages in promoting energy efficiency and low greenhouse gas emissions, the impacts will filter down into building work that would not normally require compliance with the BCA, such as minor refurbishments and upgrades.

In August 2004, the Ministerial Council on Energy announced a major advance nationally for energy efficiency, productivity and the environment, by agreeing on a comprehensive set of measures comprising the first stage of the National Framework for Energy Efficiency (NFEE). Implementation committees have been set up to deliver NFEE Stage One and cover energy efficiency measures relating to Buildings, Commercial and Industrial, Appliances and Equipment, Government, Trade and Professional Training and Accreditation, Consumer Information and Finance.

The energy efficiency policy packages included in NFEE Stage One cover:

- Residential buildings
- Commercial buildings

- Commercial/industrial energy efficiency
- Government energy efficiency
- Appliance & equipment energy efficiency
- Trade and professional training & accreditation
- Commercial/industrial sector capacity building
- General consumer awareness
- Finance sector awareness

THERMAL PERFORMANCE RATING TOOLS

Several rating tools and thermal performance software packages have been developed to facilitate the drive for best practice in energy efficient building design. Tools, such as Green Star, have been developed to drive the Australian property industry towards sustainability by promoting green building programs, technologies, design practices and operations as well as the integration of green building initiatives into mainstream design, construction and operation of buildings. Some of these rating tools are discussed in this paper.

NatHERS

The National House Energy Rating Scheme (NatHERS), www.nathers.gov.au, enables the design of a home to be assessed by skilled professionals using sophisticated computer modeling programmes to improve the quality of design and achieve building approvals. NatHERS provides a framework that allows various computer software tools to rate the potential energy efficiency of Australian homes. NatHERS defines the minimum set of information that must be used by all software tools.

NatHERS enables homes of good practice for each local climate to receive a similar rating, even though each building will be subject to widely different climatic conditions. NatHERS defines a fair and transparent process for competing software tools to be accredited.

If the level were set at NatHERS four stars, it is estimated that greenhouse gas emission savings related to heating and cooling in housing could be in the order of 690 kt of CO_2-e per year (8%) by 2010, growing to 1277 kt per year (13%) by 2020. The ongoing addition of more than 130,000 new houses annually means greenhouse gas emission savings associated with BCA changes will continue to grow compared with business as usual projections (AGO 1999).

AccuRate

AccuRate (www.hearne.com.au/products/accurate/) is the 2nd Generation of Residential Energy Rating Software for Australia developed by CSIRO for rating the energy efficiency of residential building designs. AccuRate will model far more complex buildings than was possible with the first generation rating software. Unlike older generation software, it is possible to have up to fifty thermal zones in a building, any number of which can be conditioned. AccuRate also

incorporates vastly improved natural ventilation and sky lighting models. AccuRate has gone through the rigorous verification of BESTest, the industry standard for building energy simulation.

Energy Express

Energy Express (www.hearne.com.au/products/energy_express/) is a package that estimates energy consumption and cost in commercial buildings which is used mainly by architects and engineers for cost-effective commercial building design. This tool quantifies the thermal performance of commercial buildings, and estimates energy consumption providing peak load estimation. Offering a choice between a comprehensive air-conditioning model, and a simple generic air-conditioning model, this allows evaluation of building facade options without having to specify details about the air-conditioning.

NABERS

The National Australian Built Environment Rating System (NABERS), www.nabers.com.au, is a performance-based rating system for existing buildings. NABERS rates a building on the basis of its measured operational impacts on the environment.

The system assesses the environmental impact of a working building which is a function of what it does in practice rather than the intentions in principle of its designers. NABERS focus's on the existing building stock rather than on buildings at the design stage.

NABERS will rate a building on the basis of its measured operational impacts including energy, refrigerants (greenhouse and ozone depletion potential), water, stormwater runoff and pollution, sewage, landscape diversity, transport, indoor air quality, occupant satisfaction, waste and toxic materials.

Green Star

The Green Star environmental rating system for buildings was developed by the Green Building Council of Australia (GBCA), www.gbcaus.org. It is a voluntary system that was created to establish a standard of measurement for green buildings, to promote integrated, whole-building design, to recognise environmental leadership, to identify building life-cycle impacts and to reduce the environmental impact of development. The Green Building Council was launched in 2002 and is a national, not-for-profit organisation that is supported by both industry and governments across the country and is committed to developing a sustainable property industry for Australia by encouraging the adoption of green building practices.

Green Star assesses the environmental impact that is a direct consequence of a projects site selection, design, construction and maintenance. The nine categories included within all Green Star rating tools are management, indoor environment quality, energy, transport, water,

materials, land use and ecology, emissions and innovation. These categories are divided into credits, each of which addresses an initiative that improves or has the potential to improve environmental performance. Points are awarded in each credit for actions that demonstrate that the project has met the overall objectives of Green Star. Once all claimed credits in each category are assessed, a percentage score is calculated and Green Star environmental weighting factors are then applied. Green Star environmental weighting factors vary across states and territories to reflect diverse environmental concerns across Australia.

The following Green Star certified ratings are available:

- 4 Star Green Star Certified Rating (score 45-59) signifies 'Best Practice'
- 5 Star Green Star Certified Rating (score 60-74) signifies 'Australian Excellence'
- 6 Star Green Star Certified Rating (score 75-100) signifies 'World Leadership'

Although Green Star certification requires a formal process, any project can freely download and use the Green Star tools as guides to track and improve their environmental performance.

Green Star has built on existing systems and tools in overseas markets including the British BREEAM (Building Research Establishment Environmental Assessment Method) system and the North American LEED (Leadership in Energy and Environmental Design) system. In addition, VicUrban, in its work with the Melbourne Docklands' ESD Guide, provided the intellectual property to assist in the development of a local system.

SUSTAINABLE BUILDINGS IN BRICK

To satisfy the energy efficiency measures in the Building Code of Australia and the many requirements of the voluntary systems to improve the sustainability of Australian buildings designers are met with enormous amounts of ‘green wash’ and conflicting information. Much of the misleading information promotes the benefits of lightweight buildings over those with mass with many of the rating tools that assess thermal performance being based on other models and not verifiable data.

To address these misconceptions and to produce hard data and verified simulation models , the brick industry through its over-arching body “Think Brick Australia”, is collaborating with the Masonry Research Group at the University of Newcastle in a major research program on the thermal performance of masonry housing. This comprehensive study is funded by the brick industry, the University of Newcastle and the Australian Research Council. The thermal performance of masonry housing is being investigated at both a fundamental and applied level using both experimental and first principles techniques. A key feature of the study is that the theoretical simulation models are being directly informed by the data collected from the experimental strand for the different walling systems. This therefore allows the analytical models to be verified and then used to predict the behaviour of more elaborate structures. The project is still in progress and is due for completion at the end of 2008.

The main strands of the study are as follows:

(1) The measurement of the thermal resistance of full scale wall assemblies using a guarded hot box apparatus conforming to ASTM C1363 (American Society for Testing Materials, 1997) (see Figure 1). This enables the determination of the thermal resistance (R value) of walling systems as well as the controlled study of other aspects of wall performance under varying temperature conditions.

(2) Detailed observation of the thermal performance of four, 6m x 6m housing test modules under actual weather conditions (see Figure 2). The construction systems for the modules cover the common forms of domestic construction in Australia – brick veneer, cavity brick and lightweight. The influence of windows, wall insulation and roof characteristics are also being studied as well as alternative systems such as reverse brick veneer.

(3) The development of analytical models to simulate the thermal performance of buildings with a view to producing realistic software models. Two approaches are being used: a hybrid model using computational fluid dynamics combined with zonal modelling; and a "fuzzy logic" neural network approach using the data from the test modules to "educate" a predictive model for thermal performance.

(4) A study on the "smart" use of thermal mass, taking into account the characteristics of heavy walling such as masonry which can be used to advantage in this context. Other strategies such as the optimisation of the unit geometry and cross-sectional characteristics as well as the possible use of suitable phase changing materials to store and release heat are also being considered.

Figure 1. The Guarded Hot Box Apparatus

Figure 2. Brick Veneer and Cavity Brick Masonry Building Modules (lightweight module is similar)

The research is still in progress but some results have already been published and presented (Sugo et al. 2004, 2005, 2007; Luo et al. 2006. 2007, 2008). The results have already verified the valuable inherent properties of bricks which contribute to the thermal comfort of buildings, particularly the influence of their thermal mass.

One important design fact that has already emerged is that the R value of a wall is not a direct measure of the potential thermal performance of a complete house, as it does not reflect the important influence on thermal comfort of the thermal lag inherent in high mass buildings. This was confirmed by comparing the performance of the lightweight housing module with that of a module constructed from insulated cavity brick. These two walling systems had comparable R values and yet in summer conditions the cavity brick module exhibited significantly lower internal temperatures as well as beneficial time lag effects.

These findings reinforce some of the other positive environmental performance characteristics of bricks with their low environmental impact, their longevity, low maintenance and non-toxicity, and their ability to be recycled. From a life cycle analysis perspective, bricks also perform strongly, as their energy of manufacture is more than offset by the efficient thermal performance of the final structure due to the ability of brick masonry to substantially reduce the operational energy of the building (which accounts for the bulk of total energy use).

CONCLUSION

As a result of the growing emphasis on energy efficiency and reduction of greenhouse gas emissions in the design of buildings, a range of both mandatory and voluntary energy efficiency measures have been introduced in Australia. Energy rating tools and design techniques for improving energy performance are thus becoming increasingly important.

For the brick industry to remain competitive, it is essential that the inherently desirable properties of heavy walling materials such as bricks be fully considered in any such design process. This is not currently the case as the main design emphasis is on the thermal resistance (R) value of the walling system which does not fully reflect the influence of thermal mass on the resulting thermal comfort of the building. Appropriate "user friendly" design aids also need to be readily available to assist this process. Current research at the University of Newcastle and elsewhere will hopefully rectify this situation in the near future.

REFERENCES

AGO 1999; "Scoping Study of Minimum Energy Performance Requirements for Incorporation into the Building Code of Australia", Australian Greenhouse Office, 1999.

Sugo, H.O., Page, A.W., Moghtaderi, B, (2004), "A Comparative Study of the Thermal Performance of Cavity and Brick Veneer Construction", Proc. 13th IBMAC, Amsterdam, July, pp 767-776

Sugo H.O., Moghtaderi B and Page A.W. (2005) "The Study of Heat Flows in Masonry Walls in a Thermal Test Building", Proc. 10th Canadian Masonry Symposium, Banff, June, pp 191 - 201

Luo, C., Moghtaderi B., Sugo H., Page A.W., (2006), "The Verification of Finite Volume Based Thermal Performance Software Using Analytical Solutions and Measurements", Proc. IBPSA Australasia 2006 Conference, Adelaide

Sugo H.O., Page A.W., Moghtaderi B., (2007), "The Thermal Performance of Cavity Brick and Brick Veneer Thermal Test Modules Containing a Window", Proc. 10th NAMC, St Louis, June.

Luo C, Moghtaderi B, Sugo S, Page A.W., (2007) 'Time Lags and Decrement Factors for Multi-layer Materials", Building Simulation 2007, Proc. 10th Int. Building Performance Simulation Association, Beijing, China, Sept, (pp. 95-100)

Sugo H., Page A.W., Inglis C., (2007), "Thermal Performance Studies at the University of Newcastle", Proc. ANZES Solar 07, Alice Springs, Oct 2007

Luo C., Moghtaderi B., Sugo H., and Page A.W., (2008), "A New Stable Finite Volume Method for Predicting Thermal Performance of a Whole Building", Building and Environment, 43 (2008) 37– 43.