Housing Sustainability in Australia

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SYNOPSIS

The housing sector is a major energy and resource user. Typically in developed nations 20-30% of energy is consumed in homes. With the growing concern over climate change and as the nations of the world are committed to the reduction of green house gas (GHG) emissions, major sectors such as housing need to deliver more sustainability in the future.

Housing sustainability includes a triple bottom line approach - economic, social and environmental sustainability. Environmental sustainability can only be achieved if the other two are also satisfied. The technology and know-how of environmental sustainability is available but the uptake of sustainable housing techniques has not been widespread. Hence to achieve sustainability, home construction and operation has to be economically affordable, traditional lifestyle should not be significantly changed yet environmental benefits have to be derived.

Australian housing industry builds about 140,000 new homes every year adding to its housing stock of 7.8 million dwellings. This represents a wealth of over 806 billion dollars. Investing on first home is usually the single most important investment decision to most Australians. The housing type in Australia is predominantly low density detached homes which requires increased amount of resource and energy use and thereby not sustainable. The Victorian state government has come up with a document entitled “Melbourne 2030: planning for sustainable growth” aimed at higher density housing as the future direction of housing policy.

Sustainable housing techniques in Australia and cold climates include highly insulated building envelope, orientation and solar access, use of thermal mass, double gazing of the windows, onsite use of solar energy (solar photovoltaic panels and solar hot water system), water efficient appliances, harvesting rainwater, grey water recycling, recycling of materials and reduction of waste using a compost bin etc.

In the State of Victoria, a mandatory 5 star home energy rating standard is being implemented from July 2005. This legislation means every new home constructed from 1st of July 2005 has to obtain an energy rating of 5 star for the building envelope plus a rain water tank or a hot water system must be installed. The standard is expected to be incorporated in the national building code soon. This is a significant step towards sustainability in the housing sector. Industry consultation, workshops and 12 months’ trial period was implemented before making it mandatory.

Housing research in Australia includes AHURI (Australian Housing and Urban Research Institute) research centres for social, economic and environmental research, the ‘Smart Housing’ project in Queensland, the ‘Ecohome’ project in Victoria etc. The authors are involved in the ‘Ecohome’ project which is strongly supported by industry. Ecohome features, monitoring system and thermal performance are briefly outlined in this paper.

INTRODUCTION

The energy and resource use in homes construction and operation is considerable- approximately 20-30% of all energy used in some developed nations is consumed in homes. In Australia, about 20% of green house gas (GHG) emissions are generated from residential homes (Commonwealth of Australia 1999). Therefore, the housing sector is a key area of intervention for achieving overall reduction in GHG emissions.

The limit to energy use and rise of passive solar design was triggered by the oil crises during the early 1970s (Hes 2005). Awareness of global warming and climate change during Rio Earth Summit in 1992 further reinforced the need to achieve energy efficiency. The world sought to limit its fossil fuel energy use at the Kyoto Protocol in 1997 which gave nations a framework to act. Since Paul Hawken introduced the idea of *Natural Capitalism* (Hawken et al. 1999) which regards maintaining the living system and achieving growth through innovation and sustainability, it has been growingly accepted by the people around the world. Another landmark publication "The natural advantage of nations" (Karlson et al. 2005) continued and elaborated the importance of sustainable approaches for businesses and nations towards achieving a natural 'edge' over competitors.

Housing sustainability includes a triple bottom line (TBL) approach – economic, social and environmental sustainability (Sibley et al. 2003). Recently a fourth dimension called 'governance' has been added and been renamed as TBL+1. Although in this paper the focus is on environmental sustainability, the three sustainability topics are interrelated and therefore cannot be ignored. Any environmentally sustainable home has to be economically viable and any design or behavioural changes have to be acceptable to the people living in the home (social sustainability). The elements of social sustainability are design for flexibility, comfort, safety and security. Environmental sustainability includes being energy, water and waste efficient. Economic sustainability means cost savings at construction, in running costs, in living costs, in long-term maintenance, in future modifications, good resale value and cost efficiency to the community.

The technologies of sustainable housing have been around for decades but the uptake of these technologies in the mainstream housing has been slow (Sibley et al. 2003) in the absence of legislative support. The State of Victoria recently implemented a mandatory 5 star standard (Building Commission 2005a) to overcome the slow uptake. This required consultation with industry, workshops and 12 month transition period before making the standard mandatory.

HOUSING SECTOR AND TYPE IN AUSTRALIA

Australia had 7.8 million dwellings in 2001 census, an increase of 615,000 dwellings since 1996 (ABS 2001). The current trend is that it requires approximately 140,000 new homes every year (HIA 2002) to accommodate the increasing population. For most Australians, investing on the first home is the single most important investment in their lifetime. Housing sector builds a wealth of over 806 billion dollars to the Australians (HIA 2002).

Australian housing style is predominantly low density detached homes. Low density housing requires large infrastructural investment such as road networks, water and wastewater networks, gas and electricity networks, telecommunication networks etc. There is also a general increase of travelling needs and the use of private cars. It becomes more imperative in low density housing to develop master planned communities and adopt sustainable approaches such as transit oriented development (TOD), water sensitive urban design (WSUD), building energy and resource efficient homes etc. The release of Melbourne 2030[1] by the state government of Victoria aimed at higher density housing as the future direction of housing policy.

HOUSING SUSTAINABILITY ISSUES

The housing sustainability components include energy efficient building envelope, passive solar design, onsite use of solar energy (solar hot water, photovoltaic panels), efficient water use, harvesting rainwater on site, grey water recycling, use of landscape and shading to minimize energy usage etc. On the materials and construction side, use of natural and recycled materials, low embodied energy materials and efficient construction techniques are important to adopt. The performance of a sustainable house is also somewhat related to occupants' understanding of sustainable living. A brief description of main issues is as follows:

Insulation

Insulation is the single most important aspect of good thermal design. The measure of insulation is 'R' value. It is the measure of the product's resistance to heat transfer and is a guide to its performance as a heat insulator. The higher the 'R' value, the more effective the insulation is in reducing heat flow. To achieve 5 star rating for houses in Melbourne, the minimum recommended 'R' value is R2.5 to R3.0 for ceilings and R1.5 for external walls.

Orientation and solar access

A north facing house can maximize the solar access. By keeping the living areas to the north, winter solar access can be maximized while summer sun can be easily obstructed by using eaves, verandahs or other shading devices.

Thermal mass

The purpose of thermal mass is to store heat energy when it is abundant (daytime) and release when it is scarce (at night) thereby reducing the temperature extremes. Concrete slab on ground or masonry walls can act as a thermal mass. Care must be taken so that thermal mass has sufficient solar access during winter otherwise it may actually increase the heating demand.

Double glazing of windows

A great portion of heat loss in a house can occur through the windows and it can be prevented by double glazing the windows. Double glazing comprises two panes of glass with a sealed space (about 12 mm of width) between. The space is filled with air or an inert gas with better insulating properties than glass.

Solar photovoltaic (PV) panels

Now it is possible to produce 100% of a home's electricity using PV panels. A major problem is that not necessarily the sun will shine everyday or when it is needed most. Hence a grid connected PV system with net metering is the ideal solution. It means that the household will supply the grid when electricity is produced in excess and take from the grid when it is needed and the household will be charged for the net amount of electricity used. The cost of PV systems is sometimes prohibiting although currently they usually pay off in 5-6 years.

Solar hot water system

Water heating accounts for about 30% of energy use in an average household. A solar hot water system can greatly reduce the energy use in a typical home in Australia and is highly cost-effective than the solar PV system. Most solar hot water systems use solar collectors or panels to absorb energy from the sun. Water is heated by the sun as it passes through the collectors. It then flows into an insulated storage tank for later use. A solar hot water system should be gas boosted in times of higher demand if reticulated gas is available.

Water conservation

Water conservation includes low flow fixtures, rainwater collection and grey water reuse. Water efficient plumbing fixtures and appliances include AAA rated shower heads, dual flush toilets, water efficient washing machines and dishwashing machines etc. A rainwater tank collects roof runoff and is easy to install and the water may be used for all purposes permitting local regulations. A grey water recycle system typically can supply water to subsurface irrigation of the garden.

Waste reduction and recycling

Waste minimisation can be achieved both at construction phase and at operation phase. At construction phase, use of recycled materials such as concrete with recycled aggregates from demolished buildings, reduction of onsite waste generation should be aimed for. In Australia, approximately, 40% of all waste going to the landfills are building waste. There are private companies who do the recycling of demolished building waste commercially. At operation stage, separation of recyclables at source (homes) from other waste to help the local councils in collecting and processing recyclables is important. Local councils generally provide two separate bins for households. In some council in Melbourne, even more bins are provided to facilitate separation of recyclables at source. Organic waste can be composted in a compost bin and used as manure in the garden.

5 STAR STANDARD IN VICTORIA

The 5 star standard for all new homes in Victoria came into full effect from 1st of July 2005, after a 12-month transition period. This means it is compulsory for new homes to have a 5 star energy rating for the building fabric plus a rainwater tank for toilet flushing or a solar hot water system. Without these required elements, a building permit for a new home will not be issued. The standard applies to all new houses and apartments. Apartment buildings need to achieve a 5 star average for the whole building, and no individual dwelling rating less than 3 stars.

The first 12-month transition period has shown, achieving 5 star is straightforward and, with good design, adds little to the cost of building while greatly benefiting the environment. The benefits of a 5 star house include comfort and energy and water savings.

Building cost for achieving 5 star is important for economic sustainability. Building Commission and Housing Industry Association research suggested that residential building cost will increase 3-5% in order to achieve 5 star rating (Building Commission 2005b). However, any increase in cost will be offset by ongoing savings on energy and water bills.

At this moment 5 star standard is only mandatory in Victoria. In May 2006, this standard is expected to be incorporated in the Building Code of Australia (BCA) and applicable to all over Australia.

HOUSING SUSTAINABILITY RESEARCH IN AUSTRALIA

Research on sustainable housing includes 'Smart Housing' in Queensland, the 'Ecohome' in Victoria, AHURI research centres throughout Australia etc. Australian Greenhouse Office, Sustainable Energy Authority Victoria, Building Commission are also involved. At individual level, Mobbs (1998) had shown how to build a sustainable house.

AHURI (Australian Housing and Urban Research Institute)

AHURI is a national research organisation, specialising in housing and urban research and policy. It conducts research on housing and related urban outcomes throughout Australia. It creates and disseminates knowledge in housing markets, housing policy and programs. It is organised as a network comprising a small management company (AHURI Ltd) in Melbourne and seven participating research centres throughout Australia. It receives funding as government grants from the commonwealth, state and territory.

Smart Housing in Queensland

Queensland's department of housing is running 'Smart Housing' campaign to achieve sustainability in the housing sector in that state. The 'research house' in Rockhampton is the focus of the Smart Housing initiative. A number of other demonstration projects in Queensland include the 'GreenSmart village' at Springfield Lakes, Smart Housing public housing developments of 20 units (by dept of housing) etc. The findings of sustainability outcomes of the 'research house' are available (Buyes et al. 2005; Queensland Government 2005).

Recently it has become a norm to show the members of the public sustainability aspects of housing through demonstration homes. These homes are a resource for the media, members of the construction and design industry and consumers to see housing sustainability in practice and learn how to apply more sustainable practices in residential building through common sense design and conscious product selection.

The Ecohome in Victoria

The Ecohome (figure 2) is located at the Cairnlea housing project, an housing estate development at western suburban area; about 19 kilometers from Melbourne city centre. The Cairnlea estate is 460 hectares and has 3000 housing units. A key feature of this estate is implementing water sensitive urban design principles. The Ecohome was constructed by Metricon homes in 2003, one of the progressive volume housing builders in Australia.

The goal of the Ecohome is to investigate ways in which we can minimize the impacts on the environment, while at the same time save energy and water bills for the dwellers. The knowledge gained through this pilot project will also be applied for sustainability outcomes of other development projects such as “Aurora”, which comprises 8500 plots for housing at Epping located at the northern fringe of Melbourne.

The Ecohome project is a major initiative which involves industry and research organizations in Australia. This is a collaborative research project of RMIT University and funded by the Australian Research Council linkage grant. A number of industry partners are involved including Building Commission, Metricon Homes, VicUrban, Sustainable Energy Authority Victoria (SEAV), City West Water, Melbourne Water, Hassell Architects and Origin Energy. Deakin University also is partly involved in the project.

Ecohome features

The Ecohome is a two-storied dwelling and has been added with sustainability features. Ecohome features include 450 Watt solar photovoltaic panels, gas boosted solar hot water system, a rainwater tank, grey water recycling, separate chutes in the kitchen to facilitate recycling, a compost bin etc. The Ecohome has been designed specifically to discover how affordable and realistic solutions can be utilized to make a home more environmentally friendly. In almost every aspect of its construction, consideration to conservation has been given. The result is that the home is accredited with a 5 star energy rating.

Monitoring system

Monitoring details of the Ecohome have been reported elsewhere (Rahman et al. 2005). The Ecohome has been instrumented with temperature, humidity and air quality (CO and CO_2 in ppm) sensors at strategic locations. A weather station has been placed at the rooftop of the Ecohome to record rainfall, wind speed, solar radiation etc. Temperature sensors are positioned both inside (7 sensors) and outside to assess the thermal performance and help in the thermal modeling. Humidity and air quality data will help in assessing the internal environment. All the sensors are connected to a data logging system and data are downloaded remotely through a computer located at RMIT University. Monitoring plan includes a twelve month baseline data collection when the house is empty and two years monitoring while residents live in it. At present 12 months baseline data are available and are being reported.

Thermal Performance

Figure 1 shows a sample thermal response curve of the Ecohome. The bottom most curve is the outside air temperature and the bold curve in the middle represents the average indoor temperature.

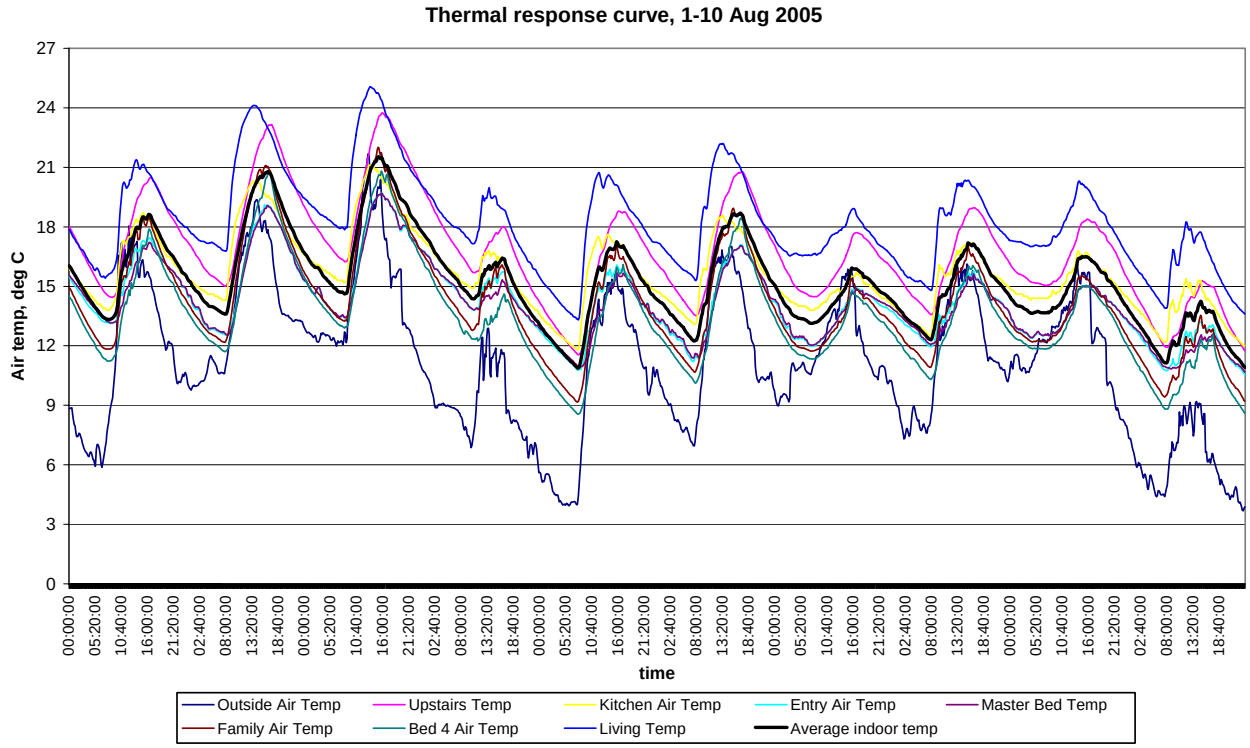

Figure 1: Thermal response curve of the Ecohome at Cairnlea in Melbourne

The data obtained so far indicate that the Ecohome generally performed very well during the winter (June-Aug), spring (Sept- Nov) and autumn (Mar-May) with occasional overheating occurring mostly during summer (Dec-Feb). This overheating is due to the fact that the house was empty and there was no natural ventilation occurring in the house. Natural ventilation by occupants will significantly improve performance during hot periods. The difference between the minimum temperatures inside and outside the Ecohome was 5-8 degrees Celsius which was a good performance. This will significantly reduce the space heating requirement. Space heating is more of a concern in Melbourne (and Victoria) than space cooling because its weather is characterized by mostly cold days with few hot days.

Figure 2: The Ecohome at Cairnlea estate, Melbourne

CONCLUSION

Housing sustainability in Australia can be achieved progressively. The 5 star standard introduced in Victoria was a major step in this direction. If this standard is successfully incorporated in the national Building Code of Australia (BCA), this will be a huge step towards housing sustainability in Australia.

The outcomes achieved from the Ecohome, a five star home, will be useful to the industry and policy makers and will help towards sustainability in the housing sector.

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ENDNOTES

1. http://www.dse.vic.gov.au/melbourne2030online/content/implementation_plans/00_summary.html

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