Green Buildings in Australia: Drivers and Barriers

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1. Introduction

The Kyoto Agreement signed in 1990 requires Australia to restrict greenhouse emissions to 108% of 1990 levels by 2012. Buildings consume some 30% of the world's resources, 10% of water and around 40% of the world's energy (OECD 2003). In Australia, around 10% of greenhouse emissions are attributed to commercial buildings, of which office buildings and hospitals contribute around 40%. There is a major initiative in Australia to promote the principles of sustainable building design which will reduce green house emissions through the reduction of energy consumption and resource conservation. The Green Building Council of Australia (GBCA) has developed a 'Green Star Rating Tool' to evaluate the environmental performance of Australian commercial buildings based on a wide range of criteria including;

- sustainable sites: encouraging the utilisation of brown field sites with existing transport links
- longevity: designing facilities for an extended life by ensuring the space is flexible to maximise options for future use
- energy efficiency: reducing energy consumption and encouraging the use of renewable energy
- water efficiency: reducing water consumption through better design, harvesting rain water, recycling grey water and treatment of black water
- material, resource and material conservation: reduction in embodied energy, design for recycling and reuse
- indoor environment quality, including air quality, lighting levels, thermal comfort and ventilation rates.

The 'Green Star Rating Tool' provides a green star rating of the building with 4 star recognising best practice, 5 star recognising Australian excellence and 6 star rewarding international leadership. New office buildings designed and constructed using standard and conventional methods would typically have a rating between 2-3 stars. In contrast, a new ‘state of the art’ green office building ‘Council House 2’ being built for the Melbourne City Council, has a provisional rating of 6 star.

The business drivers for ‘green’ buildings are all based on tenant demand and include:

- Reinforcing the ‘green’ brand of an organisation
- Satisfying Government ESD (ecological sustainable design) standards for the buildings leased and occupied by Government
- Improving staff health and staff satisfaction and productivity levels through superior indoor environment quality
- Avoiding building obsolescence by embodying ESD principles in the building design

The need to adopt principles of sustainability in building design is now more widely promoted, but many developers and owners are reluctant to invest in 'green' buildings for a number of reasons including:

- Perception of increased financial risk including: higher initial capital costs, financial modelling biased towards short term paybacks rather than life cycle costing, perceived lack of tenant demand
- Perception of risk associated with changing from traditional processes of design and construction including: different contact forms of project delivery, longer design time using integrated design teams, introduction of greener and recycled materials, changed site practices and behaviours.
- Regulatory and market environment: planning process can be protracted, approval process for new technologies and recycled materials can be lengthy.

This paper is based on a report compiled for the Victorian Building Commission reviewing the lessons learned from the construction of a number of contemporary green commercial buildings in Melbourne including: 60 Leicester Street (60L), Council House 2 (CH2), National @ Docklands, Queen Victoria Village (QV) and the Southern Cross development (Tagaza and Wilson 2004).

2. Perceived Financial Risk

Estimates of the increase in initial capital costs are generally in the range of 1-25%, which can often be offset by significant savings in the operational costs (Kats 2003). However, there are split incentives amongst the developers, owners and tenants with the developers reluctant to increase capital costs for a building that currently generates similar rental returns for the owners as a conventional office building whilst the long term operational savings are passed directly to the tenants. This simplistic but unfortunately real observation of current development practice should change once the tenant demand and associated rental returns for green buildings increases.

Recent initiatives in sustainability have questioned the validity of traditional accounting practices and contractual arrangements for commercial building developments. The most significant advance is that of viewing the cost of building sustainability in relation to payroll costs. A rule of thumb comparison suggests that the relative costs of personnel, building, and energy differ by an order of magnitude: that is, 100:10:1. Rather than simply being measured through energy cost savings, sustainability initiatives may be regarded as an investment in employee satisfaction, health, and productivity. Traditionally, financial models for commercial buildings have not included staff costs. The perceived barriers to the adoption of 'green' commercial buildings would be quickly overcome if it could be demonstrated that such buildings provided improvements to indoor air quality with associated health and productivity benefits to staff. People spend over 90% of their time indoors and the concentration of indoor pollutants is typically higher than outdoors, sometimes by as much as 10 or even 100 times. Poor indoor air quality can affect people in different ways:

- Short term: poor concentation
- Medium term: increased respiratory ailments, allergies and asthma due to mould, moisture and sick building syndrome

- Long term: terminal illnesses from prolonged exposure to volatile organic compounds (VOCs).

Poor indoor environmental quality can result in increased staff absenteeism, increased staff turnover and reduced staff productivity. The measurement of staff productivity in an office environment where the core activity is the development of ideas and transfer of knowledge is more difficult to assess than in a production environment where one can directly measure the number of widgets produced per day. In an office environment, staff health and productivity is affected by lighting levels, thermal comfort, air quality and ventilation rates (Harrison 2003, Nichol 1995, Clements-Croome 1997&2000).

A recent report commissioned in California (Kats 2003) provides a comprehensive overview of the costs and financial benefits of green buildings. The report analyses the costs associated with 33 green building projects in California (25 offices and 8 schools) and concludes that over a 20 year period the average cost premium associated with such building is between 1 and 6% depending on the level of green rating. This study assumed a discount rate of 5% and an inflation rate of 2% and considered energy, waste and water savings. The study also notes that the inclusion of a conservative 1% productivity gain to staff in the financial model would provide overall savings of 10 times the initial investment.

It is often difficult to compare directly the productivity benefits of ‘green’ building facilities based on surveys, simply due to too many variables involved. A study by Wargocki (Wargocki 2000) is one of the few studies completed based on controlled experiments. The study assessed the performance of 30 female office workers (3 groups of 10 each) exposed to 3 difference ventilation rates with outdoor air supply of 3, 10, and 30 L/s per person. Other environmental factors such as temperature and humidity remained unchanged. These workers performed identical tasks including text typing, addition, proofreading and creative thinking. The study concluded that overall productivity increased on average by 1.7% for every two-fold increase in the ventilation rate between 3 and 30 L/s per person. An earlier paper (Wargocki 1999) indicated that by reducing the pollution load on indoor air was an effective way of improving air quality, reducing intensity of SBS symptoms and increasing occupant productivity.

The City of Melbourne along with the Australian Greenhouse Office (AGO) have recently adopted a long term strategy to reduce greenhouse gases in the municipality to net zero by 2020. Energy consumption by commercial buildings is the major source of greenhouse emissions in the City of Melbourne. The City of Melbourne is providing leadership in this field by designing and constructing by GBCA rating standards a 'six star' world class building, known as Council House 2 or CH2, to accommodate their administrative staff. A future research project will evaluate the effectiveness of sustainable building practices in terms of their effect on workplace satisfaction, health, and productivity. Council House 2 provides an ideal subject for this study as extensive data relating to absenteeism, staff turnover and productivity are already available for the staff of City of Melbourne in relation to existing premises (‘Council House 1’) that will provide the basis for comparison of new data. It should be noted that productivity can easily be measured in manufacturing environments where the number of widgets produced per unit time is a definitive quantity. In comparison, productivity is difficult

to define and measure in a knowledge based workforce typical of an office environment where staff generate ideas and information. The study will also attempt to identify how physical aspects of environmental conditions, such as temperature, humidity, and air-change rates, are affected by occupant perceptions of the environmental systems of the building and to what extent do occupants benefit from involvement in a leading-edge sustainable building.

3. Perceived Construction Risk

3.1 Project Delivery Mechanisms

The type of contract selected for the delivery of the project will have a significant impact on the success of developing and implementing a green design. A longer time is needed at the design stage to fully integrate ESD design features which must be reflected in the form of project contract selected. A traditional construction tender based on detailed design documentation, or a 'novation' contract or an 'alliance' contract, all could be successfully used for the delivery of green commercial buildings, since sufficient time can be invested at the conceptual design stage. However, it is unlikely that a 'design and construct' contract, or a 'private public partnership' (PPP) arrangement would successfully deliver a green commercial building due to the design being locked in at an early stage before being fully developed and integrated. This could change as the green commercial building market becomes more mainstream and mature.

In true partnership and alliancing arrangements, all the parties involved have collective responsibility for delivering the project. Under the arrangement, non-owner participants are paid on an 'open-book compensation model', in which direct costs and project-specific overheads are reimbursed based on audited actual costs. The alliance partners also share in the 'pain' or 'gain' depending on how actual project outcomes compare with the pre-agreed targets (Ross 2003).

'Alliance' contracts in other sectors have been found to dramatically improve innovation, troubleshooting and dramatically reduce litigation. They have also been shown to reduce costs and timelines, as all parties have a responsibility and incentive to make the project succeed and, conversely, share the pain if things go wrong. A number of interviewees expressed the view that the long phase of integrated design, the steep learning curve, the importance of innovation and the new work practices needed for green buildings to succeed made them natural candidates for alliances. However, this will require significant cultural change across all levels of the building industry.

3.2 Integrated Design Teams

Successful green building projects require a considerable investment in an integrated design team at conceptual development stage with the following players represented: project owner, project manager, building contractor, architect, services engineer, structural engineer, civil engineer, environmental engineer, landscape consultant, heritage consultant, cost planner, building surveyor, and acoustic expert.

Integrated design teams allow interaction and cross fertilisation of ideas before the design is finalised leading to much improved holistic and optimised designs. Traditionally, conceptual designs are conceived by architects and developers and then passed onto the structural and services engineer and builders for design detailing and construction. Interestingly with green buildings where building orientation, energy consumption, ventilation and lighting considerations drive the design, the expertise of the services engineer is needed at the conceptual stage. This is in stark contrast to the traditional office building where the services engineer is given a final design and instructed to provide lighting, heating and cooling systems to the sealed building.

Inevitably, the integrated design process takes longer, but an understanding is required that the anticipated life-cycle savings can only be fully realised if the ESD features and practices are fully integrated at the conceptual design phase so that they function as one holistic system rather than as a collection of stand-alone independent systems.

3.3 Material selection

The choice of construction materials has a significant impact on the environmental performance of buildings in terms of the embodied energy, greenhouse gas emissions and toxicity. Desirable material features include:

- reused and recycled materials,
- materials with zero or low harmful emissions and toxicity,
- materials with high recycle potential, durability and longevity,
- materials that require less maintenance and have lower replacement costs over the life of the building, and
- materials that have greater flexibility under changing design requirements over the life of the building.

Life cycle analysis (LCA) of materials is required to provide a ‘cradle to grave’ inventory and impact assessment of the materials and systems. Embodied energy studies are needed to assess the energy used by a material in its production including; mining, manufacture, transport, installation, maintenance, and finally demolition and recycling. This is a developing field and new products on the market such as ‘Ecospecifier’ are providing guidance on the environmental impact of commonly available building products. EcoSpecifier is a commercial database of building products that have been independently vetted against sustainability criteria. There is also the US Greenbuild database in the USA which rates the environmental performance of building products in a similar manner.

A review of the material selection issues associated with the construction of the case study buildings indicated that some compromise had to be made on the materials specified during construction, either because of unacceptably high costs or availability and timely supply issues.

The most commonly cited example was in relation to the use of polyvinyl chloride (PVC). For example, the 60L building specification originally banned the use of PVC, but subsequent reviews and calculations revealed that a 100% substitution of PVC

would at least double the cost and have significant implications for some products which contained PVC components. As a compromise, PVC was eliminated from all water and wastewater pipes, electrical conduits and light fittings which resulted in a 50% reduction in the use of PVC in the 60L building compared with a typical commercial building of the same size and use.

Another major concern raised was the relatively immature market for recycled products which resulted in delays in the sourcing and supply of products and encouraged contractors to purchase new products where the price and availability were guaranteed. For example, in the construction of the CH2 building, recycled reinforcement was sourced and exported from Thailand to satisfy cost and timely availability issues. This barrier will be overcome as the recycled market supply chain develops, matures and becomes more dependable. A further issue related to the Building Standards which are focussed on new rather than recycled materials. The need to demonstrate the satisfactory performance of recycled products in some cases through testing slowed the approval process.

A balance must be met between the environmental credentials of the material with the physical performance. Some materials that have low environmental impact (such as low embodied energy or toxicity levels) do not necessarily have good strength, performance or durability characteristics, which could result in a shorter life and higher maintenance implications. For example, the use of 60% cement replacement, or the use of recycled aggregate in the production of concrete raises some long term strength and durability issues.

3.4 Site practices

The construction site provides great challenges to the successful implementation of sustainable building practices and the construction practices reviewed in this study demonstrated varying degrees of environmental performance. All construction firms commented that the Australian construction industry is still very much driven by financial performance with success measured by three criteria; cost, time and quality. Environmental performance tended to be a peripheral and secondary issue.

A significant challenge for the building contractors in this study was the continued management of large numbers of suppliers, subcontractors and tradespeople whom changed regularly during the construction phase. On-site induction that involved staff and subcontractors went some way in communicating the green intent of projects and the expected sustainable practices, but as some said: ‘It’s like telling a group of children about caring for the environment; most will learn but a few just won’t listen.’

A key sustainability issue in the construction phase is waste recycling, or the management of residual material. Some of the project contracts specified that demolition and construction waste were to be separated into waste streams such as timber, concrete, steel, plaster and PVC. It was observed that in many cases the initial enthusiasm for separating the waste materials amongst sub-contractors dissipated as the projects progressed and the recycling skips were found to contain a mix of materials. Such behaviour may reflect ignorance, laziness or time pressures to complete a project and clean-up expediently. To ensure that sustainable practices were implemented on-site, the developers and building contractors employed different

strategies, including what one called ‘environmental policing’. This involved either the appointment of an officer dedicated to check practices, or random on-site visits by project managers. ‘Soft’ strategies were also applied such as involving union representatives in site meetings to reinforce the benefits to workers of sustainable practices.

4. Regulatory Environment

Two distinctly different approaches can be adopted to embody ESD principles in the design of commercial buildings. The approach in Europe is to regulate to minimum standards of Environmental performance, whilst in the USA the free market economy is used to stimulate demand for green building practices. Australia is tending towards the free market approach although the Federal and State building regulatory authorities are investigating means of introducing some minimum standards of environmental performance. For example, the Australian Building Control Board is currently investigating how the guiding principles of sustainability can be incorporated into the Building Code of Australia to complement the existing focus of presenting minimum performance standards for structural efficiency, safety, health and amenity. In addition, the Building Commission (Victoria) is investigating the introduction of an environmental rating system for commercial buildings, similar to the star rating system used in the residential housing market. The Green Building Council of Australia ‘Green Star’ rating could provide an ideal framework for such regulation.

The pay back period for operational savings resulting from the introduction of ESD principles in Australia is currently longer than in Europe and the USA, partially due to the substantially lower costs associated with the supply of energy and water. Many building professionals share the view that until prices reflect the true cost of resources, there’s no economic incentive for people to incorporate energy and water conservation measures into their projects.

5. Agenda for the Future and Conclusions

There is strong interest in the development of green commercial buildings in Australia, reflecting the growing trend in Europe and the USA. Interviews with industry leaders involved in five recent projects suggests that green building techniques could lead to a fundamental transformation of the commercial building industry. This will significantly improve the quality of the built environment and position the industry to benefit from the sale of expertise, services and products to the Asia Pacific region.

Interest in green buildings has been generated by a number of innovative companies followed by early stage tenant demand. Generally, the companies have borne higher initial costs, although the adoption of life cycle costing can demonstrate some financial advantage.

‘Fast following’ companies are now entering the market, keen to exploit the learning of the early innovators. This provides an opportunity for Government to support these companies to encourage the development and refinement of the systems and skills that are needed for green commercial building construction to spread to the majority of the industry.

The key potential driver for the ‘fast followers’ is tenant demand for green buildings. Companies will demand green buildings if it can be demonstrated that the superior indoor environment quality results in improvements to staff health, staff satisfaction and staff productivity. Evidence and quantification of such gains will result in tenants and corporations demanding 'green' buildings and result in a paradigm shift in the way offices are designed and constructed in this country The Government could provide significant leadership by developing and demanding ‘green leases’ for all of its tenancies thereby stimulating initial tenant demand for green commercial buildings.

There needs to be acceptance and consensus in industry and government around the use of Green Star as the accepted industry rating tool. Recognition of different ratings tools leads to confusion in the market place. Green Star tools are already available for the design and construction phases, and the Green Building Council of Australia (GBCA) is moving quickly to introduce a rating tool for the operational environmental performance of buildings.

Significantly increasing the number of green buildings in Australia will require a cultural change in the building industry. A first step could be to use green commercial building projects to demonstrate an effective alternative to the highly adversarial approach between owners, managers, contractors and workers that currently dominates the industry. The alliance contract approach to construction offers significant benefits to all parties, and drives the innovation and uptake of new practices that green building requires. An alliance contract brings all interested parties into the project from the start, encourages the concept of ‘Integrated Design Teams’ and aligns the performance incentives of all parties.

Currently, most green building developments have had to conduct their own research and testing on the environmental performance of materials, thus adding to the time and cost incurred by the projects. Some commercial tools have proved useful, including EcoSpecifier, which is a database of building products that have been independently assessed for their environmental performance.

The union movement is a key player in the building industry and needs to be engaged as a supporter of green buildings. Employers and unions need to work towards inclusion of a short program on sustainability principles and practices in their training packages.

Finally, a green star rating of a building only considers the base capability of the building in relation to ESD principles. The successful environmental performance of the building in operation is dependent on the building owners and tenants. General disclosure of building performance in terms of the green star criteria would be a powerful means of alerting consumers to the ESD benefits and would further stimulate tenant demand.

6. Acknowledgements

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8. Recommended Further Reading

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