Sustainable Building and Construction

Implementing Green Building in Western Australia

David Beyer

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Website: **http://www.sustainability.dpc.wa.gov.au/docs/sustainabilityinformation.htm**

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Murdoch University.

DECLARATION

I declare that this dissertation is my own account of my research and contains as its main component work, which has not previously been submitted for a degree at any tertiary education institution.

David Beyer
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ABSTRACT

Buildings and their construction are the main structural elements of human settlements and are therefore are intrinsically linked to all our lives. Creating sustainable human settlements is essential for human and ecological well-being.

This thesis examines the building and construction sector through its components parts and key elements, both at an organisational and a structural level to determine the requirements and the pathways for creating sustainable building and construction, specifically in Western Australia. This includes an analysis of the sector from a global perspective, the benefits of sustainable building to the occupants and users and also the environment, and an assessment of two buildings to determine their sustainability characteristics.

It is written in advocacy of sustainability which is seen as a fundamental requirement of human existence, and it concludes with a suggested framework whereby the local West Australian sector can create an ‘all of sector’ sustainable building programme.

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Chapter 1 Introduction

I recognize the right and duty of this generation
to develop and use the natural resources of our land;
but I do not recognize the right to waste them,
or to rob, by wasteful use,
the generations that come after us
Theodore Roosevelt, 1910
(GSA, 2000).

1.0 Overview

Building and construction is the avenue by which much of human settlements are developed and as such it is a sector that can have profound effects on sustainability (CIB, 1999; CRISP, 1999; CSIRO, 2000b; Newton, 2001a; OECD, 2002a).

Since the 1992 Rio Earth Summit and the advent of Agenda 21 much of the building and construction sector has taken up the challenge of sustainability to provide a more efficient, lasting and healthy product (CIB, 1999). Through its many and varied organisations and associations it has systematically identified its negative impacts on environmental, social and human health and then developed sustainability strategies throughout all stages of the building and construction life-cycle.

There are the obvious component stages of building and construction such as building materials, design, the actual construction process, the fit out or furnishing of the building, the operation or occupancy of the building and finally the decommissioning or deconstruction stage (CIB, 1999; Lead Liew, Vale et al., 2001). These components are directly influenced by the management and operation of the sector and can all be influenced by sustainability measures, both as individual components and holistically, where all components are necessarily treated as interwoven links of the process. The individual component parts can be assessed to determine the most detrimental impacts and hence what improvements are required to give a better product. Importantly though, the real gains can be made when all the component parts are considered as links in a product chain. By considering all components in their natural sequential order, each facilitates and supports the successful implementation of the other (HIA, 2001; DHW, 2002c). For example, planning policy and guidelines define and support land development and sub-divisions which define the individual blocks for building design, which in turn defines the construction itself. The result of all these stages is the built environment in which we live and work. All of these aspects are key components in considering, formulating, and implementing a more sustainable building and construction sector.

There are also the less obvious elements of human settlements and therefore building and construction that also need to be considered and factored in to ensure a fully sustainable product. These are the issues of community and neighbourhoods, sense of place, heritage and intrinsic worth of the natural environment (Barron and Gauntlett, 2001; Armstrong, 2002). These elements have traditionally had a more diffuse or abstract connection to the sector, but their importance becomes more relevant and necessary when viewed from a sustainability perspective. Although they are influenced more by urban planning and development, nonetheless they are important issues that need to be considered by the building and construction sector, especially at the design stage, but also during construction where impacts on the biota can be strongly felt.

How our built environment is developed, planned, designed, constructed and used will largely determine our quality of life. A well planned and designed built environment will consider the natural environment and validate it as intrinsically important and also necessary to our own well-being (Macy, 1993). It can and must be one that supports ongoing wellness and integrity of the natural environment as well as the individual and society, whilst maintaining social and economic prosperity. The sustainability of our built environment, and our physical health and emotional well-being is intrinsically linked to the quality of the natural environment.

1.1 What is Sustainable Building?-Definitions and Principles

Definitions of sustainability are varied and possibly need to be framed within a specific context to hold specific meaning, although there is broad agreement that it is about balancing and integrating environmental, social and economic elements.

There is no unified consensus on what it means to be sustainable in terms of building and construction and human settlements. Kilbert's definition is 'the creation and responsible management of a healthy built environment based on resource efficiency and ecological principles' (Kilbert 1994). In a similar manner, Vieria calls it 'those strategies that look at a site's natural land, water, air and energy resources as integral aspects of the design' (Vieria, 1993). Early, however, sees settlements from a more passive emphasis, which also brings in a sense of spirit: the human settlement 'integrates natural systems with human patterns and celebrates continuity, uniqueness and place-making' (Early, 1993). From this author's perspective they are 'our constructed human places that can ***adequately*** satisfy our needs (security, health, comfort and spiritual well-being) *by maximising* the natural resources of the local area (materials, climate) whilst not affecting or adversely impacting on the natural environment (resource depletion, pollution, waste)'.

Many definitions have been suggested (CIB, 2000; BEER, 2002) but it may require an understanding of all the elements of a comprehensive sustainable building design guide or assessment system to fully appreciate all the aspects of sustainable building and construction (PTI, 1996; UMN, 2000; CIWMB, 2001; Reardon, 2001; USGBC, 2001; Cole and Larsson, 2002).

See Appendix 1. 'The Hannover Principles'
and 'Five Principles of Ecological Design'

Using principles as guidance and to also lay an appropriate ethical foundation for what is sustainability, the Western Australian State Sustainability Strategy (SSS) framework has been defined and written around eleven principles (seven foundation principles and the four process principles), which 'go beyond the well established notions of inter-generational equity' (SPU, 2002) (see Figure 1.1). These principles are important guideposts for achieving sustainability and can be applied to specific requirements, such as building and construction. (Also refer Figure 7.1)

Figure 1.1. **Sustainability Principles of the WA State Sustainability Strategy**

Foundation Principles

Long Term Economic Health

Sustainability recognises the needs of current and future generations for long-term economic health, diversity and productivity of the earth

Equity and Human Rights

Sustainability recognises that an environment needs to be created where all people can express their full potential and lead productive lives and that dangerous gaps in sufficiency and opportunity endanger the earth.

Biodiversity and Ecological Integrity

Sustainability recognises that all life has intrinsic value, is interconnected and that biodiversity and ecological integrity are part of the irreplaceable life support systems upon which the earth depends.

Settlement Efficiency and Quality Of Life

Sustainability recognises that the earth can only adjust to a more balanced state if the ecological footprint is of settlements is reduced (through less material and energy demands and reductions in waste etc), and quality of life is simultaneously improved (through health, housing, employment, community etc).

Community, Regions, 'Sense Of Place' and Heritage

Sustainability recognises the significance and diversity of community and regions for the management of the earth, and the critical importance of 'sense of place' and heritage (buildings, townscapes, landscapes and culture) in any plans for the future.

Net Benefit from Development

Sustainability means that all development, and particularly development involving extraction of non-renewable resources, should strive to provide net environmental or conservation benefit and net social and economic benefit for future generations.

Common Good from Planning

Sustainability recognises that planning for the common good requires equitable distribution of public resources (like air, water and open space) so that natural carrying capacities are not exceeded and so that a shared resource is available to all.

Process Principles

Integration of the Triple Bottom Line

Sustainability requires that economic, social and environmental factors be integrated by simultaneous application of all the principles of sustainability, and seeking mutually supportive benefits with minimal trade offs.

Accountability, Transparency and Engagement

Sustainability recognises that people should have access to information on sustainability issues, that institutions should have triple bottom line accountability on an annual basis, that regular sustainability audits of programs and policies should be conducted, and that public engagement lies at the heart of all sustainability principles.

Precaution

Sustainability requires caution in applying these principles, avoiding poorly understood risks of serious or irreversible damage, designing for surprise and managing for adaptation.

Hope, Vision, Symbolic and Iterative Change

Sustainability recognises that applying these sustainability principles as part of a broad strategic vision for the earth can generate hope in the future, and thus it will involve symbolic change that is part of many successive steps over generations. (SPU, 2002)

Highlighting the views of what sustainable building and construction means can give insight into how different elements of the sector might respond to reform initiatives. There is the 'realist's' view, those that are only responsive to market drivers and will not progress beyond the minimum best practice as defined by regulatory requirements and planning and building codes (Figure 1.2), and there is the more imaginative and envisioned approach (Figure 1.3) that envisages a more comprehensive reform to the whole sector, so that it would include both environment and social components in its thinking and would be firmly embedded into the principles and practices of sustainable building and construction.

Figure 1.2 **Industry Perceptions and Views of Issues in the Built Environment.**

1. A general consensus on the industry's main environmental impacts and agreement that these extended beyond the construction phase to include supply chain issues and the effects of post construction activities such as operation, maintenance and re-use of buildings

2. Less emphasis on the social component of sustainable development and the industry's influence on it, but some agreement among those that did consider that the industry had an important role to play in shaping viable communities

3. Differing views on the scope of the industry's influence on sustainable development; some considered only the direct impacts of construction activities while others included the industry's wider role in shaping patterns of development

(CRISP, 1999).

Figure 1.3. **Envisioned Sustainability in the Built Environment**

Imagine buildings producing more energy than they use, water cleaner when it leaves the building than when it arrived, better indoor light and air quality, and healthier and more productive work environments. Imagine projects where physical, biological, socioeconomic, cultural and environmental needs are so complete, that the Environmental Assessment concludes: no mitigation required.

Ideas developed by William McDonough, Dean Emeritus of the School of Architecture at the University of Virginia, and Amory Lovins, President and Executive Director of the Rocky Mountain Institute, (GSA, 2000).

These two different views exemplify the fundamental debate of sustainability and ecological ethics. Depending on which view is held will ultimately govern the response and type of initiative. Two key levels to the sustainability debate are the visionary, based on ethics and values, and the responsive that is based on empirical evidence for the need to change.

An individual or a society that holds the ideological belief that sustainability provides the framework that can define and guide human endeavour will need no argument for change; all that is required is deciding on the most appropriate and viable course of action.

The evidential aspect is more complex because the starting point is about need, importance, and degree of change required. For some there is a denial of any need for action, whilst others differ on the importance of change. On the critical issue about the degree of change, there is awareness of ecological issues and general agreement that sustainability is required, but disagreement on the level and depth of change and how quickly it should happen (Beyer, 2002).

The challenge is to translate the general awareness of ecological issues to commitment to change both at an organisational and individual level. The responsive actions, based purely on evidence of global warming, resource depletion, environmental pollution and human health will bring many beneficial changes, but they may lack the fundamental and holistic advances that the more visionary and pro-active sustainable actions, based on full life-cycle thinking, would bring.

1.2 Thesis Structure and Scope of Chapters

This thesis is intended to give the reader a thorough understanding of the building and construction sector. It investigates all key elements of building and construction with the aim of determining the key strategies that, if implemented, would lead to the sector being more sustainable in Western Australia. Note that the terms 'sustainable building' and 'green building' are used interchangeably throughout this thesis, as they are throughout the sector: both have equivalent meaning.

Chapter 2 gives an outline of building and construction within the global context. This is to give the reader an appreciation of the importance of this sector to current and future human development and therefore, by extension, its importance to global ecological health. Many of the main sustainability issues that concern this sector have little difference throughout the world. Whether it be land development, building design, materials selection, operation or occupancy, there are definite requirements that need to be fulfilled before buildings can be designated sustainable. By giving a global picture of the sector it is intended to show that many issues and initiatives throughout the world are to a large extent readily transferable, an issue which is particularly relevant in terms of equity and quality of life throughout the world. There are a number of representative organisations that have a truly global focus whose data and analysis has been invaluable in being able to present a global picture of the sector. Many of these are working in collaboration with the United Nation Environment Programmes' (UNEP) 'Cities as Sustainable Eco-systems' initiative (UNEP-IETC, 2002a).

Chapter 3 will build the case for further, deeper and stronger implementation of sustainable building and construction. It will focus on two aspects; the eco-centric and the anthropocentric, both of which fall within requirements for sustainability. Firstly there is the case for greater environmental sustainability that can result from a better built environment. This is where many 'green building' programmes are situated; to provide a product that is environmentally sound in terms of resource and operational efficiency (UMN, 2000; Reardon, 2001; NAHB, 2002c).

Secondly is the anthropocentric case. This aspect results mainly from the provision of an environmentally sustainable product; which is to say that in some ways it is a by-product of the other (DPWS, 2001; Anonymous, 2002a). The anthropocentric case will focus on three key issues:

- Employee productivity increases
- Improved occupant health
- Financial gain for the occupant

Chapter 4 takes a more specific look at the sector's organisational and management structure within government and industry under the themes of issues and barriers, and responses and initiatives. It aims to highlight the current state of the sector in terms of institutional and process reform, and to what depth the sector is addressing sustainability issues.

Chapter 5 will focus on the key components or elements of building and construction as defined by frameworks of sustainability. These are the tools for sustainable or green building, including resource guidelines and toolkits, design guides and checklists, and performance or rating assessment systems that have proliferated in recent years. Many of these components are consistent throughout the world; the main variations being influenced by climatic and geophysical differences. Most of these programmes are situated, not surprisingly, in the more developed OECD nations and most are government or industry based. Examples come from North America with some from the EU and also Australia, all of which are readily transferable to developing countries.

Chapter 6 contains the case studies of a residential and a commercial building, conducted using the draft NABERS environmental rating system (EA, 2001; Vale, Vale et al., 2001). It contains an analysis of the buildings themselves and also a review and analysis of the rating system. This is to assess its applicability to different types of building in Western Australia and also its usefulness in raising awareness and understanding of the requirements of sustainability in buildings.

Chapter 7 takes a local focus on the sector in Western Australia. The issue to be explored here is how to build upon existing initiatives, government and industry association policy statements, and the State Sustainability Strategy (SSS) in order to facilitate broader, deeper and lasting implementation. Whilst the main elements of sustainable building and construction remain the same, local climatic and geophysical conditions, and the structure of the local building industry, especially in the residential home market which is dominated by standardised project home companies, necessitates an approach tailored to issues of design and materials selection, as well as the delivery of essential services.

Chapter 8, which is the concluding chapter, will give a synopsis of green building and the possibility for implementation in Western Australia. This includes how current initiatives might evolve and what a more comprehensive strategy might include.

1.3 Methodology and Research Rationale

This thesis has been researched and written with an action-orientated approach. The reader will notice the emphasis on the theme of implementation. This focus has been taken for three specific reasons.

1. The main barriers to achieving a sustainable building and construction sector are less about technology than they are about commitment, awareness and education in government, industry and the public realm (CIB, 1999; HIA, 1999b). Whilst there are continuing advances being made in the manufacturing and production of building products, specifically from recycled materials and also from improvements in eco-efficiency and cleaner production (CSIRO, 2000; EA, 2000; CfD, 2001a), nonetheless the sector is in no way significantly impeded in making advances by the implementation of development, design and construction

initiatives. Similarly the owner, occupant or user can make significant contributions once they are provided with a high performance product.

2. It will be shown that this sector has programmes and tools that are sufficiently developed to initiate change for sustainability. These programmes are comprised of government/industry partnership training initiatives as well as guidelines and performance assessments for industry professionals to develop and supply a more sustainable product (HIA, 1999b; EA, 2000; BDP, 2002). Equally so are the Government sponsored programmes for user and occupant awareness and education (AGO, 2001).
3. Because of the above intentions, this project was developed as a joint honours thesis and input to the SSS. This was facilitated by the joint role of Professor Peter Newman. Its goal is therefore intentionally academic and applied research.

The building and construction sector exemplifies the most basic issues in the case for sustainability in that there is no particular technological fix required: the main game is to put into place a 'framework' that can carry the sector into a unified and level playing field. There is a vast amount of information available in printed publications as well as on the internet which is being regularly updated at a rapid rate. A number of the publications were posted as recently as September and October 2002 and many programmes are currently being instigated.

The sector is in a dynamic state in many parts of the world including Australia; the extent and depth of its transformation can be determined, not only by the promotion of green building programmes but also by the fundamental criteria of environmental and social ethics which form a deep commitment to the application of sustainability.

The world we have created today as a result of our thinking thus far
has problems that cannot be solved by thinking the way we thought
when we created them   *Albert Einstein*

(GSA, 2000).

This can set up a dichotomy of differing stances. One stance is of soft instrumentalist reform, where sustainability initiatives are enacted through changes to building codes and voluntary programmes, but it lacks the specific requirement of a united and informed change at all tiers of the sector. The other is one that is embedded in the core values of sustainability and which has a unified focus on bringing the sector to a point where it is operating in a way that is as much about ecological design as it is about ecological living. In this sense, not only will a client be asking for a built product (a home, workplace, institutional, commercial or industrial site) to be a place of ecological, social and individual well-being, but also the sector as a whole, from government and industry management through to the design and building professionals, will be operating with a commitment, knowledge and understanding of what a sustainable product is and how it can be delivered.

This dichotomy is not necessarily a cause of conflict. Whether or not the sector (or indeed society) eventually becomes embedded in the values and ethics of sustainability, there is a prerequisite for it to be operating and producing a more sustainable product. At issue here is a change in behaviour and a broadening of parameters that validates and considers equally the environmental, social, and economic components.

Much of this thesis is devoted to 'making a case' for a sustainable building and construction sector. It will contend that there is a strong and compelling argument that there is no reason why this sector cannot become more sustainable, and therefore by extension, the argument for a commitment to implementation, specifically at a government and industry level.

There are many important areas of this subject that are not dealt with in this thesis. These mainly concern aspects of design and construction, such as universal design, accessibility and retro-fitting of existing buildings.

In acknowledging that this topic has a scope that is broad enough to be broken down into numerous theses, the main intention has been to clearly show that there is much in place for the sector to move towards sustainability, and that on the whole this sectors' barriers to becoming more sustainable are issues of lack of commitment due to inertia and poor understanding, and lack of integration and synergy amongst all stakeholders.

1.4 Research Sources

The bulk of research for this thesis has been via electronic sources. The internet has facilitated global research of current sustainability initiatives, technical manuals, guidelines, assessment rating systems, journal articles and research papers, resulting in a body of evidence that is comprehensive and compelling.

A justification for the predominant use of electronic reference sources may be required. Firstly, the quality and depth of online journal articles and research papers is no different to the printed versions found in university libraries. Similarly, many bibliographic sources are in PDF format, the electronic equivalent to the printed book. Many of the technical manuals, guidelines and assessment rating systems are only available in electronic or CD ROM format, which allows them to be updated or modified as required, and also allows ease of access for the widespread dissemination of materials, certainly an advantage for the rapid transfer of knowledge and information.

Chapter 2 The Global Context

The pursuit of sustainable development brings the built environment and the construction industry into sharp relief. This sector of society is of such vital innate importance that most other industrial activities in the world simply fade in comparison

(CIB, 1999, p17).

2.0 Introduction

This chapter will give an overview of building and construction in a global context. Whilst there are the direct or obvious components, such as planning, development, design and materials selection, construction, occupancy and de-construction, there are also the more discrete or diffuse elements that include affordability, location and accessibility, community and sense of place.

Building and construction is import for sustainability for many reasons. It is linked to all other major sectors including mining, manufacturing, agriculture and transport. The current main environmental issue of global warming holds particular importance to the building and construction sector. It is estimated that the combined energy use of building and construction amounts to ~40% of global greenhouse gas emissions (UNEP-IETC, 2002c). The sector also impacts on other environmental issues including resource depletion, pollution and waste at each stage through mining, production or manufacture, design and construction, operation and occupancy and deconstruction/demolition (EES, 1998; CIB, 1999).

There are also the social issues of affordability, liveability and livelihood that are impacted by building and construction. These are affected in terms of urban form and transport, social cohesion and liveable communities, quality of housing or building product and also lifestyle (Newman and Kenworthy, 1999; Thorpe, 2000; Barron and Gauntlett, 2001; Scheurer, 2001; Armstrong, 2002; Engelman, Halweil et al, 2002; DHW, 2002c).

Economically, this sector has a profound influence on all other sectors and is often used by governments as a measure of economic growth (HIA, 2002). Economic benefits achieved by the sector through the implementation of sustainability that will be felt by the provision of a more superior product, will be realised directly through reduced consumption and waste, specifically in terms of energy-efficiency measures, as well as efficiency in water use and disposal. Other savings can be realised though the construction of more adaptable, durable, and long-life buildings (CSIRO, 2002c).

2.1 Sustainable Building and Construction: A Global Perspective

In every country, the construction industry is both a major contributor to socio-economic development and a major user of energy and natural resources; therefore its involvement is essential to achieve sustainable development in our society

(UNEP-IETC, 2002c).

To gain an appreciation of the size and importance of this sector requires viewing from a global perspective. Building and construction contributes on average 10% of GNP and more than half of capital investment in all countries. It is estimated to have 111 million employees world wide and as being the world's largest industrial employer (CICA, 2002). In many countries it accounts for up to half of all raw material extraction by weight, as well as being the largest producer of solid waste, estimated at 40%, although a growing proportion of this is recycled (Roodman and Lenssen, 1995). The built environment accounts for about 40% of green house gas emissions. This increases to as much as 50% in some countries if construction activities, including materials production and transport are also taken into account (UNEP-IETC, 2002c). This demonstrates that the built environment is the largest single contributor to greenhouse gas emissions globally (CIB, 1999) (refer Figure 2.1).

Figure 2.1 **Environmental Impacts of Buildings**

The impact of buildings on the environment is staggering. Every year, building construction:

- Consumes 25 percent of the global wood harvest
- Consumes 40 percent of the materials entering the global economy
- Consumes 3 billion tons of raw materials, turned into foundations, walls, pipes, and panels
- Consumes 50 percent of the copper used in the United States
- Generates 50 percent of the global output of greenhouse gases and the agents of acid rain

As the critical component of a habitat, buildings affect their proximate and surrounding areas, sometimes creating unwanted impacts on residents and the community. Building with sustainability in mind can dramatically lessen negative impacts

(CIWMB, 2000, Chapter 1).

There is a strong link between building and construction and urbanisation. Recent human development has seen a transitional demographic shift from predominately rural based societies to urban centres (Newman and Kenworthy, 1999; O'Meara, 1999). More than 50% of the global human population currently lives in cities and this percentage is increasing as human population increases, predicted to peak at approx 9-11billion people by 2070 (CIB, 1999; O'Meara, 1999). This presents the building and construction sector with many challenges beyond simply providing sufficient shelter. Although many of the issues of urbanisation and human settlements extend beyond the scope of building and construction, nonetheless there is vast potential for influence that a sustainable building and construction sector can bring (CRISP, 1999; CICA, 2002). This sector therefore holds great importance to all human activities, as well as ecological and environmental health.

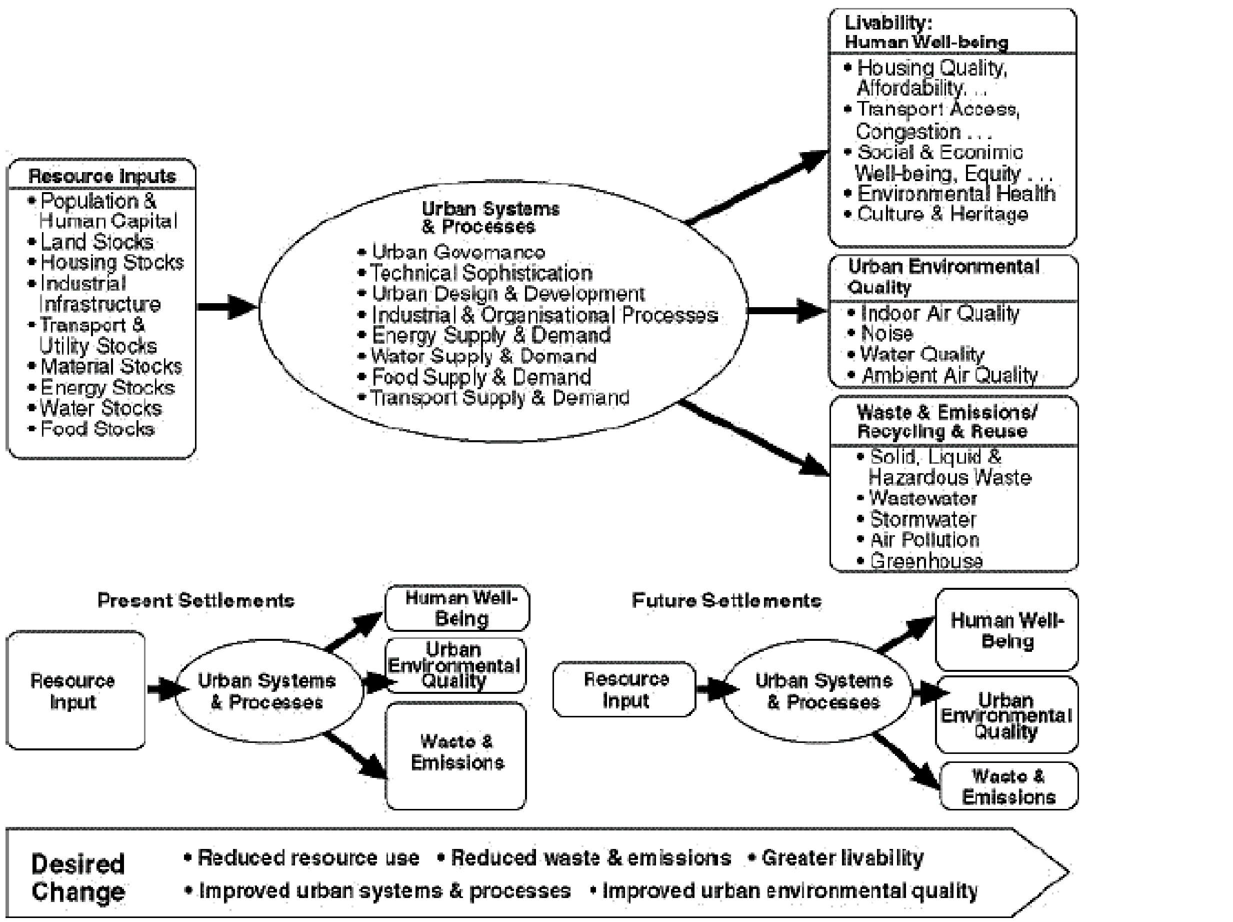
2.2 Building and Construction as a Contributor to a Sustainable Ecosystem.

The links between building and construction and human endeavour may seem obvious, but are important to grasp if sustainability is to be fully understood and implemented. In regard to human activity, the task or outcome of sustainability can be likened to mimicking natural ecosystems where all inputs contribute to the health and well-being of the host and all outputs can be reused or recycled as useful inputs: thus the result would be a closed loop cycle. The current reality is that many aspects of human activity have negative impacts at the input stage and further, produces many waste products that are not, or are not able to be, reused: thus the result is a open cycle that is driven by the single bottom line of economic growth whilst ignoring the negative impacts on ecological health (CSIRO, 2002e). Newman and Kenworthy's definition of sustainability in regards to cities as 'the reduction of the cities' use of natural resources and production of wastes, whilst simultaneously improving its liveability, so that it can better fit within the capacities of local, regional and global ecosystems' (Newman and Kenworthy, 1999, p7) aptly fits with what might be the endeavour of sustainability in regard to building and construction. This is a theme that will be explored throughout this thesis.

The 'Extended Metabolism Model of Human Settlements' (Newman and Kenworthy, 1999) (Figure 2.2) gives a clear explanation of how all the endeavours of human settlements are inextricably linked, and shows the pathways from inputs to outputs.

Traditionally the manner in which the resource inputs were attained and the waste outputs were disposed of was not seriously recognised or considered beyond the direct economic cost, although there were enough warnings as to the impending crisis (Carson, 1963; Ehrlich, 1971). The almost global recognition of the current ecological crisis, [despite some dissenters (Lomborg, 2001)], due to global warming, ozone depletion and loss of bio-diversity, has rapidly led to the necessity of 'closing the loop' of human activity. Hence the importance of the systems or eco-system approach, that is embedded in the framework of sustainability. Clearly not only in terms of building and construction but in all human endeavour the more efficiently the inputs are mined, produced, delivered and used (or consumed) will have direct impact on the level of waste outputs. If these 'wastes' are seen, and used, as valuable resources in themselves, we begin to come closer to the closed loop cycle of the natural ecosystem (CSIRO, 2002e). Critical to this is that the 'wastes', or possibly more correctly the 'excess resources' are not toxic nor synthesised in a manner such that they are unable to be re-used. This theme is continued below under CASE (Cities as Sustainable Ecosystems) and will underpin all issues and strategies presented throughout this thesis.

Figure 2.2 **Extended Urban Metabolism Model**



(Newman and Kenworthy, 1999)

2.3 Global Responses: Agenda 21 and The United Nations Environment Programme

Agenda 21 was a key outcome of the 1992 Rio Earth Summit. This policy document outlines the global response to the global ecological crisis and sets out in broad terms plans for implementation in all areas of sustainable development. It is based on the premise that 'sustainable development is not just an option but an imperative' (UNCED, 1992a). Agenda 21 gives specific attention to building and construction in Chapter 7 - Promoting Sustainable Human Settlement Development, Part G. Promoting Sustainable Construction Industry Activities. Although briefly stated, it outlines the basis for action, objectives, activities and means for implementation that all countries need to undertake 'to improve the social, economic and environmental quality of human settlements and the living and working environments of all people, in particular the urban and rural poor' (UNCED, 1992b). A result of Agenda 21 has been an overall increase of activity that has questioned, challenged and to a large extent caused a redefinition of the building and construction sector. Many global and local initiatives have been, and are still being, developed to implement the recommendations that arose from the Rio Earth Summit and subsequent events.

The United Nations Environment Programme (UNEP) is the coordinating body to which many organisations and alliances contribute their assessments and recommendations on these issues. Included in UNEP's cooperative efforts are the International Council for Research and Innovation in Building and Construction (CIB), the International Union of Architects (UIA), the International Initiative for the Sustainable Built Environment (iiSBE), the International Solid Waste Association (ISWA), the International Council for Local Environmental Initiatives (ICLEI), the Asia Institute of Technology (AIT), the Regional Environment Centre for Central and Eastern Europe, and the Confederation of International Contractors' Associations (CICA). Many of these organisations' contributions are being coordinated under the banner of the UNEP-IETC (International Environmental Technology Centre) CASE (Cities as Sustainable Ecosystems) initiative. As stated above, the link between cities and building and construction is inextricable, and this is evidenced throughout the CASE programme's stated aims. The importance given to CASE is in the recognition that the well-being of the natural environment and humanity is very much dependent upon the health of cities. The CASE programme, like any healthy ecosystem, focuses on the interaction and relationship within and between cities as well as the interactions of all urban activity and the environment. Particular attention is given to developing the opportunities for all types wastes to become useful inputs (UNEP-IETC, 2001).

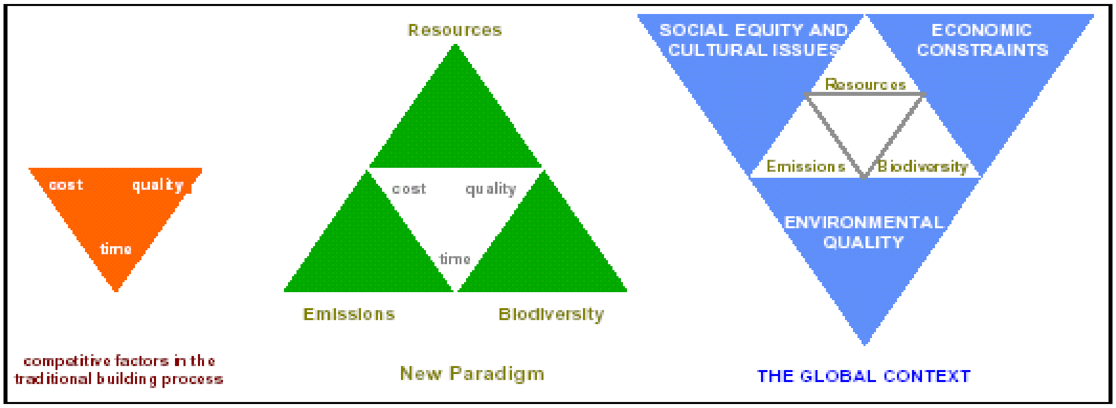
CIB is the leading international organisation for research and collaboration in building and construction. Its purpose is to provide a global network for international exchange and cooperation in research and innovation in building and construction, in support of an improved building process and of improved performance of the built environment. In response to Agenda 21, CIB produced its own 'Agenda 21 on Sustainable Construction' the principle component of which was an in-depth and searching analysis of the future directions of, and optimal ways to engage in international collaboration on research and innovation in building and construction (CIB, 1999). This report, similar to the UNCED Agenda 21, gives a broad outline of global issues but also sets out a framework for a global response. It identifies the main issues and challenges of building and construction as:

- Management and Organisation
- Product and Building issues
- Resource Consumption
- Impacts on Urban Development
- Social, Cultural and Economic issues

This report also identifies the progression to a more sophisticated and holistic understanding of building and construction. Figure 2.1 shows a three stage diagrammatic progression with the initial focus on maximising financial returns within the constraints of time and quality, followed by a broader emphasis on environmental issues concerning resources depletion, pollutions and ecosystem destruction. More recently the focus extends to embrace social, cultural and heritage issues.

In a report on global construction released for UNEP in 2002, CICA assessed the relevance and importance of construction and the built environment globally, albeit from the interests of contractors. This report emphasises the intrinsic links that building and construction has to all aspects of human endeavour. Principal amongst these are the issues of energy consumption and therefore global warming, resource use and waste, water, indoor environment and health, urban form and sprawl, transport and accessibility, and location and affordability (CICA, 2002, Executive summary). It also acknowledged the state of the sector in terms of what has been achieved, what actions are underway and future challenges (see Table 2.1).

Figure2.3. **Progression to a Sustainable Approach to Building and Construction**



(CIB, 1999, Section 2).

Table 2.1. **Sustainability Profile of the Construction Industry.**

- Achievements
  - Developing countries' share of total construction output worldwide has increased from about 10% in 1965 to about 29% in 1998.
  - Mature economies have uncoupled the growth in the production of CO_2 emissions in the built environment, as well as in construction and demolition waste through increased recycling, from GDP growth.
  - Third industrial sector holding ISO 9000 and fifth holding ISO 14000 certificates.
- Unfinished business
  - Reducing CO_2 emissions through raising the energy performance of existing buildings.
  - Improving health and safety on construction sites.
  - Promoting increased training.
- Future challenges and possible commitments
  - Further reducing CO_2 emissions in the built environment through the development and integration of renewable energy technologies.
  - Promoting the integration of environmental technologies in construction.
  - Agreeing a realistic set of performance indicators against which the construction sector can benchmark its progress.

(CICA, 2002, Executive Summary).

The CICA report also drew extensively on CIB's Agenda 21 on Sustainable Construction to produce an extensive list of issues that are of concern and need to be addressed as part of the response to sustainability (see Figure 2.4). Typically these issues fall into three general categories, being the environmental, buildings and human health, and the social. Many of the issues are interlinked and cannot be considered independently, for example environmentally-friendly construction materials are directly related to health in buildings, and building related transport aspects relate to urban sustainability, both of which relate to social impacts.

Figure 2.4.

Suggested Principal Environmental Issues in the Global Construction Sector

Environmentally-friendly construction materials.

As much as 50% of all materials extracted from the earth's crust are transformed into construction materials and products. Including energy in use, when installed in a building, they account for as much as 40% of all energy use. Moreover, these same materials when they enter the waste stream, account for some 50% of all waste generated prior to recycling or recovery or final disposal.

Energy efficiency in buildings

In developed economies, the construction, operation and subsequent demolition of built facilities account for about 40% of all energy end-use and a similar percentage of greenhouse gas emissions. In Europe, moreover, the potential for reducing greenhouse gas emissions in existing and new buildings is greater than that of any other sector, and consequently represents the most significant objective for reducing emissions in order to reach the targets laid down in the Kyoto Protocol.

Construction and demolition waste management

Construction and demolition waste constitutes the largest waste stream by weight in the EU. Disposing of these waste materials is presenting increased difficulties in many parts of the world. Increased emphasis needs to be placed on waste minimisation, reuse and recycling.

Water conservation

The operation of buildings places a strain on raw water reserves, while waste water and sewage needs to be treated before being returned to watercourses. Ways of conserving water and more efficient and effective means of treating wastewater need to be developed taking better account of land use planning for such facilities.

Health in buildings

The quality of the internal environment of a building is an essential element to the health of its occupants. Problems caused by damp and mould can be avoided through good building practices. Bio-climatic considerations and good ventilation can also reduce or even eliminate the need for air-conditioning in the summer months while reducing the amount of energy required for heating in the winter.

Building-related transport aspects

Studies have demonstrated that relatively compact towns and cities well-served by public transport systems are appreciably more energy-efficient than cities that have a relatively low urban density (often referred to as 'urban sprawl'). For as long as modern civilisation continues to rely on the combustion of fossil fuels as its principal source of transport energy, there will be an ongoing environmental imperative to construct buildings to relatively high densities, served by efficient public transport systems.

Urban sustainability

While construction activities and the operation of built facilities are only one of many aspects linked to urban sustainability, the quality and efficient operation of buildings and infrastructure are of fundamental importance.

Sustainable architecture

There is a lot that can be done to improve the overall performance of buildings, by implementing principles and measures in the design process, leading to sustainable architecture. Sustainable architecture relies on the continuous dialogue and close cooperation among all involved in the design and construction process, in order to improve the sustainable quality of every building.

Moreover, sustainable architecture must be considered in the context of a holistic and integrated approach to the overall quality of the built environment, in particular in the urban context.

Societal impacts arising from construction activities and the built environment

How more sustainable construction can improve the living context and the relationship between citizens and their environment whether rural or urban, and contribute effectively towards social cohesion, job creation and regional economic development.

(CICA, 2002, Sect 2).

One other initiative that is intended to influence the global building and construction sector, although in a different manner from the Agenda 21 on Sustainable Construction, is the Green Building Challenge (GBC). This international collaborative effort is developing a building environmental assessment tool that exposes and addresses environmental aspects of building performance. Participating countries can then selectively use the assessment tool to either incorporate into or modify their own tools (Cole and Larsson, 2002).

The goals of the Green Building Challenge process are:

- To advance the state-of-the-art in building environmental performance assessment methodologies
- To maintain a watching brief on sustainability issues to ascertain their relevance to "green" building in general, and to the content and structuring of building environmental assessment methods in particular
- To sponsor conferences that promote exchange between the building environmental research community and building practitioners, and showcase the performance assessments of environmentally progressive buildings

(Cole and Larsson, 2002).

The assessment of sustainable (or green) building is an important area that is given much attention and will be explored in detail in Chapter 5.

2.4 Conclusion

This chapter has attempted to give a 'global' overview of the main impacts of the building and construction sector, as well as the issues and challenges it faces as it attempts to progress to being more sustainable. The examples used were chosen because of their specific 'global' intent and were not meant to address regional or local issues. Also, the emphasis of collaboration and sharing of knowledge is a feature of these programmes as evidenced by the UNEP-IETC banner, and also the GBC programme whose specific intent is to develop a generic assessment tool that is freely available to all users. Other initiatives and programmes have the same intent but are not intended for a global audience.

All of the themes presented in this chapter will be followed throughout this thesis. These include:

- Policy and Management
- Urban Form and Liveability
- Development, Design and Occupancy
- Environmental Issues
- Affordability and Cost of Green Building
- Sustainable Design Guides and Assessment Tools

The next chapter will state the case for sustainable or green building by discussing the benefits to the environment as well as to people in terms of productivity, improved indoor air quality, and costs.

Chapter 3 The Benefits of Sustainable Building

...simply promoting greater efficiency in the use of our resources is no longer enough. By applying sustainable principles, we can also create better work environments and communities. Rethinking standard design practices, using environmentally preferable products, and re-examining how we use and maintain our facilities will also lead to a healthier and more productive workforce

(GSA, 2000).

3.0 Introduction

This chapter explains why sustainable building and construction is needed. It provides a rationale for the benefits of green building to the public consumer in terms of design and development, as well as the performance of the building. These benefits can be measured specifically in terms of occupant health and productivity, and more broadly, through quality-of-life and liveability.

This chapter will build the case for sustainability from the environmental perspective and also from an anthropocentric perspective. Whilst many green building programmes are focussed towards environmental concerns with inclusion of the benefits to the occupants, specifically in terms of design, materials and indoor environmental quality (IEQ), there is also a strong case that can be stated for green buildings in purely anthropocentric terms.

It will be argued that green buildings are a smart lifestyle choice as well as having definite advantages for business. The first part of this section will state the environmental case. This will be followed by the anthropocentric case, which will look firstly into productivity, specifically in the workplace and educational institutions. Productivity gains are a direct result of a better, smarter and more sustainable building envelope including interior design considerations, internal fit-out and indoor air quality (IAQ) (Dingle, 1999; Heerwagen, 2002). Interlinked with this will be the second aspect of the anthropocentric case, which is improved IEQ and occupant health in the home, workplace and institutional environments such as schools (PTI, 1996; UMN, 2000). The third area will focus on the financial gains for the building owner or occupant. This will be looking at up-front costs, pay-back periods, affordability and net financial gain as a result of the implementation of sustainable design.

Many of the benefits of green building associated with productivity, health and costs are inter-related. With the application of integrated design, first-costs can be reduced, whilst delivering buildings that are designed and constructed to enhance the interior environmental quality through smart design and appropriate materials that affords better comfort and health for the occupants, resulting in improved productivity and well-being (CARB, 1991; QDPW, 2000; BEI, 2001; CIWMB, 2001).

3.1 Environmental Benefits

The argument for the environment is fundamental to the argument for sustainability. There is irrefutable evidence of the need for greater sustainability initiatives to protect the environmental health of the planet (Brown, 2001; Ege and Christiansen, 2002). For many, acceptance of environmental intrinsic worth is a strong enough case to make the necessary lifestyle changes to human attitudes, practice and behaviour (Macy, 1993; Sharma, 1996). The fundamental principals of deep and spiritual ecological, that are embedded in the environmental argument, state that current human behaviour is destructive to the planet and to our own well-being (Berry, 1993; Bookchin, 1993) and that simply creating an argument based purely on the anthropocentric criteria of prosperity, productivity and personal health is ethically deficient.

A common concern of the environmental movement is that people value immediate issues, such as smog or water pollution, far higher than the longer-term evolving sustainability issues such as climate change or oil vulnerability. Many environmental issues that are 15 years or more in the future are beyond many people's understanding of the eventual consequences. Yet, global environmental issues of global warming, water, land and air pollution, resource depletion and waste management are crucial at this point in global ecological well-being (Flavin, French et al., 2002).

Promoting and realising the human-centred advantages of green building can help realise environmental benefits. Even those who are apathetic or who feel disempowered about their ability to resolve the global ecological crisis, can be promoted to behaviour change, and possibly even attitudinal change more aligned to ecological systems, if they can achieve an immediate improvement in their health, productivity and financial situation as a result of green building.

3.2 Green Buildings and Productivity

> *Buildings with daylight, fresh air, and occupant control are consistently rated as more comfortable and contribute to occupants' performance and productivity*
>
> (UMN, 2000).

Productivity and IEQ are closely inter-linked, but for the purposes of understanding the benefits of green building they are issues that can be viewed separately. There is an increasing body of data to conclusively prove that essential elements of green building in terms of design, materials and fit-out can positively influence human potential and increase productivity (BRE, 2001; Newton, 2001a; Heerwagen, 2002; WBDG, 2002). In stating the benefits of green building, productivity increases would be attractive to any business, including educational institutions. Productivity increases in green buildings relate to both the employer and employee, and benefits include:

- Reduced absenteeism/ less illness
- Retention of staff/ length of service
- Contentedness and well-being
- Higher workplace satisfaction and morale

(Dingle, 1999; Heerwagen, 2002).

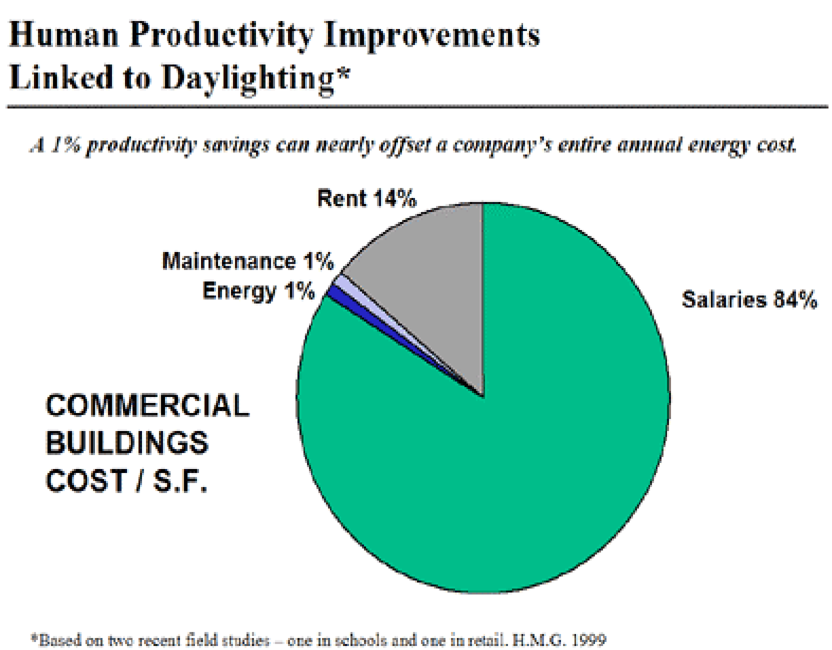
Employees who feel they have greater control over their work environment and who have visual and physical access to the natural environment, have consistently higher productivity and are more healthy (WBDG, 2002). Productivity improves when employees and students have access to fresh air and natural lighting, and also have personal control over the amount of air and lighting that is available in their work environment (CARB, 1991; HBI, 2000; WBDG, 2002).

One study demonstrated that sales increased by an average of 40% and school test performance improved typically 10 to 20% when occupants were exposed to daylight from non-glaring windows or skylights (CIWMB, 2001). Productivity is also influenced when workers have more control over their own environment. Increases of 3 to 7% have been recorded when workers were provided with temperature control of only $\pm 3^{o}$ (Heerwagen, 2002).

By considering IEQ at the earliest design stages can have profound effects on a company's operating cost. Figure 3.1 shows the proportion of costs in commercial buildings. Of significant importance is that salaries, which are contingent on productivity, occupy the largest proportion of costs. Any beneficial improvement that can be included in the overall design of the project that improves productivity by as little as 1% can often offset the entire energy and operational costs of a building (EES, 1998).

Productivity is directly related to IEQ, which is influenced by design considerations and materials and equipment selection. Materials that are classified as sustainable are less likely to have harmful emissions. The presence of formaldehyde and volatile organic compounds (VOCs) in the indoor air environment, combined with poor ventilation, can vastly impede human productivity and have detrimental effects on overall human health (Dingle, 1999).

Figure 3.1 **Proportion of Operation Costs in Commercial Buildings.**



(WBDG, 2002).

3.3 Human Health and Interior Environmental Quality (IEQ)

The indoor environmental quality (IEQ) of a building has a significant impact on occupant health, comfort, and productivity. Among other attributes, a sustainable building should maximize daylighting, have appropriate ventilation and moisture control, and avoid the use of materials with high-VOC emissions

(WBDG, 2002).

People living in urban areas spend, on average, 90 to 95% of their time indoors, whether it be at home, work, education, shops, recreation or in vehicles (PTI, 1996; Dingle, 1999; CIWMB, 2000; BEI, 2001; Newton, 2001b). The issue of interior environmental quality (IEQ) and indoor air quality (IAQ) and the effects on human health are therefore critical to individual and social well-being. Poor IEQ and IAQ are a direct result of inadequate building design, materials and fit-out. Improvements in these areas are therefore essential components of sustainable building.

3.3.1 Interior Environmental Quality

Visual connections to nature through windows enhance mood, reduce stress and promote a high quality of life

(Heerwagen, 2002, p4).

Interior Environmental Quality (IEQ) is a key issue for human settlements and sustainability, and is an essential component of green building (UMN, 2000). IEQ embodies a broad set of goals which:

- provide an environment that is physiologically and psychologically healthy
- minimise production and transmission of air pollution
- provide a full range of supportive sensory conditions
- provide needed operational control of systems to occupants
- produce environments that enhance human comfort, well-being, performance, and productivity (UMN, 2000).

IEQ goes beyond the quality of the air to include all the conditions of the indoor environment that pertain to human comfort, productivity and well-being, and which also support environmental health. Human well-being is positively influenced physically, emotionally, psychologically, and spiritually, if they are in an environment in which they have some level of personal control and which contains natural features such as trees, flowers and water. Whilst productivity increases are related to many diverse factors in the home and work environment including organizational, environmental and social issues, data consistently confirms that improvements in IEQ have direct influence on productivity increases in the order of 3% or more (BRE, 2001; Heerwagen, 2002; WBDG, 2002). The specific requirements to enhance IEQ in new and refurbished buildings include:

- more daylighting
- better access to windows
- attractive outdoor views, ponds included
- control over personal environment.

3.3.2 Indoor Air Quality (IAQ) and Sick Building Syndrome

Poor IAQ, which exists in up to 30% of all buildings, causes sick building syndrome (SBS) which is a proven condition that is detrimental to human health (HBI, 2000; BRE, 2001). The main symptoms of SBS include cold and flu-like conditions, headache, mental fatigue, nausea, dizziness and irritations of the eye, nose and throat, which all can contribute to a lack of productivity (Dingle, 1999).

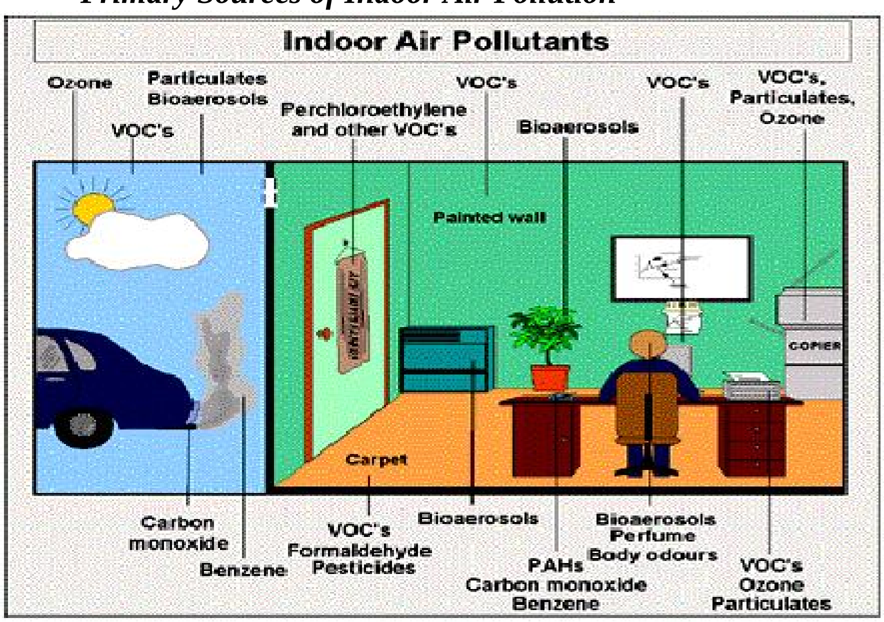
The United States' National Institute for Occupational Safety and Health (NIOSH) studies (1987) conclusively show that the three most common causes of sick buildings are:

1. Poor Ventilation: 50% of the buildings had inadequate fresh air and 18% were operating with no fresh air
2. Inadequate Filtration: 56% of the buildings had inefficient filters, 41% were basic low-grade filter pads, and 15% were of reasonable quality but poorly installed
3. Lack of hygiene: 42% of the ventilation systems were dirty including nine percent with grossly contaminated ductwork (HBI, 2000).

While IAQ is strongly influenced by ventilation flows within buildings, much of the initial poor indoor air quality in new and renovated buildings results from out-gassing of toxic emissions from the internal fit-out of the building including materials, furnishings, equipment, and appliances.

The relationship therefore between quality of materials and ventilation is important. Whilst much of the problem might be solved by improved natural and active ventilation systems, quality non-emitting materials will significantly improve IAQ. Many residential and commercial buildings are fitted-out with materials, furnishings and equipment that may contribute to indoor air pollution and unhealthy conditions. Another influence on IAQ in urban environments is from external air, which can also have significant levels of pollution and which eventually enters and mingles with indoor air. Figure 3.2 shows the main contributing factors to poor IAQ.

Figure 3.2 ***Primary Sources of Indoor Air Pollution***



(Newton, 2001a, p97).

3.3.3 Emissions and Sensitivity

While people of all age groups may react to emissions of VOCs and formaldehyde, which affect the respiratory system, children, the elderly, and those that are ill are much more susceptible (Dingle, 1999; Newton, 2001a). Poor IAQ affects the very young because they have underdeveloped immune systems and will experience a larger body dose of air pollutants than adults, the elderly, since they may be frail, are more susceptible because of existing illnesses, and all people with existing conditions such as asthma, emphysema, bronchitis and hay fever are all at risk (Newton, 2001a). With a demographic transition to urban centres, increasing global population, and an aging population in developed countries, including Australia (Newton, 2001a), this is an issue of growing importance as far as personal and pubic health costs and well-being are concerned.

3.3.4 IAQ and Costs

There is a compelling and logical argument for improved IAQ. There is also a strong awareness and growing concern over the problems of IAQ and its potential to cause large industry losses (Heerwagen, 2002). In terms of the economic costs associated with poor IAQ 'estimates based on US figures indicate that poor IAQ in Australia could incur potential costs of several billion dollars per year' (Newton, 2001a, p101). It is through appropriate design and the internal fit-out, including material selection, where the greatest and most immediate impacts can be created.

3.3.5 Consumer Demands

IAQ is beginning to rank higher on consumer lists of demands (Newton, 2001a; Heerwagen, 2002). A US survey shows that 88% of people are aware that products outgas harmful chemicals into their indoor environment, and IAQ ranks second in importance on a list of desirable home upgrades and general environmental issues that consumers care about (Roberts, 2001).

The designer or project team has much greater ability to influence the design of the building than in the choice of appropriate materials. Even so, a high-quality indoor environment can be achieved through appropriate materials, equipment and appliances as well as a healthy design that enhances the quality of our interior environment. Figure 3.3 lists the essential criteria in materials and equipment selection and use.

Figure 3.3 **Indoor Air Quality (IAQ) is Enhanced by Meeting the Following Criteria**

- Low or non-toxic: Materials that emit few or no carcinogens, reproductive toxicants, or irritants as demonstrated by the manufacturer through appropriate testing
- Minimal chemical emissions: Products that have minimal emissions of Volatile Organic Compounds (VOCs). Products that also maximize resource and energy efficiency while reducing chemical emissions
- Low-VOC assembly: Materials installed with minimal VOC-producing compounds, or no-VOC mechanical attachment methods and minimal hazards
- Moisture resistant: Products and systems that resist moisture or inhibit the growth of biological contaminants in buildings
- Healthfully maintained: Materials, components, and systems that require only simple, non-toxic, or low-VOC methods of cleaning
- Systems or equipment: Products that promote healthy IAQ by identifying indoor air pollutants or enhancing the air quality (CIWMB, 2002).

3.4 Financial Costs of Green Building

We're talking about first-cost here - how much more (if any) it costs to incorporate green features into a building project. It would be wonderful if life-cycle costs were considered as a matter of course in building design today - but they are not. Most of us in the building profession are forced to deal almost solely with first-cost in justifying our projects (EBN, 1999).

3.4.1 First Costs, Operating Costs and Life-cycle Costs

In quantifying costs of green buildings there are two factors that need to be considered; the initial capital outlay of the building or first-cost, and the payback period, the time that it takes to pay back the 'additional' sustainability features of the building (Langston, 2001; CfD, 2001c). There is much conjecture over whether building to the 'additional' requirements of sustainability, that is, developing greater efficiency in terms of energy, water and material resources whilst simultaneously improving the comfort and health for the occupants, will increase the initial capital outlay of the building project (Tendler, 1999; Sullivan, 2001; SEAV, 2001a; Johnston, 2002). However by considering all the costs and benefits over the full life of the building, the life-cycle cost assessment of green building will conclusively show net gains in financial, environmental and social terms (Tendler, 1999; Heerwagen, 2002).

Not all projects necessarily have, or require 'additional' sustainability features to be considered green. In many projects, the design and material features that enhance green building criteria are more carefully selected at the early design stages. In terms of designing and constructing residential homes and small commercial projects, many of the green building criteria can be fulfilled easily by incorporating passive solar/energy efficient design, solar hot water system, water wise gardens, and efficient appliances and fittings, much of which is mooted for inclusion in Building Codes of Australia (BCA) amendments (Johnston, 2002; ABCB, 2002a). There are other technologies and features such as rainwater tanks, grey-water systems, and photo-voltaic panels that are important, though not essential features in green building design, which would add to first-costs.

The California Sustainable Building Taskforce found that whilst '*sustainable buildings may incur higher first costs than other buildings due to alternative design analysis, computer energy modelling, product research, post-occupancy evaluation, and life-cycle costing, if these elements are incorporated during the project development and integrated design phases, the potential for higher first costs is greatly reduced'* (CIWMB, 2001, p24). In Australia, costing associated with the proposed BCA amendments show first-cost increases in the order of approximately 5-9% (DHW, 2002b). Significantly though, these cost analyses only considered the building envelope (as was the brief of the assessment), ignoring broader construction parameters that a green building project would include, such as site and landscaping. The assessment took a singular approach to one element of a project. Practitioners of green building design realise that 'if strategies are designed synergistically, the initial building costs can be minimised and significant savings *in reduced operating and maintenance costs* can be realised over the life of a building' (Tendler, 1999, p2).

One of the most important aspects of costs in building is a life-cycle costing (LCC) of all stages of the building cycle (EES, 1998; UMN, 2000; CIWMB, 2001; Langston, 2001; BDP, 2002). Life-cycle cost (LCC) analysis is a method of analysing the cost of a system or a product over its entire lifespan with the objective of being able to choose the most cost-effective approach for using available resources in that product or system. A full LCA and LCC case study was carried out to determine a comparative assessment on a standard house and energy efficient house in Michigan, USA. It shows 'that from an investment standpoint, setting aside future uncertainties, both homes are approximately of equal value' (Blanchard and Reppe, 1998). Whilst this assessment is not conclusive, what is highlighted is that the building process must be treated holistically, and that by considering the full life of any project, as shown in Figure 3.4, the first-costs can be assessed in a different light. Cost savings in green building are realized predominately at the design stage. If the building design and construction are done within a green building framework, the initial construction costs and long-term operational costs can be significantly reduced.

Figure 3.4 **Minnesota Sustainable Design Guide**

(UMN, 2000).

Links between costs and productivity are tied together in interesting ways, especially in the commercial sector. Productivity increases and improved human health can have cost benefits to companies that would far exceed a small increase in building design costs. Initial design costs amount to approximately 2% of the total, and personnel costs are 85% or more, with the remainder consisting of operation and maintenance costs. This indicates that the small additional outlay in design to improve indoor environmental quality at the early stages of project initiation can have significant effects on the workplace and hence on productivity, as evidenced by the following example:

> *In a typical large office block, by far the greatest lifetime expense is the salaries of the workers (84%, compared with gross office rent -14%, total energy - 1%, and repairs & maintenance -1%). If smart building design can give even a small, 2%, gain in worker productivity (e.g., by improving health, reducing absenteeism, and optimising indoor traffic circulation), the savings generated are potentially similar to the entire energy budget*
>
> (CSIRO, 2002c).

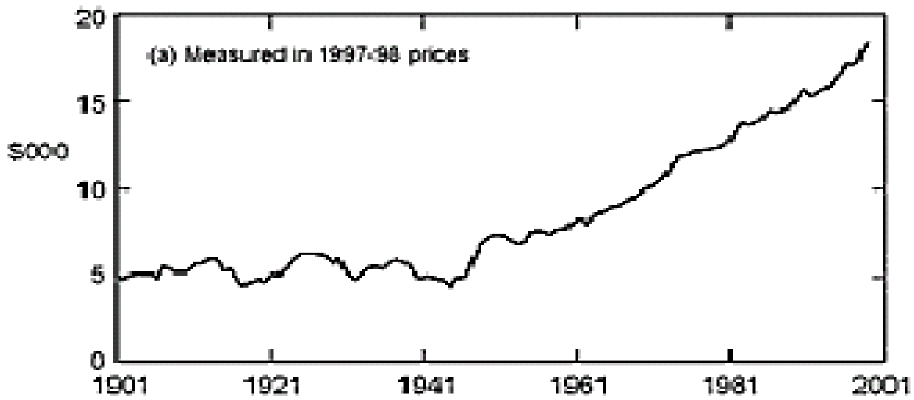
Thus far, costs have been considered from the first-costs perspective and it has been shown that by applying an integrated approach throughout all stages of the project, or in other words, by considering a life-cycle approach, the 'additional' first-costs, if any, will be minimal. The other costs element to be considered is operational costs.

3.4.2 Operating Costs

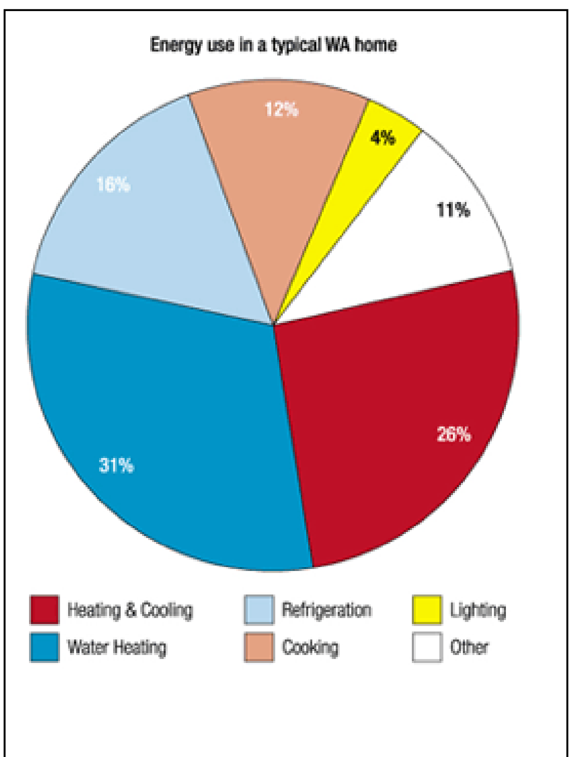
Approximately 50 percent of the energy use in buildings is devoted to producing an artificial indoor climate through heating, cooling, ventilation and lighting (Roodman and Lenssen, 1995).

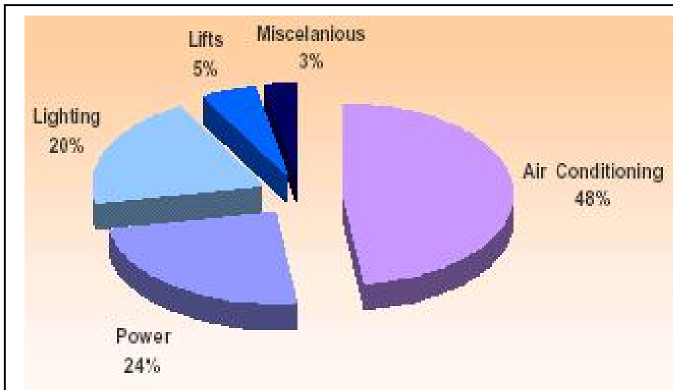
The other significant cost saving is in operating costs. Operating costs relate to energy, both electrical and fuel, as well as water consumed by active systems within buildings. Figure 3.5 shows the increasing consumption levels in Australian households across a range of key resources including energy, water, materials, and also house area (m^2) which has increased 3% per year since 1990, whilst family or average occupancy numbers continue to shrink (3.3 persons in 1976, 2.6 in 1999, and projected to be at 2.4 persons by 2011) (ABS, 1999; Newton, 2001a). Typically, in residential buildings, space heating and cooling and hot water heating consume the most operating energy, whilst in commercial buildings, heating, ventilation and air conditioning (HVAC) is the greatest consumer (SEDO, 2002) (see Figure 3.6).

Figure 3.5 **Household Consumption Australia 1901–2001**



(Newton, 2001b)





Energy use in typical WA commercial building

Figure 3.6 **Typical Distribution of Operating Energy Use in Western Australia** (SEDO, 2002).

Life-cycle costing (LCC) of energy efficient and green buildings shows significantly reduced operating costs in terms of savings on energy and water. Both in the residential and commercial sectors, green buildings consistently use less energy than conventional buildings. The California Sustainable Building Taskforce states that on average, it is cost effective to exceed minimum energy performance codes requirements by 13% using existing technology, and one commercial project alone will save approximately $US400.000 per year in energy (CIWMB, 2001). Cost savings for the average house in Australia from energy efficiency measures due to simple passive solar design principles, approximate $400 per annum, saving approximately 15 tonnes of greenhouse gas emissions (AGO, 2001). Other direct cost savings are in reduced water consumption. Residential water usage in Perth comprises 40% indoor use and 60% outdoors, much of which can be reduced through water saving techniques such as the reuse of grey water and replacing large lawn areas with water-wise gardens and native plant species.

3.4.3 Affordability

The fact that operating efficiency pays is indisputable, and that it also supports overall ecological gains makes a compelling case for green building. Even so, the critical issue of affordable housing still needs to be addressed. United States' surveys show that people are actually prepared to pay extra to achieve longer-term efficiency and financial gains that result from sustainable building strategies (Roberts, 2001). These people are the earlier adopters who are also financially willing and able to cover an additional capital outlay to achieve longer-term efficiency gains. On the assumption that residential green buildings will cost more in first-costs, nominally 1 to 8% (Blanchard and Reppe, 1998; CSIRO, 2000b; Roberts, 2001; Sullivan, 2001; Johnston, 2002; ABCB, 2002a; DHW, 2002b), consideration must be given to link housing affordability to green building, especially for those in lower socio-economic situations.

Affordability is an essential consideration in the implementation of green building. The disadvantaged often live on the urban fringe or in degenerated suburbs with low resale potential and in poor quality housing that has high operating costs as well as poor IAQ, all of which directly contributes to perpetuating a low socio-economic status (Barron and Gauntlett, 2001; Armstrong, 2002; DHW, 2002a). Housing is just one aspect of this social condition, yet providing this group with better quality housing is not only financially beneficial but also potentially improves equity as well as personal health and well-being. It would be socially unsustainable if these people had to pay additional first-costs for a residential home.

3.4.4 Energy Efficient Home Loans

In the Australian context, for those in social housing, and who require government housing loans, financing options that are tied to construction of energy efficient homes can be made available to counter the problem of affordability. Government housing agencies must recognise that financial gains are to be made in providing a more sustainable housing product for their clients and tenants. If green-buildings do cost more in additional first costs, the long-term financial gains from reduced operating costs will result in reduced overall expenditure.

Energy efficient loans, eco-loans and green home loans, are all home mortgage loans that offer a reduced interest rate, as well as various incentives that are contingent on an energy efficient, passive solar home design and construction, as well as energy efficient appliances, are available to reward the benefits of green building. In Australia these loans are available for any customer who has a house that complies with the energy efficiency requirements (HIA, 1999a). Similar arrangements could be made by government housing and social welfare agencies that could be linked to social housing recipients.

3.4.5 Commercial Buildings

Financial savings from reduced operating costs in commercial buildings can be significant. Energy management is being incorporated into commercial buildings in terms of retrofitting to save on heating and cooling costs, appliance use and the operation of equipment (MBA, 2001; PCA, 2001).

3.4.6 Costs of Urban Form and Buildings

It is also important to point out that building costs form only one part of the construction of settlements. There are direct and indirect building costs associated with the infrastructure development that is required to support human settlements. As cities continue to expand due to global population growth and the demographic transition, there is a continued need for essential supporting infrastructure including transportation routes, schools, hospitals, shops, as well as the provision of services such as electricity, gas and telecommunications (Newman and Kenworthy, 1999; O'Meara, 1999). The argument for a more compact city is irrefutable in terms of being cheaper to run and easier to function. Outer ring or fringe suburbs are consistently more costly in terms of transport and service infrastructure, as well as having adverse environmental impacts associated with higher levels of energy use and resource consumption (Newman and Kenworthy, 1999; DPI, 2001b). New subdivision development on green-field sites, being located on the urban fringe, have increased operatining costs for the residents in the form of access and transport to employment, schools and shops. These issues are critical to costs of human settlement and link into the extended stewardship of the building and construction sector.

3.5 Conclusion

This chapter has attempted to highlight the benefit of sustainable building by focussing on four main themes:

- Intrinsic worth of the natural environment
- Productivity
- Indoor Environmental Quality, Indoor Air Quality and Occupant Health
- Costs and Financing

All four issues directly relate to the well-being of both the natural ecosphere and humanity, both individually and collectively. They also pertain to four fundamental objectives of sustainable building, which are:

- Reducing the overall impact on the environment
- Using energy, water, and other resources more efficiently
- Protecting occupant health
- Improving employee productivity

To achieve all of these four requirements within a project does not require a compounded effort; all four are inter-linked and are fundamental parts of good building design and material selection.

The critical issue for creating market change is to convince both the consumer and also the builder that these requirements can be achieved at an affordable price. For many that means that there is no, or very minimal, up-front price increase. The issue of first-cost is important and needs further consideration. Australia has recently experienced industry concerns over the price effects of introducing minimum energy performance requirements for residential homes, a very minimal first start towards a more sustainable product. Meanwhile, other government sponsored programmes call for exceeding minimum energy requirements by up to 30%.

Design and construction costs savings can be realised in many ways. The most important of these is that the whole project is conducted as an integrated process and also that the full life-cycle of the project is considered. Integrated Design treats the project as a whole system and encourages integration of parts, efficiency in materials and construction process and performance of the final product. Individualising or compartmentalising costs to singular components ignores where savings can be made in other areas. For example, if a builder only considers the envelope (as done in BCA amendments), it ignores savings that could be found in site works and landscaping, materials selection or mechanical systems. It is clear that by working with an integrated design process, the additional first-costs that some green buildings require can be significantly reduced.

Life-cycle thinking and life-cycle costing requires the designer or project team to consider and evaluate all elements of the project from cradle to gate. When all costs, that is first, operating and maintenance, are considered, a more realistic picture of comparative costs is realised. Life-cycle thinking is an important tool for creating change in this sector and it must be integrated into building projects. If the financial benefits that result directly from improved occupant health and productivity can be promoted, then green building will gain market prominence. For the organisational elements of the sector, as well as industry professionals, understanding and promoting life-cycle thinking can be a beneficial tool in creating market change.

Many of the strategies in green building design guidelines are not only smart in their sustainability characteristics, but also smart in their money saving ideas. Tendler (1999) lists seven benefits from green building:

1. Reduced operating costs; energy saving up to 40%
2. Reduced waste costs
3. Reduced liability- enhanced indoor air quality (IAQ) can reduce sick building syndrome
4. Enhanced employee productivity
5. Public relations
6. Streamlined regulatory approvals
7. Niche marketing opportunities (Tendler, 1999).

These benefits would result from applying the principles and practices that are outlined in green building guidelines and assessment tools, but it is with government and industry organisational support that green building will move from occupying a market niche to being standard design and building practice.

The next chapter will discuss the barriers and opportunities for green building from an organisational and institutional level, both within government and industry.

Chapter 4 Barriers and Opportunities for Green Building

A 'green' building places a high priority on health, environmental and resource conservation performance over its life-cycle. These new priorities expand and complement the classical building design concerns: economy, utility, durability, and delight. Green design emphasizes a number of ***new*** *environmental, resource and occupant health concerns:*

- *Reduce human exposure to noxious materials*
- *Conserve non-renewable energy and scarce materials*
- *Minimize life-cycle ecological impact of energy and materials used*
- *Use renewable energy and materials that are sustainably harvested*
- *Protect and restore local air, water, soils, flora and fauna*
- *Support pedestrians, bicycles, mass transit and other alternatives to fossil-fuelled vehicles*

(BEER, 2002).

4.0 Introduction

The previous chapter discussed the benefits of green building, both for the environment and also for the users and occupants. It was noted in Chapter 2 that the sector has recognised how it needs to respond to the 'obvious' environmental impacts but that there is some variance and conjecture over how far its sphere of influence extends and how much it can and should influence issues of community and social development. Even so, there is much that can and has been done by this sector towards the implementation of sustainability in regards to direct impacts on environmental and human health and well-being.

This chapter will look into the themes of issues and barriers, and responses and initiatives that are relevant to this sector within an institutional, organisational and management perspective and with which it must contend if it is to become more sustainable. These include issues in both government and industry that the whole sector must understand and come to terms with to progress to more sustainable practices. Whilst acknowledging that the institutional and administrative issues are important and ultimately essential in supporting the green building process, nonetheless many designers and builders are taking the lead in their own business operations by supplying a more sustainable product.

This chapter will not attempt to comprehensively cover the details of green building issues or initiatives, rather it aims to highlight the current state of the sector in terms of institutional and process reform and to what depth it is addressing sustainability issues.

4.1 Management and Organisational Issues

Management and Organisation is a key aspect of sustainable construction and the subject must engage not only technical issues but social, legal, economic and political matters as well

(CIB, 1999, Section 3.2.1).

The nature of this sector is that many disciplines are involved (CIB, 1999) and also 'activities related to buildings form a complex web of disciplines and responsibilities, spanning urban planning, landscaping, building design, products manufacture, construction, refurbishment, operation, maintenance, demolition and recycling' (Lead Liew, Vale et al., 2001, Sect 1.2). A sector-wide approach to dealing with the detrimental impacts of the building and construction sector is required and will support the individual and fragmented initiatives that are currently underway (CIB, 1999; HIA, 1999b).

Impacts that result from the building and construction sector are many and varied and there is a broad array of environmental impacts associated with building and construction (Table 4.1) that need to be dealt with by both government and industry (HIA, 1999b; EA, 2000). Some of the issues pertain directly to either government or industry and all are integral to supporting greater sustainability.

Bringing all or many of these disciplines into a more unified and coordinated process, i.e. within a sustainability framework, would assist in the sector's transformation. One of the fundamental tenets of sustainability is integration (GSA, 2000; CIWMB, 2001). All key actors in the product and supply chain must understand and be involved in supplying a sustainable product. Consistency in approach in all tiers of the sector is required if a sustainable outcome is to be achieved. It is important therefore to determine where the sector is situated, and if it has the criteria of integration and consistency of approach in place to support it if it is to progress toward being more sustainable.

An oft cited requirement for sustainability actions and implementation is recognition and ownership of the issues and a shared vision for actions at all levels, critically by senior management, both across the sector as a whole and within agencies and organisations (Stead and Stead, 1996; Tamura, 2000; EA, 2002). 'The concept ***that*** sustainable enterprise strategy ties business strategies to ethics' (Tamura, 2000, p15) seems to imply that a sector, and an organisation within that sector, that desires to operate from a clear ethical stance can use sustainability as their framework for undertaking their operations, because 'it supports a strategic vision of *the sector* or firms surviving over the long-term by integrating their need to earn an economic profit with their responsibility to protect the environment' (Stead and Stead, 1996, p168). These core ethical values, as well as ownership and responsibility of issues and actions, are central to the structure of Environmental Management Systems (EMS) (CERES, 1999; Tamura, 2000; EA, 2002).

An EMS is a way of guiding a sector or an organisation to achieve and sustain performance in accordance with established goals and in response to constantly changing regulations, environmental risks, and social, financial, economic and competitive pressures (Tamura, 2000). An EMS will require that all issues that are impediments to achieving sustainability be identified and will systematise the responses and actions to achieving lasting and meaningful change.

Refer Appendix 2. Proposed Environmental Management System (EMS) for a Hypothetical Building Company

Table 4.1 **Direct and Indirect Environmental Impacts Associated with Building and Construction**

(Beyer, 2002).

Sector Component	Component Element.	Environmental Impact.
Planning and Development	Planning policy Subdivision development Development approval	• Greenfield development • Urban sprawl • Lack of integrated planning • Small influence over infill • BAU
Design	Architectural form and Materials selection	• Large ecological footprint • High embodied energy • Poor thermal qualities/high operational energy • High resource use • Toxic or non-benign materials • Poor recyclability
Materials Directly from manufacturer or from suppliers	Mining operations & timber logging Manufacture fabrication and distribution	• Habitat or eco-system destruction • Air, water and land pollution • Associated resource use and energy intensity
Construction Methods Include materials and equipment selection and method of construction	Materials & methods during construction	• High labour cost • Material use and waste • Poor workmanship • High resource use and waste, i.e. Energy and water • Destruction of vegetation and habitat • Land, air and water pollution
Occupant Behaviour Influenced by: Urban form Local potential Building design Internal fit out	Eco sphere and local area biota Material goods Services (energy, water)	• Land, air and water pollution • Degradation of local area • Energy use of fixed and transferable appliances • Water use • Material goods including furnishings and fittings • Food consumption & waste

4.1.1 Barriers to Progress

It is essential to identify the current state of play in the sector if there is to be an orchestrated and unified move towards sustainability; as a starting point, identifying the barriers to change will give insight for moving forward. The CIB report lists the main barriers to progress in terms of process and management issues as:

- Professional and institutional inertia defending the status quo
- Lack of understanding of the problem among construction professionals
- Inadequate or defective vehicles for participation by the stakeholders
- Market delay
- Insufficient data
- Lack of communication between sectors that do exist
- Lack of client buy-in
- Political insecurity (government electoral periods limit the horizon)

(CIB, 1999, Sect 3.2.2).

Although relevant to any new market or sector, these issues indicate the importance of awareness raising and education about the benefits of sustainable building and construction.

4.1.2 Criteria for Sector and Organisational Implementation

For this sector to move towards sustainability there are a number of essential steps that need to be fulfilled. The following criteria are drawn from frameworks for environmental management system (EMS) (Tamura, 2000; EA, 2002). It is critical for the decision makers, those at the management and organisational level, to commit to and create a system that can lead, direct and support the down stream process changes required. This requires above all that executive leadership must understand sustainability and commit to its principles (Stead and Stead, 1996; GSA, 2000). Coupled with this, a vision and mission statement which is translated into specific objectives and targets with high level visibility throughout all levels of the organisation is required. There must also be a formalized process for identifying the environmental aspects and impacts of an organisation's operations, products and services, as well as training throughout all tiers of operations which is crucial to attaining the awareness, skills and knowledge required for transformation. Finally performance must be measured via audits and assessment (CIB, 1999; GSA, 2000; EA, 2002).

These steps set in train the organisational framework that can support the practical elements of reform.

California: Building Better Buildings. A Case Study.

The California 'State Sustainability Building Taskforce' is a partnership of 32 Government agencies set up to develop a strategy to achieve the establishment of the state's sustainable building goals which are *to site, design, deconstruct, renovate, operate, and maintain state buildings that are models of energy, water, and materials efficiency, while providing healthy, productive and comfortable indoor environments and long-term benefits to Californians* (CIWMB, 2001). This initial move of setting the goal of environmental sustainability was the state's vision, and also shows ownership of the fact that there are significant environmental issues that must be resolved.

The Taskforce has identified the administrative, organisational and fiscal barriers that impede the full-scale implementation of green building as:

- Incomplete integration
- Lack of life-cycle costing
- Insufficient performance and operating standards
- Lack of incentives and insufficient technical information

(CIWMB, 2001, p22).

This identification of issues also provided a guide map from which the taskforce issued the plan of action. This sets out a comprehensive framework that all tiers of the building and construction sector will access. This is encapsulated in a ten point plan of recommendations and action (Figure 4.1).

Figure 4.1 **Building Better Buildings: A Blueprint for Sustainable State Facilities**

Recommendations and Action Plans

1. Modify the state's capital outlay process to ensure that the Governor's sustainable building goals are met and that appropriate projects are reviewed by the Sustainable Building Task Force
2. Incorporate life-cycle costing, integrated design, commissioning, and post-occupancy evaluation into the state's capital outlay program
3. Develop cost-effective building performance, operation, and maintenance standards
4. Invest additional resources for full-scale implementation of sustainable building practices
5. Develop comprehensive annual reporting requirements to measure progress in implementing the state's sustainable building goals
6. Develop "leadership buildings" to showcase sustainable building practices
7. Develop sustainable building technical assistance and outreach tools, including a training program for state departments, as well as local government and private sector partners
8. Create programmatic, fiscal, and administrative incentives to facilitate the implementation of successful sustainable building approaches, including a Governor's Sustainable Building Award
9. Implement guidelines to acquire leased space with cost-effective sustainable building features
10. Provide Task Force assistance to federal, state, and local agencies in key infrastructure areas

(CIWMB, 2001)

This plan of action indicates the commitment and initiative required to achieve change. It incorporates the most fundamental elements of sustainability that actions would require: vision, integration, partnerships, life-cycle thinking, measures of progress and performance, awareness, education and training, and incentives. Point 10 indicates that expertise in sustainability is provided to support the change process.

4.1.3 Responses and Initiatives for Change: Mandatory and Voluntary

Currently there are two broad methods being employed at an organisational level to bring about change within this sector. Based on the acknowledgement of environmental issues, specifically issues related to energy, water, resource consumption and human health, the actions undertaken consist of amendments to building regulations as well as support for voluntary initiatives (ABCB, 2001). The regulatory amendments are specifically in the form of building codes and wholly relate to energy efficiency measures, thus they do relate to sustainability but are not in any way a full sustainability initiative. The promotion of voluntary initiatives enacted through government and industry partnerships potentially, and often do, encompass the broader environmental sustainability criteria, but by their voluntary nature they do not have any set compliance regimen, although they do often have an assessment component.

An important distinction needs to be made between energy efficiency and sustainability. Energy efficiency and energy related matters are only a subcomponent of broader sustainability issues. As will be seen in Chapter 5, all green building guidelines contain a number of key elements, of which energy is only one part.

Building codes have undergone a significant review in recent years, both internationally and in Australia, specifically relating to energy matters (ABCB, 2000). Traditionally building codes stipulate minimum performance requirements; that is they are designed to eliminate worst practice, not promote best practice (ABCB, 2001). Building code amendments are aimed at shifting construction practices from mainly prescriptive criteria to more performance based guidelines, and the emphasis has been on increasing energy efficiency within buildings (AGO, 2000). In Australia, these amendments are still in the process of review, and consensus has not yet been achieved due to strong industry pressure and concern, mainly relating to increases in building costs (DHW, 2002b). The main amendments to the Building Codes of Australia (BCA) consist of increasing the thermal capacity of residential homes, including the mandatory inclusion of roof and ceiling insulation, maximising solar access, draft proofing and sealing of openings, as well as insulating of hot water pipes (ABCB, 2001).

These energy provisions will bring significant reductions to overall greenhouse gas emissions. Even so, many local amendments to national or regional building codes as well as environmental or green building guidelines, require that their buildings exceed the minimum energy performance requirements by up to 30% (CIWMB, 2001; DNRE, 2002; GAHBA, 2002). In Australia, the state of Victoria has a requirement for all new residential buildings to achieve a 5 star energy efficiency rating (DNRE, 2002) which will still exceed the proposed amendments to the BCA. Whilst amendments to building codes are seen as a beneficial step, they in no way reflect or come close to the scope or criteria of broader sustainability in building and construction.

The voluntary initiatives that target industry reform are often partnerships between government and industry and have a diverse and broad spectrum approach which include: training and accreditation, tool kits and information on green building practices, checklists, promotion, networking, demonstration and showcasing, and incentives and awards (HIA, 1999a; ABEC, 2000; CIWMB, 2001; MBA, 2001; PCA, 2001; RAIA, 2001). These programmes are industry's response to environmental concerns and are often designed to create improvements in the building process because of the recognition that 'if our industry doesn't initiate improvements…changes will be enforced by legislation' (MBA, 2001, p3).

Whilst undertaking voluntary changes in their practices can only be viewed as positive, few of these initiatives have a method of compliance assessment or verification of product improvements. Building professionals who gain programme accreditation can promote themselves as being 'more green' in their practices and product, but there is no specific compliance standard which can give a measure of sustainability characteristics, nor is there verification of sustainability criteria other than via independent case studies which are sometimes conducted by the supporting organisation to promote the initiative (ABEC, 2000; Cass, 2001; BDP, 2002). Whilst these programmes produce definite product improvements, there is no challenge, no 'aspiration quality' that can aim for sustainability (Vale, Vale et al., 2001). Some results, hopefully many, will be good examples, others will be token 'green wash' that will have few sustainability characteristics.

CIB's Agenda 21 on Sustainable Construction reviews a spectrum of initiatives that are employed to improve new and existing buildings including:

- Regulation such as building codes
- Energy pricing as a lever to improve energy performance
- Enabling and support mechanisms such as information, training and tool kits
- Incentives and demonstrations such as tax benefits (CIB, 1999).

Significantly, the report concludes that all of these approaches are useful in encouraging change, but that '*measures to change market demand are the most promising method for achieving substantial change in market-orientated economies'* and that a '*valuable measure to affect market demand is…the implementation of rating and labelling programmes'* to provide clients with tools that will allow them to identify high performance buildings (CIB, 1999, Sect 4.1). Assessment and measurement of sustainability is therefore an important component in guaranteeing measurable and meaningful change.

Most sustainability assessment rating tools actually require a trained, paid assessor to verify a compliance record (BRE, 1999; Lead Liew, Vale et al., 2001). To date there are few checklists or *tools* that clients can use independently of qualified assessors. With these tools lacking, the client is uninformed and is forced to be reliant on the industry associations' or professionals' goodwill in providing a sustainable product.

4.2 Elements for Reform

Thus far, an overview of institutional reform and initiatives to improve buildings has been given. The following gives an overview of two critical elements that are required to support the building process. Planning and development, and materials manufacture and production have a critical role to play in achieving sustainability. If these two components are assessed and deemed as sustainable then there is strong down-line support for the other components and therefore for the implementation and continuation of sustainability throughout the building and construction sector (DHW, 2002d). Once these critical components are in place then the building designer has the necessary structural elements available to deliver a green building.

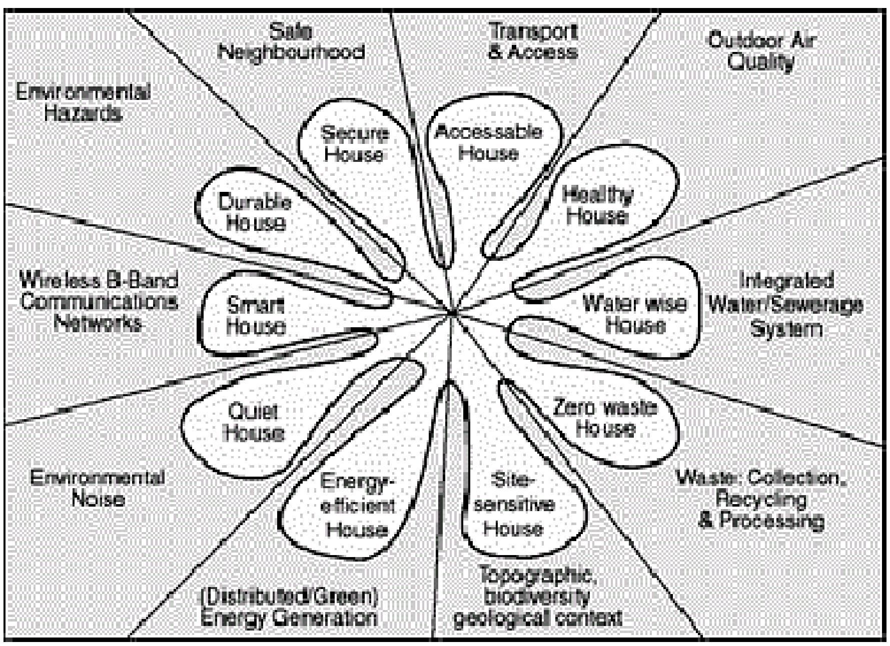
4.2.1 Planning and Development

Some of the greatest opportunities for interventions to bring about more sustainable settlements are through sustainable urban design, such as the design of new settlements, infrastructure, building and facilities (Newton, 2001a).

The decision making process that begins at the level of regional or urban planning, which defines the shape and structure of land development and subdivisions, is essential to ensure the appropriate placement of sites that would support designers in supplying green buildings. There are many sustainability issues that relate to urban form and how the structure of neighbourhoods needs to be defined to influence liveability, transport, employment, and economic and ecological health (DPI, 2001e; UNEP-IETC, 2002a). Community neighbourhoods should be interconnected and clustered to form viable town centres with availability of transport options and proximity to services and employment (Newman and Kenworthy, 1999; DPI, 2000a; Scheurer, 2001).

Urban planning and subdivision building development, whether new or revitalised, are inextricably linked. There are many issues that can be considered in an integrated framework to achieve a more sustainable settlement. Figure 4.2 shows the interlinking of housing to transport, air quality, comfort, and security to name but a few.

Figure 4.2 **SPLASH – Sustainable Planning of Land Use Activity, Subdivision and Housing**



(Newton, 2001b)

In terms of building and construction, a well-planned development will lay the building blocks for a more sustainable built environment (DHW, 2002c). The key relevant parts of this are the development form and block placement, orientation and shape. Form and placement relate to the larger planning issues of liveability such as those covered in planning design codes like 'Liveable Neighbourhoods' (DPI, 2000a**)**. Issues that are specific to design and construction relate directly to solar access and overshadowing, cross-flow ventilation, and also access, security, and privacy. If the building designer, specifically building companies that are operating on tight financial margins (HIA, 2002), are guaranteed that a maximum of residential blocks in any given sub-division or development will meet the criteria for favourable solar access and cross flow ventilation, then the homes can be designed to meet this layout with no or minimal individual variations required, and consequently no or minimal capital cost increases (SEAV, 2001a). Building companies and project home companies often occupy a large percentage of the residential home market and also supply much of lower priced homes for first and second home buyers (HIA, 2002; DHW, 2002d). It is therefore essential that they are supported in supplying a more sustainable product without adversely affecting cost (Barron and Gauntlett, 2001; DHW, 2002b).

Further planning issues relating to sustainability to consider are:

- Urban density and infill
- Environmental integrity and intrinsic worth, including
    - Retention of natural land form
    - Retention of native vegetation,
    - Retention and protection of wetlands or other significant areas

4.2.2 Materials

> *The Holy Grail of the green building movement would be a database in which the life-cycle environmental impacts of different materials were fully quantified and the impacts weighted so that a designer could easily see which material was better from an environmental standpoint* (EBN, 2001, p1).

Materials manufacture and supply is a vast field of research and one that cannot hope to be adequately covered in this thesis. It is therefore only intended to give an overview of the current issues and state of play in this sector.

The use of sustainable materials is an essential element if a building project is to be considered sustainable (EBN, 2001; CfD, 2001a). Typically the building and construction sector enters the materials market at the point of selection and procurement, usually at the design stages. There are critical issues that organisations and designers need to understand if they are to deliver a more sustainable product. It is also important that the designer has both general and specific guidelines by which to make an informed choice. There are some general guidelines in terms of building materials that need to be considered in selection. CIB states that as far as the manufacturing of products is concerned, the significant issues are:

- Reducing the embodied amount of material and energy of the products (renewable materials, low-energy recycling, increasing durability and technical life expectancy)
- Low emissions from products in use (environmentally friendly coatings, pre-treatment)
- Repairability (design for disassembly and repair in the factory) and recyclability (used products returned to their producer; product stewardship)

(CIB, 1999, Sect 3.3.4).

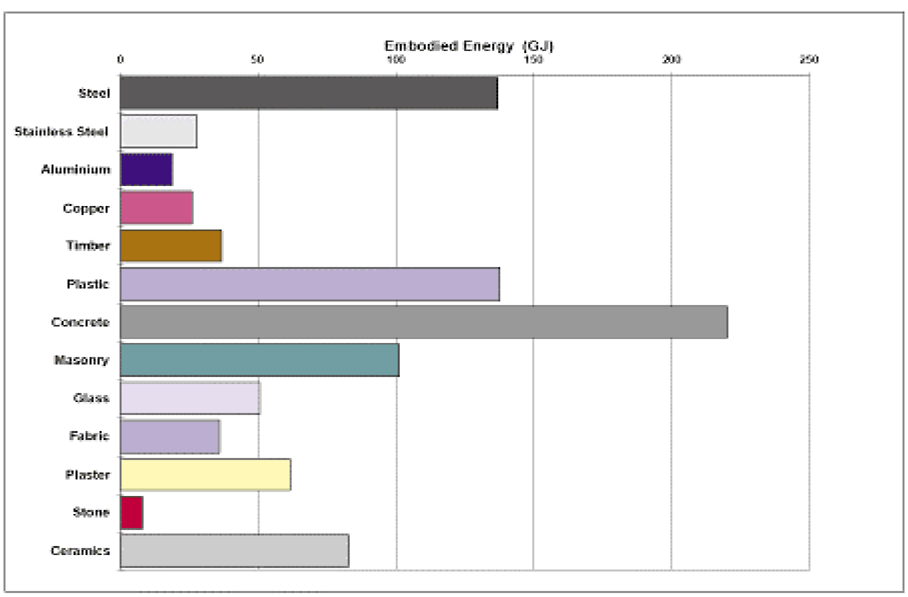
The ‘YourHome Technical Manual’ also suggests a guide list that can be used to reduce the total amount of materials consumed and their environmental impact from building projects:

- **Make** more efficient use of existing materials
- **Minimise** the amount of waste
- **Use** materials with least environmental impact
- **Consider** both operational and whole life-cycle performance of materials and designs
- **Use** fully recycled materials or materials with recycled content
- **Re-use** whole buildings or parts thereof to reduce consumption of new materials
- **Choose** materials with a lifespan equivalent to the projected life of the building
- **Design** to extend building lifespan (current average 50 years - aim for 100+)
- **Design and build** for de-construction, re-use, adaptation, and recycling
- **Encourage** development of new, efficient, low impact materials and applications by creating demand
- **Consider** how and where the materials are sourced and the impacts this causes
- **Minimise** the energy used to transport materials by using locally produced material- use of lightweight material where appropriate also reduces transportation energy
- **Minimise** the energy used to heat and cool the building by using materials that effectively modify climate extremes
- **Understand** how chemicals used in the manufacture of some materials might affect your health
- **Minimise** or eliminate emissions during use and manufacture

(Reardon, 2001).

As useful as these guidelines are, they do not give a quantifiable assessment for the sustainability of the material, such as indicated in Figure 4.3.

Figure 4.3 **Embodied Energy in a House by Volume of Materials.**



(CSIRO, 2002a).

Quantifying a material for sustainability involves a complex web of processes that require a sophisticated level of understanding to make an informed decision (Reardon, 2001; CfD, 2001a; CfD, 2001b; CSIRO, 2002c), and very much depends on the parameters used for assessment (EES, 1998; EBN, 2001). From the building and construction sector's perspective, materials that have undergone a full life-cycle assessment (LCA) and have low embodied energy would be considered desirable, but there are many criteria that can make assessment a complex and confusing task (EES, 1998; EBN, 2001; CfD, 2001a), a point that is accurately explained by the 'Centre for Design' at RMIT University:

By far, one of the most critical factors in considering the environmental impacts of any material is the need to move beyond the material itself and more clearly understand its context, i.e. where and how it's used, maintained, abused, recovered or discarded and dumped. Too often the environmental impact of materials is assessed in isolation from their total context with simplistic comparisons being made about 'material X being greener than material.' Whilst such claims might be true in some instances, there are a range of other scenarios where the reverse can be just as true. Assessing materials without knowing or understanding their full life-cycle environmental impact has the potential to result in a one-dimensional view of how they might impact on the environment and therefore question their ultimate value (in environmental terms) of being specified in the first place (CfD, 2001a).

LCA of materials is a vast area of research that has produced many computer tools in recent years to assess a material or a building component (EES, 1998; Langston, 2001; CfD, 2001a; CfD, 2001c; CSIRO, 2002d). Whilst this new generation of computer tools that have proliferated in recent years has made the assessment of sustainable materials much easier for designers, most buildings that are designed and constructed to be sustainable are limited by the amount and extent of sustainable materials that are available (CfD, 2001a; CSIRO, 2002b). Currently, a comprehensive supply of sustainable building materials is lacking within the sector and 'even in the greenest of projects it is likely that many products will be used that are not themselves green—but they are used in a manner that helps reduce the overall environmental impacts of the building' (EBN, 2001).

Materials that include a high-recycled content are often of the highest priority because the capturing and reuse of waste materials reduces resource consumption, lowers the embodied energy of the material and lessens landfill and associated impacts including potential ground water pollution. There are also emerging trends, especially in the residential markets, to use primary raw materials for construction, mainly straw bails, mud brick, rammed earth and rubber tyres (Earthship, 2002). The use of non-processed and raw materials constitutes an important section of building construction and their applicability and usefulness could benefit from further research (ETC, 2002).

From a building materials perspective, government and government agencies can support sustainability in building and construction through research and development as well as promotion of appropriate materials. Stimulating the development and uptake of these materials is an essential role of government which can involve cooperative research with academia and scientific institutions. This is evidenced throughout Australia with the work of Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australian Greenhouse Office (AGO), Environment Australia (EA) and national Cooperative Research Centres (CRC).

4.3 Conclusion

This chapter has given an overview of the main issues and challenges, as well as responses in the building and construction sector from an institutional and management perspective. It has also been identified that there are some fundamental changes that are required, specifically the integration of all the processes that support sustainable building, and that this sector can take a more comprehensive and integrated approach to achieving a better and more desirable outcome.

It also considered both regulatory and voluntary options that are available to government and which are being implemented in partnership with industry. These regulatory options, mainly in the form of mandatory building codes, whilst achieving valuable change, are usually only focussed on eliminating worst practice. The scope of voluntary options includes many aspects of environmental sustainability and can potentially take the sector much further to achieving significant change. However, these voluntary options lack any rigorous mechanism to measure, assess or verify the success of the initiatives, that is to say they consider the individual components rather than the total package.

This is true also for urban form and materials. Without these two fundamental structural supporting components of building and construction in place the sustainability of the building will be compromised. As with design initiatives, designers and project managers are not necessarily impeded by technology, but rather by the acceptance and accessibility by the sector of new materials and systems components. New technology, such as de-materialisation, stimulates beneficial change, but '*it must also be recognised that while the potential for favourable applications are evident, certain constraints restrict rapid entry into existing markets of the construction sector. Progress towards performance-based specifications holds the key to increased product acceptance and market penetration'* (CSIRO, 2002b). It is important then, that new ideas, like new technologies, are rigorously assessed and proven to assist in their uptake by industry. (CfD, 2001c; Heerwagen, 2002; CSIRO, 2002c). A method of quantifying change is important if this sector is to be, or is seen to be, increasing its sustainable practices and principles, both at the organisational level, as well as the process and product level.

The following chapter will consider how the sector can create a more sustainable product, specifically through the development, application and promotion of green building guides and assessment or rating systems.

Chapter 5 Guidelines and Assessment Criteria for Green Building

A building environmental performance assessment method has a vital role to play in the implementation and realization of sustainable development. It must be integrated into the whole process of planning, design, construction, operation and maintenance of a building project. It is capable of providing market incentives for high environmental performance; prompting more environmentally sound building design, and suggesting environmental performance targets for the building and other related industries

(Lead Liew, Vale et al., 2001).

5.0 Introduction

The previous chapter focussed on organisational and management issues and response initiatives within the sector that must be implemented for a more sustainable product to be achieved. It was found that there is a mixture of actions employed to achieve change, including government legislation and regulations, and voluntary programmes that are mostly in partnership with industry. Whilst these programmes are beneficial in promoting better practice, they have no specific assessment mechanisms to measure changes in performance; therefore their success is not readily quantifiable.

This chapter will look into green building guides and assessment or rating systems that have and are being developed and continue to be implemented throughout the world. These types of programmes are varied in content, scope and application and are generally used by industry professionals: developers, designers and builders (Lead Liew, Vale et al., 2001). Only one assessment programme, NABERS (National Australian Building Environmental Rating System), which is currently being developed, is being specifically designed to be used by both professionals and the general public (Vale, Vale et al., 2001). The main thrust throughout this chapter will be to assess the green building guides and assessment or rating systems to determine their applicability and usefulness in achieving change towards sustainability in this sector. The intention is to give an understanding of how these programmes are used to create a more sustainable green building project by reviewing their main contents.

There are also software programmes and assessment tools that are designed for many applications at the pre-design and design stages. Some give a qualitative measure of building materials and components, including Life-cycle assessment (LCA) and Life-cycle costing (LCC) (EES, 1998; BRE, 2000; CfD, 2001b; CSIRO, 2002d), and others give a simulated rating of thermal energy efficiency of the building envelope (Lead Liew, Vale et al., 2001; CfD, 2001c). These will not be considered further in this discussion because they are concerned only with specific features and components of buildings and not the overall design and assessment of the project.

5.1 Parameters

Sustainability is generally aimed at balancing environmental, social and economic aspects simultaneously. There is some variance in the degree to which green building guidelines address aspects of social sustainability. Currently they are predominantly used as environmental sustainability tools and generally do not contain the broader categories that can encompass the political, social or heritage aspects of the built environment (DPWS, 2001). As stated in Section 1.2, it may require an understanding of all the elements of a comprehensive sustainable building design guide or assessment system to fully appreciate all the aspects of sustainable building and construction. There may be much that is lacking in a guideline or assessment system, depending upon where the parameters are drawn, i.e. does it include social and heritage criteria or even more abstract elements of sense of place and community cohesion? This returns to the familiar theme voiced in previous chapters of the true or full extent of building and construction issues and how much the sector can be expected to influence these issues.

Whilst many green building programmes profess to be sustainable in outlook, they are often limited to environmental sustainability and human health concerns (UMN, 2000). At this point in the evolution of guidelines and assessment criteria for sustainable building and construction and human settlements, the environmental and social are treated as separate assessments. Other more community and sense of place issues are considered in planning guides and community assessment criteria (Bartuska and Kazimee, 1999; DPI, 2000a; ENA, 2002).

There is also an evolving understanding of assessment methods in rating the performance of buildings in terms of the parameters of what they attempt to assess. CIB states that 'the notion of performance can take on different facets due to the various interests and requirements of the actors, and will consider various ranges of environmental sustainability issues, as well as introduce various ways of rating the performance and communicating the results' (CIB, 1999, Sect 3.3.5). Critical to this, other than the parameters chosen for the rating, is the measurement scale used, whether it will be based on simulation, weightings, or actual measurable performance (Lead Liew, Vale et al., 2001; USGBC, 2001).

5.2 Guides to Green Building

Green building guides are a combination of tool kits, resource guides, checklists and design guidelines, which are generally used at the pre-design and design stages and which have varying degrees of detail for use by the project team or designer. They provide the necessary information to create a sustainable building project, and when used by project managers and designers, who desire to apply the holistic concepts that are set out, these tools are invaluable in achieving sustainable outcomes (UMN, 2000).

There are two distinct forms of green building guides. There are broader resource tool kits (GSA, 2000; BEI, 2001; CIWMB, 2001), and there are the more specific design guides that are used to overlay environmental issues on the design, construction, and operation of both new and renovated buildings (UMN, 2000; BCBC, 2002). Although distinct in their application, often the content and usefulness of each has many overlays. Generally the building design guidelines form a component part of the broader resource guides, both of which are often the product of a comprehensive sustainable building and construction initiative (CIWMB, 2001; BCBC, 2002).

5.3 Sustainable Building Tool Kits and Resource Guides

This guide will help you to understand what sustainable development means and how to take advantage of its benefits by making its principles and practices part of everything you do

(GSA, 2000, Introduction).

Tool kits and resource guides provide a comprehensive list of resources of green building requirements and programmes. They are often databases that give information and provide links to specific initiatives and programmes to achieve required outcomes. Usually within these kits are specific green building design guidelines, which will be discussed in the next section. The content and scope of recourse kits can be varied but their purposes are essentially the same; to provide access to useful and relevant information for project managers on all forms of green building.

An overview of a comprehensive green building tool kit from California is given below (CIWMB, 2002). This particular toolkit has been selected as an example because it has a detailed and easily useable format. It also is only one component of a more integrated and comprehensive state government initiative.

The 'California Sustainable Building Task Force' has created the 'Sustainable Building Tool Kit'. It contains detailed information and documents under the following headings:

- Case Studies
- Fact Sheets and Virtual Tours
- Financing
- Links
- Performance Standards
- Product Directories
- Programs
- Publications
- Sample Construction Documents
- Training

Included within each heading are more detailed information links; for example *Fact Sheets and Virtual Tours* contains the following:

Life-cycle Building Phases

- Design and Construction/Renovation
    - Sustainable Building Basics
    - Construction and Demolition (C&D)
    - Project Design
- Post-Occupancy
- Commissioning

Environmental and Public Health

- Air
- Energy
- Materials
- Waste Reduction and Recycling
- Toxins
- Water

Also within this tool kit, under the 'Performance Standards' heading are specific green building guidelines and rating systems:

- Sustainable Building Guidelines
- Rating System (CIWMB, 2002).

This tool kit is only one part of a fuller Californian sustainable building initiative, but forms the interface with all elements of the programme. The toolkit is set-up to be used electronically and each heading and sub-heading has hyperlink references to other key resources and relevant information. For example, under the Publications heading are the policy documents that relate to the 'California Sustainable Building Task Force' and the 'Building Better Buildings Blueprint', which is the foundation document of the whole initiative.

There are innumerable other green building resources guides and toolkits that provide differing amounts of information. They can pertain to such areas as:

- Sector wide issues (GSA, 2000)
- Green Building Development (BCBC, 2002)
- Building Envelope (BEI, 2001)
- Materials (CfD, 2000; CfD, 2001b)
- Office Fit-out (NAEEEC, 2001)

All of these programmes have the aim of improving environmental performance of the built environment within their stated parameters.

Appendix3 shows the contents heading lists of a tool kit and a resource guide

- *California Sustainable Building Tool Kit*
- *Green Buildings BC Resource Guide*

5.4 Green Building Design Guidelines

The Minnesota Sustainable Design Guide is intended to address environmental related concerns by providing a design tool that can inform thinking and decision-making throughout the life of the building—during the design, occupancy, and even next use phases

(UMN, 2000, Overview).

Green building design guidelines set out the framework whereby the designer can put together and combine all the key environmental sustainability components of any project. The systems set out in the guidelines can achieve a significant level of overall sustainability even though some sustainability elements may be lacking. Conversely, some key and desirable elements that are in the design guidelines may be difficult to include in the project due to certain constraints: this is referring to the greater overarching issues of urban form as well as the availability of local green building materials. This again highlights that these two critical elements must be in place if all sustainability objectives are to be achieved. Design guidelines also have a broad role in stimulating the uptake of green buildings and therefore need to be flexible and adaptable enough to make the process easily accessible as well as acknowledging differing priorities and needs. To that end well structured design guidelines should be structured to meet multiple needs, such as those set out in Figure 5.1.

Figure 5.1. **Goals of the Minnesota Sustainable Design Guide**

- Educate designers, building owners, operations staff, and occupants about the concepts, goals, and significance of sustainable design
- Develop an orderly decision-making process with measurable outcomes along with a database of decisions and outcomes on each project
- Provide flexibility in the way priorities are set and outcomes are measured within the system so it can be adapted for ***different*** clients or agencies, regions, and building types
- Organize information in a hierarchy that permits users to easily understand the entire process but then allows them to go into more detailed information as needed to implement the system
- Create a system that can easily grow and change as more experience and new information becomes available

(UMN, 2000).

Green building guidelines are designed to create an end result that is environmentally sustainable. They set out the criteria that if followed will ensure a satisfactory performance level that the project manager or designer can achieve, either by fulfilling a checklist or from their own creative design possibilities.

Design guidelines are themselves intrinsically linked to assessment systems for rating environmental performance. They give recognition to each individual component that an environmental building rating system would assess. The design guides are project based in that they set out requirements that must be fulfilled within certain categories, and often include a simple checklist (SAC, 2002) or a more detailed performance assessment (QDPW, 2000; DPWS, 2001; HBA, 2001; NAHB, 2002c) that the design team can use to track their level of progress and success. The checklist can be as basic as a tick, but more often a numerical score is given for each category and sub-category that is fulfilled.

A checklist that has a point score informs the project team or designer of their level of achievement, but this system of ticking or numbering boxes to rate sustainability is contentious because it can give the false impression that if all the criteria are met the project is somehow sustainable (Vale, Vale et al., 2001, Sect 4.0). This issue of compliance and assessment highlights both the level of complexity that green building projects can require and also the difficulty of how best to assess sustainability, particularly at the design stages. Checklists, if used with awareness and an understanding of what true sustainability means, can nonetheless be useful. They need to be taken within the perspective and context of what the guidelines are trying to achieve; usually a result which can give a measurable figure by which to rate the sustainability of the project outcome. This point highlights the important issue of how to create a meaningful and objective assessment of sustainability by the use of a scoring system. The NABERS system is also measurable but comes from a different perspective than ticking boxes as a check list and will be covered later in the chapter.

5.5 Elements of a Green Building Programme

The components or contents of green building programmes are well defined and have a general consistency throughout (Lead Liew, Vale et al., 2001; NAHB, 2002c), although they often have different key categories, headings and parameters based on their stated aims and objectives. They also have different levels of detail that are required. They may take the form of a simple and broad checklist (EBN, 1999; EBN, 2002), a more comprehensive design guide (BRE, 1999; UMN, 2000; DPWS, 2001; BEER, 2002; Cole and Larsson, 2002) or an assessment tool used for new and/or existing buildings (BRE, 1999; USGBC, 2001; Vale, Vale et al., 2001), whether they are residential, commercial, institutional, or industrial. Table 5.1 shows a contents list of typical green building programmes, which also indicates the breadth of issues covered.

Some programmes might cover all these elements but use a different set of headings. This is evidenced in the both the GBTool, which resulted from the Green Building Challenge (Cole and Larsson, 2002) and also the NSW EPGB (Environmental Performance Guide for NSW Government Buildings), whose framework was closely based on Green Building Challenge (DPWS, 2001).

Table 5.1 **Typical Elements of Green Building Programme**

Site Development	Energy Efficiency (Site)
Energy Efficiency (Envelope)	Energy Efficiency (HVAC)
Energy Efficiency (Appliances/Lighting)	Resource Efficiency (Design)
Resource Efficiency (Material Selection)	Indoor Air Quality
Water Efficiency	Waste Management
Landscaping	Land Development
Home Owner's Manual	Business Operation

(NAHB, 2002b).

GBTool addresses six performance issues to give an environmental assessment:

1. **Resource consumption**- related to the depletion of natural resources including energy, water and land
2. **Loadings**- related to the outputs of the construction process, building operation and demolition that place stress on the natural environment
3. **Indoor environmental quality**- related to the building features that can affect the health and comfort of occupants
4. **Quality of service**- related to the features of the building that influence adaptability, flexibility, maintainability and general control of the building
5. **Economics**- related to the life-cycle cost of buildings
6. **Pre-operations management**- related to the maintenance and operation policy that enhances environmental performance of buildings

(Cole and Larsson, 2002).

GBTool (also discussed in Chapter 2) has the diversity of being used as a simplified assessment method in order to encourage market demand for green buildings, as well as providing a detailed assessment of buildings, and also as a design tool.

The NSW EPGB is an environmental building guide that was developed by drawing on existing green building design guides and assessment frameworks, as well as the environment guidelines from the Sydney 2000 Olympics and is structured under five headings:

1. Resource Consumption
2. Environmental Loadings
3. Quality of Internal Environment
4. Functionality
5. Wider Planning Issues

The EPGB is an example of what the GBTool was designed to achieve, that is, to provide a design guideline and an assessment framework that can be adapted for specific uses and needs. Many programmes have been designed by drawing on existing bodies of work and are continually evolving. The GBTool which was created as a benchmark for participating members to design their own assessment was itself designed from a number of existing methods (Cole and Larsson, 2002). In turn GBTool is used as the basis for the development of local green building programmes (UMN, 2000; DPWS, 2001).

Appendix 4 shows the heading and sub headings of two sustainable building design guides:

- *Your Home Technical Manual*
- *Minnesota Sustainable Design Guide*

5.6 Rating Assessment Systems

The ratings produced by the system are designed to report the reality of the situation of a building as it exists, so are not based on simulations

(Vale, Vale et al., 2001).

Building environmental rating systems are tools which attempt to give an assessment of the entire built project that has been initiated and directed within an integrated sustainability framework. While in the planning, design and construction phases, the green building project was only assessed on simulations of how the finished product might perform. The simulation software tools that are used during the design stages of the building process are invaluable in assessing potential performance but they are unable to determine future occupant behaviour. ‘A clear relationship between simulation and building performance is difficult to achieve’, especially across varying climate zones, and is therefore unable ‘to report on the reality of the situation of a building as it exists’ (Vale, Vale et al., 2001, Sect 4.6). Once in the commissioning and occupancy phases however, the building has moved from a conceptual project to become a functioning and therefore assessable built environment. This is at the point when the building begins to be used and the systems become active, and when the actual performance can be measured and assessed.

This is when the actual rating system can be most useful. By assessing both the constructed building systems, including the site and the building fabric, and how the user or occupant operates the building systems as well as their own behaviour habits, a true reading of the building environment is achieved (Vale, Vale et al., 2001, Sect 6.2). Whilst much of the building might have been designed and constructed to operate on passive systems, there are usually active mechanical systems (certainly in large commercial projects) that are required. It is important to recognise though, that the occupant or user is an active component in any built environment, and how they choose to work with the sustainability components embedded within the project is a key determinant of the project's longer term success (Shipworth, 2000; Scheurer, 2001).

Most rating systems miss this critical issue because they are structured to give an assessment through the design and construction phases only. Even so, the criteria that are included in the assessment are extensive and have a strong focus on indoor air quality to ensure occupant health.

5.7 Implementation Issues

There are a number of issues that need to be considered in the implementation of these programmes and their effectiveness in achieving meaningful and lasting change. The focus of this section is on how a green building design guideline or assessment system can gain market prominence as well as be effective in progressing sustainability in the built environment. The issues have been grouped under the following headings:

- Costs and Complexity
- Assessment Compliance
- Priorities
- How to Score Sustainability Performance of Buildings

5.7.1 Costs and Complexity of Application

These programmes are being implemented on a voluntary basis, generally through government and industry partnership. Even though they are voluntary, one of the greatest impediments to the take up of these programmes is the perceived added complexity and workload, and hence cost, at the pre-design and design stages in achieving a product that complies with the programme's stated aims and requirements.

The structure of the building industry is such that many companies are small partnerships or operate on extremely tight competitive margins (CIWMB, 2000; DHW, 2002d). As a consequence, the time and costs associated with training and assessment may make them inaccessible for many building companies, both large and small (HIA, 1999b; USGBC, 2001).

The LEED systems in the US, which rates new commercial construction, major renovations and high-rise residential buildings, has recently undergone a significant review to make it more user friendly and cost-effective because it was realised 'that the certification process itself—particularly the documentation—was perceived as costly and unwieldy in many of its requirements' (USGBC, 2002). The costs of receiving a full LEED certification were in the order of $US30-60, 000 due mainly to lack of full understanding of the information requirements, as well as higher design and consultation fees. Even design guidelines for residential projects require additional input time and documentation to fulfil the project requirement.

The issue of cost and complexity also extends into other initiatives associated with sustainability, such as environmental managements systems (EMS) and public environmental reporting (PER). Simplicity of application will reduce both costs and time and will therefore support the uptake of green building programmes (Vale, Vale et al., 2001).

5.7.2 Assessment Compliance

Builders use these as guidelines or indicators of what can be achieved in terms of sustainability. In some cases it is not possible for them to achieve what the design guide or the rating requirement sets out. Two typical examples of this relate to site issues and materials.

Many programmes award a higher score for brown-field or black-field development (or re-development) than for green-field development. Since many building companies have no control over the planning or development process and are required to build where their client's land is located, they consistently fail to achieve this element of the programme. Therefore, where the assessment criteria asks for inner urban or infill development, the development is not able to comply.

Another compliance issue is the selection of appropriate materials. Whereas some regions have available green building materials, whether they are recycled or are recyclable, others are very much controlled by the dominant building materials market. An example of this is in Western Australia where the vast quantity of building is from clay bricks mined and manufactured locally (DHW, 2001).

These issues are not the fault of the design guide or assessment system, rather they are a sustainability issue that these programmes signal to the industry and the sector as a whole. It highlights that sustainable building and construction requires a whole sector commitment to achieve a significant outcome.

Another aspect of compliance also relates to the voluntary nature of the programme. The Australian residential building industry is currently promoting the 'GreenSmart' programme, which involves designers and builders being given a two day training in environmental design and construction, after which they receive a GreenSmart accreditation (HIA, 1999a). Whilst this programme is acknowledged as being beneficial there is no clear record or measure of compliance standards. The result is that the GreenSmart label can be attached to a project regardless of the number of green components included. This contrasts with other programmes where all builders have some mandatory requirements that have to be achieved (HBA, 2001; GAHBA, 2002; NAHB, 2002c).

5.7.3 Priorities

An element of green building programmes is the method of deciding which priorities to include and how to rate the issues that would have the greatest environmental and social benefits (EBN, 1995). This is an issue for a number of reasons. Whilst all elements or requirements of green building programmes are important, there are some that can be easily attained for minimal cost that would give great benefit. Other issues may be highly critical to a particular region that guidelines might not acknowledge, whilst a global issue such as the enhanced greenhouse effect may be critical now, but may become less important in the future (Vale, Vale et al., 2001). Listing priorities often holds some subjectivity for a number of reasons and the issues that professionals deem as important can differ from the public's perception of critical issues. Table 5.2 shows a priority list based on a survey of industry professionals.

EBN (Environmental Business News) states that in defining priority issues 'we first need an understanding of what the most significant environmental risks are, and that these may be global in nature, or more specific to the particular region or site' (EBN, 1995). A professional might therefore have a broader or global picture of issues, whilst the general public's perception could well be more locally based.

Table 5.2 **EBN's Priority List for Sustainable Building**

1. **Save Energy:** Design and build energy-efficient buildings
2. **Recycle Buildings:** Utilize existing buildings and infrastructure instead of developing open space
3. **Create Community:** Design communities to reduce dependence on the automobile and to foster a sense of community
4. **Reduce Material Use:** Optimise design to make use of smaller spaces and utilize materials efficiently
5. **Protect and Enhance the Site:** Preserve or restore local ecosystems and biodiversity
6. **Select Low-impact Materials:** Specify low-environmental impact, resource-efficient materials
7. **Maximize Longevity:** Design for durability and adaptability
8. **Save Water:** Design buildings and landscapes that are water-efficient
9. **Make the Building Healthy:** Provide a safe and comfortable indoor environment
10. **Minimize C&D Waste:** Return, reuse, and recycle job-site waste and practice environmentalism in your business
11. **Green Up Your Business:** Minimize the environmental impact of your own business practices, and spread the word

(EBN, 1995).

5.7.4 How to Score Sustainability Performance of Buildings

As mentioned previously, the issue of assigning a score to provide some measure of sustainability is contentious and is relative to the framework or parameters that are used. There are many intangible or abstract elements that are difficult to attach a direct measure to, such as individual and social well-being: even so, a green building can provide many aspects that will enhance the prospects of achieving these intangibles. These include interior environmental quality and accessible design, both of which can be assessed on their relative merits.

A scoring regimen that rates sustainability characteristics in buildings should be universally recognisable and remain consistent and relevant for the life of a building, which can be between 50-150 years or more, even if some of the assessment criteria or priorities change over time (Vale, Vale et al., 2001, Sect 4.2). There are many environmental rating systems for building and construction that are in use throughout the world which use a variety of scoring or assessment methods (Lead Liew, Vale et al., 2001).

These include:

- Assessment measured against current best practice
- Weightings based on perceived importance of issues
- Simulations of probable performance measured against a base building
- Actual measurements of performance based on the reality of the situation (EES, 1998; BRE, 1999; Lead Liew, Vale et al., 2001; USGBC, 2001; Vale, Vale et al., 2001; SEAV, 2001a; CfD, 2001c; Cole and Larsson, 2002).

Best Practice Benchmarking is a method is to create a performance level measured against existing best practice, thus setting a progressive benchmark to compete against. The GBTool is modelled on this method (iiSBE, 2002). The reference buildings and practices are not based on any regional influences but these core component references are able to be adapted or manipulated to suit regional requirements. This system of benchmarking hypothetical buildings, which is based on current based practice, is structured on weightings of categories.

A number of assessment systems determine the sustainability score by assigning weightings to each environmental initiative within the programme (BRE, 1999; USGBC, 2001; Cole and Larsson, 2002). The assigned weighting is a numerical value based on the perceived relative importance of each particular environmental issue, as determined by a body of experts in interest groups. Although there may be agreement on which issue is of higher priority than another, there can still be problems and concerns of subjectivity based on regional or time specific criteria, as well agenda based interests. Whilst much of the concern may be genuinely environmental, nonetheless, government, industry or public concerns might influence the outcome. Most critical though is how the overall assessment of the building project will be affected if the perceived importance, and consequently the weighting, changes over time.

Simulations are based on computer modelling of how a building envelope might perform within chosen design parameters. They are used only at the design stage, commonly for energy performance. Whilst it is acknowledged that these tools are invaluable in achieving an improved product, they are unable to accurately predict actual performance, and they cannot know how the user or occupant will behave within the building (Lead Liew, Vale et al., 2001).

Another method of assessing a project's degree of sustainability is to report on the reality of the situation, rather than measuring against a hypothetical benchmark or reporting on how a simulated design might perform. This system would create a 'set of goals and targets to be met' which would be able to 'define a desired state of building and the buildings' ability to deliver services' (Lead Liew, Vale et al., 2001 Sect 1.4.2). The assessment score would then be measured against this set of goals. NABERS is currently being designed around this type of assessment. The authors have extensively reviewed existing assessment methods to determine a system that can be rigorous in assessment as well as remain relevant as priorities change over the lifetime of building. NABERS will be covered in detail in the following chapter.

5.8 Conclusion

The topics covered in this chapter- tool kits and resource guidelines, and building design guides and assessment systems- are the nuts and bolts of achieving sustainable green building. They are all key functional and usable components that the organisational level of the sector, both government and industry, need to deliver to the industry professionals in order for them to provide a more sustainable product.

The resource guides are required to determine the most appropriate design tools for any project, whether it be commercial, industrial, educational or residential. The sustainable or green building design guides are the essential tools to guide industry professionals throughout the full life-cycle of any project, in order to deliver a high performance green building. They are arguably most useful at the pre-design stage, but are invaluable in being able to monitor the progress of the project and to know that it will achieve the desired outcome. The assessment tools are also useful throughout the pre-design and design stages but are specifically used to determine a true measure of the ‘as constructed’ built environment.

This chapter has emphasised that these functional components of green building projects are well developed and easily and freely accessible through the internet. This format is expedient for the rapid dissemination of these programmes and also allows for them to be updated as necessary. In terms of instigating a new green building initiative, many of these resources are designed to be adapted for creating programmes that are specific to a regional area.

A number of issues were also covered in regard to the design guides and assessment systems. Specific to the uptake of green building practices was the additional work load required and associated costs to both implement and comply with green building requirements. Most programmes are voluntary and only a few have mandatory requirements to achieve a compliance certificate. Whilst this voluntary system achieves some degree of market change whilst also avoiding government regulatory intervention, there is no mechanism for consistently achieving high performance buildings other than via client demand, which in itself is fraught with issues because of lack of understanding of what constitutes a high performance green building. This therefore raises the issue of defining the criteria of sustainability in buildings and being able to assess or rate green buildings. Green Building assessment systems were discussed in some detail in this chapter with a focus on the best way to rate the performance of the buildings. It was suggested that whilst weightings and simulations are useful during the design phases of the project, a system that rates both the performance of the buildings and the behaviour of the user or occupants can give an accurate measure of how sustainable a building actually is. Such a system is NABERS.

Chapter 6 will give an assessment of the draft NABERS system. Two case studies, an existing residential building and a new commercial building, have been assessed using this system to determine their sustainability characteristics, and also to assess how well NABERS achieves its stated aims.

Chapter 6 NABERS and Case Study Assessments of Green Buildings

The NABERS team consider that the long-term purpose of a building environmental rating system must be to encourage improvements in the environmental performance of buildings. The purpose of this is to reduce, and one day to eliminate, the adverse effects that the procurement and operation of buildings in Australia have on the natural environment of Australia and of the world

(Vale, Vale et al., 2001, Sect 1.1).

6.0 Introduction

This chapter deals specifically with the draft NABERS (National Australian Building Environmental Rating System) rating system and the case studies of a commercial site and a domestic residence that were conducted using this system. The aim of this chapter is to discuss both the case studies in terms of their environmental performance, and also how the assessment system itself performed, i.e. did the system achieve its stated objectives?

The two case studies are both situated in the southern suburbs of Perth, Western Australia. The commercial site is the new building complex at the Environmental Technology Centre (ETC) at Murdoch University. The domestic site is a suburban residential home in Snook Crescent, Hilton. They will henceforth be known as 'the ETC' and 'Snook residence' respectively. A brief description of each case study is included in Section 6.5. Note: the Snook residence is owned and lived in by the author of this thesis.

Appendix 5 provides a description of both buildings and the full data of these case studies, and should be viewed to complement this chapter.

The NABERS system referred to in this chapter is the final ***draft*** version from December 2001 (Vale, Vale et al., 2001), which is currently under review following stakeholder feedback. The necessary tables and scoring criteria were drawn from the draft document and adapted into a usable format for use on the case studies. This draft version was in a suitably complete form for conducting case studies and to achieve meaningful results.

6.1 Overview

The NABERS project aims to develop Australia's first comprehensive Building Environmental Rating System. It was commenced in April 2001 with funding from Environment Australia and is being developed by a team from the Universities of Auckland and Tasmania (EA, 2001). The principal project authors are Dr Robert Vale, Professor Brenda Vale and Professor Roger Fay. All are sustainable design experts and registered architects.

A key objective in developing this environmental rating system is to create a tool that can provide information on the sustainability of our existing building stocks and promote a better understanding of how we see and live in the built environment (EA, 2001). This should lead to greater demand and investment in sustainable building alternatives. To further these objectives, the system is being designed for use by both professionals and the general public without the need for specialised assessors.

The scope for developing NABERS includes:

- Evaluating Australian and international building environmental rating systems and energy rating systems and analysing their strengths and weaknesses
- Formulating an Australian Building Environmental Rating System
- Developing a strategy for implementation (EA, 2001).

It was determined that in the formulation of this system the following issues would have to be considered:

- **Prioritising of environmental impacts**; and allowance for re-prioritising over time, if required
- **Rigorous assessment** that is based on actual measurements, i.e. no subjectivity, or predictive simulations
- **Performance based assessment**, rather than relying on checklists or prescriptive codes, to allow for creative solutions and deeper understanding of environmental issues. Prescription can stifle creativity and can impede the introduction of emerging construction technologies
- **Adaptability** to allow the system to be updated to take account of changing environmental, social, and economic factors
- **Ease of application** and avoidance of complexity to allow the system to be available to a wide audience, both professional and public, and also to reduce assessment costs
- **Aspirational scoring** to achieve an 'aspirational quality' of targets to aim for rather than a predetermined number to beat. This addresses the issue of how to rate sustainability and what constitutes an acceptable outcome
- **Parameters of application**, whether to assess only buildings or to include wider infrastructure such as planning and supply of essential services
- **Point of Application** determines the effectiveness of the system, whether its is at pre-design, design, or occupancy
- **Public Profile** that will allow NABERS to become a widely known and well understood system (EA, 2001).

The development process led to the release of the final draft for NABERS in December 2001, which was followed by consultation with broad stakeholder interest groups.

6.2 Elements of the System

NABERS is designed around three basic principles:
1) All buildings of all types in Australia could be rated by NABERS
2) It will be capable of rating both new buildings and existing buildings
3) Ratings will be carried out at yearly intervals; each successive rating will signal where improvements can and are being made

NABERS is a ‘broad brush’ tool, which gives a rating of the overall environmental impact of a building. Many of the criteria have a social element as well as environmental, e.g. transport. It is not intended as a detailed tool for environmentally sustainable design. However it can be used at the design stage, because it provides a list of necessary criteria for achieving sustainable buildings, as well as performance targets for designers to aim at. It is designed to be used without the need for specialist assessors, thereby allowing considerable cost saving for the user. The system is structured as a series of questions that can be answered by the designer, owner or user. These questions are divided into two types:

- Basic fabric of the building as constructed (Building questions)
- The way that its users operate the building (User questions)

The NABERS system has some distinctive elements, specifically:

- It combines two distinct scoring criteria to produce an assessment that gives both a measure of environmental sustainability as well as indications of specific deficiencies that might be rectified
- It is purely a performance based tool. The authors believe that prescriptiveness stifles design creativity and that there are many different solutions to achieve a desired performance level
- It sets a high and challenging assessment threshold and is designed to give designers and all users something to aim at rather than a number score or checklist to beat
- It rates actual performance and does not rely on simulation or weightings that are measured against standing best practice

(Vale, Vale et al., 2001).

6.3 Main Headings and Sub-Headings

The system is structured under eight main headings with a number of sub-headings in each, and with questions pertaining to either building fabric or user behaviour. Figures 6.1 and 6.2 show all the main headings and sub-headings of the commercial and domestic ratings respectively.

Figure 6.1 **NABERS Rating: *Commercial***

Applies to any building that is not "domestic". Does not include buildings whose principal purpose is to house an industrial process as it is assumed that the dominant environmental impact of such buildings will be from the process itself.

Land

- Nature of site (Building) *for buildings **under** three years old*
- Total site area per m2 of building total floor area (Building)
- Total site area per building user (Building)
- Area of site planted with beneficial plants (User)
- Impermeably paved area of the site (Building/User)

Materials

- Cost of building per m2 of floor area (Building)
- Materials types for structure, walls, floors and roofs (Building) *for buildings **under** three years old*
- Building age (Building) *for buildings **over** three years old*
- Time since last major internal re-fit (User) *for buildings **over** three years old*

Energy

- Energy efficiency – total energy consumption in kWh/m2
- Greenhouse emissions of the whole building (Building/User)
- Greenhouse emissions for high performance buildings (Building/User)
- Renewable electricity use (User)
- Buildings that generate more energy than they use (Building)

Water

- Water consumption (for whole site) from public supply per person (User)
- Source of on-site water supply (Building)

Interior

- Nature of internal fit-out, equipment and operation (Building/User)
- Percentage of workplaces within 5 metres of a window (Building)
- Percentage of workers able to control light levels at their workplace (Building)

Resources

- Total building area per person (Building)
- Intended use of building – number of hours per day (User)
- Intended use of building – number of weeks per year (User)

Transport

- Distance to nearest local shop (Building)
- Distance to nearest urban centre (Building)
- Number of car park spaces provided on site (Building)
- Distance to public transport (Building)
- Provision of bicycle facilities (Building)

Waste

- Provision of on-site recycling facilities (Building/User)
- Provision of local collection for recyclables (Building)
- Wastewater re-use (Building)
- Use of more sustainable sewage treatment system (Building)

(Vale, Vale et al., 2001).

Figure 6.2 **NABERS Rating: *Domestic***

Applies to buildings used as a home, including houses, apartments, units, co-housing

Land

- Nature of site (Building) *for buildings **under** three years old*
- Total site area per m2 of building total floor area (Building)
- Total site area per person (Building)
- Area of site planted with beneficial plants (User)
- Impermeably paved area of the site (Building/User)

Materials

- Cost of building per m2 of floor area (Building)
- Material types for structure, walls, floors and roofs (Building) *for buildings **under***
- *three years old*
- Building age (Building/User) *for buildings **over** three years old*
- Time since last major internal renovation (User) *for buildings **over** three years old*

Energy

- Energy efficiency – total energy consumption in kWh/m2
- Greenhouse emissions of the whole building (Building/User)
- Greenhouse emissions for high performance buildings (Building/User)
- Renewable electricity use (User)
- Buildings that generate more energy than they use (Building)

Water

- Water consumption (for whole site) from public supply per person (User)
- Source of on-site water supply (Building)

Interior

- Nature of internal fit-out, appliances and operation (Building/User)

Resources

- Total building area per person (Building)
- Intended use of building – number of weeks per year (User)

Transport

- Distance to nearest local shop (Building)
- Distance to nearest local supermarket/bank/post office (Building)
- Distance to nearest urban centre (Building)
- Use of alternative means of transport for the journey to work and school (User)
- Total number of cubic centimetres of engine capacity per occupant (User)
- Annual kms driven per household (User)

Waste

- Use of on-site composting facilities (User)
- Provision of on-site recycling facilities (Building/User)
- Provision of local collection for recyclables (Building)
- Use of more sustainable sewage treatment system (Building)

(Vale, Vale et al., 2001).

Although all main headings remain the same for both, there are some differences in the sub-headings. NABERS Commercial also has three additional questions under ‘Interior’ and ‘Resources’ which relate to location and personal control of work stations, and hours of use per day respectively. Consequently the total points attainable for the commercial rating are 150 and the domestic rating total is 140 points.

6.4 The Scoring System

The NABERS scoring system has some innovative features designed to ensure the ratings are rigorous and will remain relevant for the life of the building (refer Section 5.7.4).

NABERS assessments result from actual measurements that report the reality of the situation as it actually exists. It is a reporting system that does not have to rely on weightings or simulations because it assesses newly occupied and existing buildings. Even so, there are a variety of design tools available for designers, including energy simulations, that can assist in achieving high performance green buildings that might be able to score well across all categories (CfD, 2001b; CfD, 2001c).

The scoring system has a dual rating assessment that results in a simple overall percentage and a NABERS medal. The single score is determined by adding the total of each sub-heading which is then expressed as a percentage of the total possible score (see Figure 6.3). For the two case studies, the ETC scored 100 points of a possible 150, thus achieving 66%, and the Snook residence scored 72 of a 140 maximum, thus achieving 51%.

Figure 6.3. **The NABERS Domestic Rating System**

Fill in your total scores under each Heading in the list below (the scores from the line marked TOTAL in the scoring box at the end of each Heading). Then add all eight scores to get your basic NABERS score. TOTAL for Heading 1: LAND
TOTAL for Heading 2: MATERIALS
TOTAL for Heading 3: ENERGY
TOTAL for Heading 4: WATER
TOTAL for Heading 5: INTERIOR
TOTAL for Heading 6: RESOURCES
TOTAL for Heading 7: TRANSPORT
TOTAL for Heading 8: WASTE
BASIC TOTAL
Convert to a percentage: **BASIC TOTAL divided by 140, then multiplied by 100** **%NABERS SCORE**

(Vale, Vale et al., 2001)

While the single score gives an indication of relative achievement, it provides no information on the spread of the score across the main headings. For example, either building may have achieved high scores in certain categories, and achieved low or no scores in others. Therefore, in terms of sustainability, there may be some significant impacts that are not made apparent in the single score. To address this problem, at least to some extent, NABERS awards medals based on how well a building is rated across all main headings. Figure 6.4 indicates how these medals are awarded. It can be seen that a building will have to perform well across a wide range of assessment criteria to achieve any of these medals. To gain a green medal, at least one star will have to be attained in each main heading category.

The authors state that these medals have been made deliberately hard to win because it is intended that the NABERS medals have value, just as a bronze, silver or gold in the Olympics has value (Vale, Vale et al., 2001). For the case studies, the ETC building achieved a NABERS Green medal, scoring an average of 1.6 stars for 'Transport'. The Snook residence scored 0 stars for 'Water', therefore achieving no medals and receiving a NABERS Basic.

Figure 6.4 **NABERS Medals**

- If **no stars or half a star** are earned in any category, the total score is described as "NABERS Basic". However, if a building earns scores of at least **one star** in each category, it will qualify for **"NABERS Medals**" as set out below.

NABERS Green

- A building must earn at least **one** star in each main heading to have the right to a "NABERS Green" rating

NABERS Bronze

- A building which earns at least **two** stars in each main heading will earn both its overall score, and the title "NABERS Bronze"

NABERS Silver

- A building which earns at least **three** stars in each main heading will earn both its overall score and the title "NABERS Silver".

NABERS Gold

- A building which earns at least **four** stars in each main heading will earn both its overall score and the title "NABERS Gold".

NABERS Platinum

- A building which earns at least **five** stars in **four** main headings will earn both its overall score and the title "NABERS Platinum".

(Vale, Vale et al., 2001)

This dual scoring system achieves a simple yet comprehensive sustainability assessment that clearly shows how well a building and also the occupant performs whilst simultaneously 'exposing' the deficiencies. It would then require a fuller review of each category to ascertain where these failings occur and if any improvements can be made. As subsequent annual assessments are carried out, progressive improvements can be tracked.

The other important factor that has been considered by the authors is how to ensure that sustainability assessments remain relevant over the life of a building, which could vary from 50-150 years or more. The method of expressing the single score as a percentage means that if assessment categories are changed, the overall percentage will remain constant. This allows for additional categories or sub-headings to be added if necessary as the system becomes more detailed over time, without substantially changing the overall rating, thus allowing newer ratings to be meaningfully compared with earlier ones (Vale, Vale et al., 2001, Sect 4.3).

The critical factor for NABERS though, is that both the building itself and the occupant or user behaviour are assessed simultaneously. This combination is fundamentally important in progressing greater awareness and deeper understanding of the impacts of human behaviour on the built environment as well as the broader sustainability of the planet. In this sense, NABERS is both an assessment tool as well as an educational tool. The building questions and user questions alert both professionals and clients to the range of environmental issues in the built environment, and highlight the requirement of having to plan, design and assess any project in an integrated and holistic manner. Certainly in terms of design, giving serious consideration to user requirements can increase the possibilities of achieving a sustainably built environment.

6.5 Assessing the Case Studies

This assessment will discuss the deficiencies in each case study as identified by NABERS. It will give an assessment of how well the system is able to track sustainability issues and what it misses or is unable to rate. It will also question the systems parameters and the assessment criteria of selected sub-headings.

A brief description and photographs of the ETC (see Photo 6.1 & 6.2), and Snook residence (see Photo 6.3 & 6.4), are given to orientate the reader with each case study.

Appendix 5 contains full descriptions and assessments of both case studies

The ETC. The new buildings complex is located at the South Western corner of the 1.7ha ETC site. There are three buildings, administration, and a wet and a dry laboratory, which total $200m^2$. The three buildings have been interlinked by a courtyard which is intended to be used as an activities area and meeting place. This 'outdoor' site will make use of Perth's moderate climate. The total outdoor area is $200m^2$. For the purposes of this assessment the total building area is considered $400m^2$ and the site area that bounds the newly constructed buildings and linked courtyard equals $1080m^2$.

Photo 6.1

ETC Courtyard, looking north to administration and office building. Note: large windows on south side for diffuse daylighting. Also, covered walk-ways for weather protection. The dry lab is to right of picture.

Photo 6.2

Office building, looking at north wall. Note: small glass area on north side, PV arrays, solar hot water system and rammed earth walls. Lawn is reticulated with grey water. Bio-max sewerage treatment is shown at foot of picture.

Snook residence. The Snook residence, situated in the suburb of Hilton in the City of Fremantle, was developed in the early 1950s. The original house design and materials are typical of this suburb, which is timber frame with asbestos cladding, fibreboard wall lining, timber floors and tiled roof. This type of building has extremely poor thermal capacity and the suspended floor contributes to this situation, as does the local topography which had the west wall exposed to full summer sun. A recent home extension saw two new rooms added along the western wall of the original house. Insulation has been added to the original house, as have additional windows to the north wall. The total site area is $790m^2$ and the total house area is $126m^2$.

Photo 6.3

Snook residence front entrance. New extension is lower, on left side of picture.

Photo 6.4

Rear of house, looking at north wall. New extension to lower right. Note pergola roof has reverse pitch to capture additional winter sun. Ponds are at lower right, for summer cooling from westerly winds, vegetable garden at foot of photo.

6.5.1 Case Study Assessment by Main Headings

This section is intended to work through each main heading discussing issues that arose as well as the efficacy of the NABERS system in assessing and addressing the complexities of these two case studies. The issues raised will also be related to the built environment in general. Following this will be a discussion of some critical issues that were identified in the case studies. Included is a score for each site, which is a percentage of the maximum stars achievable within each heading category.

Heading 1. **Land.**
Score. ETC. 48%. Snook. 45%

This heading covers a variety of issues related to location of new developments, size of site per building area, size of site per person, as well as biodiversity and permeability.

Both sites were penalised for having a small built area relative to their land areas. As a new building, the ETC was assessed as urban infill. Although favourably located in the greater urban form, both buildings were assessed as occupying too great an area of land, both in terms of building area and persons per total site area. This clearly signals issues of urban density, infill and sprawl. Both sites have beneficial plants and also high permeability, for which both achieved high ratings.

Urban form and density are critical in the sustainability debate and need to be questioned wherever possible. This heading adequately succeeds in highlighting these issues and the broader issue of ecological footprint, i.e. how much land each human needs to occupy relative to their situation and needs.

Heading 2. **Materials**.
Score. ETC. 90%. Snook. 40%

As indicated in Chapter 4, Materials is a vast topic which is difficult to adequately cover under a single heading. As such, there are specific areas that NABERS explicitly chooses not to cover, such as recycled materials and construction waste. The contrast between the two case studies indicates that this heading is successful in achieving a meaningful assessment.

In having both low construction costs per m^2 as well as performing strongly in choice and use of materials, specifically recycled aggregate, including crushed bricks, fly ash and glass gullet in the concrete slab and rammed earth walls, the ETC achieved a very high rating (ETC, 2002).

Of significance for the Snook residence, which was recently renovated, is that it scored nil stars based on the time since last major renovation (<1yr). Whilst frequent renovations contribute to resource depletion, the renovations and extension adds to the thermal capacity of the house, and materials used were from predominately recycled sources.

This is a difficult heading to assess adequately, an issue that is acknowledged by the authors of NABERS. While some of the sub-headings might not seem to adequately capture all the issues, overall the results support issues of level and type of resource use as well as costs of construction.

A possible enhancement would be the inclusion of additional sub-headings to add greater depth to this complex topic. For instance, giving support for retro-fitting strategies designed to improve thermal performance and indoor air quality (IAQ).

Heading 3. **Energy.**
Score. ETC. 100%. Snook. 52%

As a result of global warming, energy related matters have been the focus of many government and industry initiatives, which in turn are stimulating broader sustainability initiatives. The sub-headings in this category support both reduced levels of consumption as well as renewable energy use.

The ETC building assessment confirms that high energy performance can be achieved in a commercial building in an urban environment. It is a net producer of renewable electricity from photo-voltaic cells and is able to feed the electricity grid. This is due not only to its passive solar design features, which require no artificial heating and cooling and support reduced lighting, but also importantly active occupant behaviour in reducing levels of daily consumption, e.g. awareness of equipment and appliance use.

The Snook residence has no renewable energy sources and is totally reliant on the electricity grid, and therefore only received stars that related to consumption levels. Even though this building has poor thermal qualities, albeit somewhat improved with the retro-fitting, the occupants are conscientious and use minimal lighting, and very little heating and cooling energy.

NABERS is clearly able to show the distinction between sources of energy, and consumption of energy, which are both critical in reducing greenhouse gas emissions. There are also government programmes that support renewable energy systems as well as encouraging reduced levels of energy consumption.

Heading 4. **Water**.
Score. ETC. 40%. Snook. 0%

In WA, it is particularly difficult to achieve a high star rating for this heading. In particular, it is very difficult to achieve the stated objective of self-sufficiency from rain water alone. This is due to the length of the dry summer season and the consequent need for large storage capacity. This situation differs for the eastern states where rainfall is more evenly spread throughout the year. Even so, there is potential to support water needs and reduce volume of mains consumption through on-site rain water catchment.

The ETC, as a commercial site, has relatively low water consumption within the buildings, and the site vegetation is fed via sub-terranean grey-water reticulation. A rain water tank has been installed at the site since this assessment, which will reduce mains consumption even further.

The Snook residence has been strongly penalized under the NABERS rating and fails to score a star for consumption level per person (173Lt/day/person), even though consumption is well below the Perth average (approximately 335Lt/day/person). The occupants are conscientious in their level of water use both indoors and outdoors and the site has more than 90% native species. It remains unclear if the mains consumption goes largely to reticulation purposes or for house use, although statistically 60% of domestic water use is for gardens. Being

a newly planted garden, water use levels may reduce as plants become established, although annual consumption levels show inconsistent variations over the last three years.
There is conflict between the NABERS criteria and average domestic water consumption in Perth. Whilst NABERS considers water consumption per occupant at the Snook residence to be high, it is well below the local average, which could be considered a significant conservation measure that is deserving of reward.
Recent state government water strategy initiatives in WA have heard debate on greater use of grey-water, and promotion of rainwater catchment, both of which would ensure a higher NABERS rating in both case studies.

Heading 5. **Interior.**
Score. ETC. 90%. Snook. 50%

This heading highlights the important issues of indoor environmental quality and indoor air quality.

The ETC has scored highly in this category, which shows that even the rigorous assessment that NABERS requires can be achieved through good building design, construction and fit out. The buildings have no floor coverings, preferring a polished concrete slab finish. Some ventilation requirements are mechanical or active systems but the buildings are designed to make use of natural cross flow breezes, which is supported by user habit. The fit-out materials are either from solid timber, fully recycled, or from sustainable sources. The ETC has potential to use non-active fibre technology for floor, window and desk top cleaning, and low-toxic, low allergen cleaning agents, which are not directly or obviously covered by NABERS.

The Snook residence scores low numbers across some sub-headings. While it is acknowledged that reducing indoor emissions through product selection is a high priority, ventilation itself is a critical issue. It does gain a star for using low emission, 'breathe-easy' acrylic paints and for appropriate and adequate ventilation throughout the house. There is no reward for occupant behaviour in maintaining strong cross-flow ventilation by manually opening windows and doors. Also all home cleaning uses non-mechanical fibre technology, which is not specifically acknowledged or rewarded by NABERS

The scoring in this heading is somewhat ambiguous in that a maximum of 10 stars can be scored under sub-heading 5a. This differs from all other NABERS scores, where each sub-heading can score a maximum of 5 stars only. It is suggested that this be adjusted to maintain consistency throughout the system.

Heading 6. **Resources**
Score. ETC. 40%. Snook. 60%

This heading relates to the size of the building and occupant numbers, as well as frequency of use.

ETC buildings are designed to use indoor and outdoor work spaces depending on seasonal variations, which affect the overall building size and therefore perceived levels of resource consumption per person per m^2 of building. The ETC design creates a large usable work space without high resource consumption, and therefore confuses what NABERS is trying to achieve in that it affects the definition of building area and occupancy use. While the ETC may not be a typical commercial site, nonetheless it highlights the fact that using building area as a measure of resource use may not give a true indication. If only the indoor area of the ETC was considered, (which would better mimic other sites) the rating would increase from nil to 3 stars.

With only two occupants at the Snook residence, this site has been penalized due to per capita consumption, yet in terms of floor area and materials used for the extension, consumption could be considered lower than average. While it scores 5 stars for frequency of building use, the building area per person is considered high.

It is therefore questionable whether this heading accurately reflects levels of resource use. While the assessment is focused on consumption per person, or ecological footprint, it seems to miss how effectively those resources are exploited. The heading does not consider levels of resource consumption within the home. This would include the relative merits of fit-out equipment and furnishings in terms of eco-efficiency and energy efficiency.

Heading 7. **Transport.**
Score. ETC. 32%. Snook. 60%

This heading raises the critical issue of location and its effect on transport use, as well as personal behaviour patterns regardless of location.

This is the most contentious of the NABERS headings in regard to the ETC, which is severely penalised according to NABERS criteria. Its overall location rates poorly for sustainable transport in terms of proximity to public transport, urban centres and local shops and it is unlikely that these issues can be resolved in the near future. The site's area allows for ample parking, though this is not reflected in daily volumes of car usage. Bike racks are provided at the ETC with pool-bikes for on campus use. Adequate shower facilities are also provided.

Snook residence gains a good overall score, mainly due to the proximity of shops. It is penalized by the small number of occupants, which affects engine capacity per person even though it is a one-car household and the vehicle is used infrequently.

This heading succeeds in highlighting issues of both transportation habits and location issues within the greater urban form, both of which are inter-related. The use of six sub-headings greatly assists in covering a range of topics.

Heading 8. **Waste**
Score. ETC. 90%. Snook. 75%

Due to the provision Local Government kerbside recycling collection facilities, both case studies have gained a high score in this area. While both sites have active on-site composting facilities, due to the structure of NABERS sub-headings, the ETC is only awarded 1 star to Snook's 5 stars. This does not unduly impact on the overall score for the ETC, and it is acknowledged that composting of organic matter at commercial sites is uncommon.
Critical though, is the issue of sewerage treatment. Perth city has extensive deep sewerage urban infill and a condition upon the purchasing of the Snook residence was the connection to deep sewerage. This condition impacts strongly on alternative sewage treatment systems, i.e. dry composting toilets, as well as grey water recycling, although the recent development of the state water strategy may see changes to these requirements.

6.5.2 Exposing the Issues

The NABERS assessment has succeeded in exposing where both properties can be improved, if possible. Both fail significantly in one particular area:
The ETC complex fails due to its location, which impacts on the issues/headings of ‘Transport’ and ‘Land’.
This relates to the important issues of urban form and planning and development that are highlighted by NABERS.
The domestic residence fails on the issue/heading of ‘Water’, not due specifically to the overall level of water consumption but because of the small number of occupants, which affects per capita usage volume as defined by NABERS.

- This issue/heading highlights that of some assessment criteria need to be based on regional or local conditions and requirements and therefore questions the validity of the NABERS assessment criteria.

In the case of the ETC, it failed predominantly in the area of transport due to its location, over which it had little control. Local area planning, including the Murdoch University strategic plan, has no provision for local shops or urban centres to be built within the vicinity of the ETC. Therefore the ETC, whilst potentially improving its overall single percentage score through improvements in other categories, is unlikely to be able to achieve a higher medal rating because of its isolated location and the impact on the transport heading, under which it will not be able to increase its star rating. In the case of the Snook residence, if the number of occupants were to increase, both its overall score, as well as the medal score would improve. This pertains to a number of headings but impacts most significantly on ‘Water’.

In both cases there were critical areas that were ***possibly not given full consideration*** because the project design strategies undertaken were not ***specifically*** based on the guidance of a sustainable design guide, green building checklist or assessment framework (DPWS, 2001; AIAColorado, 2002; BCBC, 2002; BDP, 2002; EBN, 2002). Therefore, in the case of the ETC, had issues of site and transport, which relate to urban form, been better understood it may have been built in a more favourable location, had that been an option. In a different manner, in terms of the domestic residence and occupant numbers, issues of family size, site and house size, levels of consumption and density are raised, all of which relate to urban density and ecological footprint.

6.6 Assessing the Assessment

The structure of this system clearly highlights where improvements, if possible, can be achieved. In some cases, desired improvements in terms of the NABERS system cannot be achieved internally, but need changes in urban form and planning guidelines. The ETC case study is an example of this.

The design of the NABERS system reflects some fundamental requirements of sustainability. As a rating system, it is able to send a picture or story of what each site can do to improve its sustainability characteristics and as such has a definite and strong educational capacity.

NABERS succeeds in highlighting some fundamental elements of sustainability:

- Awareness and understanding of relevant issues, both direct and diffuse
- Integration of all component parts, i.e. the whole is greater that the sum of the individual parts
- Early planning and design to ensure appropriate outcomes
- Active human involvement measured through patterns of use and behaviour

NABERS is able to highlight where issues lie within the built environment. Equally, the case studies themselves have exposed NABERS to some of the conflicts that are present between the natural and built environment, as well as regional requirements. It is suggested that there is a possible conflict in how adequately NABERS assesses the users of the buildings.

NABERS addresses and confronts the important and highly relevant consideration that the occupant is an active user of buildings. This acknowledges that the best designed systems, including buildings, require the active and considered input by the occupant or user; in other words, a passive solar home still requires appropriate use and operation to be fully functional.

In terms of these case studies, the occupants are committed to environmental sustainability and hold strong ethical values that are measured in their daily actions and behaviours. However, it is felt in both case studies that, how the occupants were rated or assessed does not necessarily tell the true story of their personal attitudes and behaviours, and that they are not clearly reflected in the NABERS rating. It could be construed from the rating that the occupants are high consumers (relative to some accepted norm) across a number of categories because NABERS consistently penalizes small occupancy numbers in regards to site, water, transport, and resource issues.

Care must be taken in addressing personal attitudes and behaviours. For those who are committed to environmental sustainability, it may seem disheartening to find their best intentions are not rewarded; and for those who are only beginning to consider their attitudes and behaviours, a harsh or difficult assessment can possibly negatively impact on their intentions. The challenge therefore is how to set a challenging assessment as well as reward appropriate user behaviour.

NABERS is a specifically performance based system. That is, it sets targets to which designers and clients can aim whilst not holding to any prescription (Vale, Vale et al., 2001). Its aim is to support creativity and diversity in achieving sustainable outcomes and uses the performance regimen as a tool to measure relative achievement.

It is suggested that the assessment of some sub-headings may better represent behaviour patterns as well as signal issues of levels of consumption, if the criteria were adjusted so at least one star could be scored based on level of consumption compared to regional averages. Specific to this is the issue of water consumption.

The average water consumption at the Snook residence is significantly less than average Perth consumption, yet it gains no stars within the NABERS assessment. Whilst it is acknowledged that the average water consumption in Perth is extremely high by global standards (Newton, 2001a), nonetheless, consumption that is well below average might be rewarded in order to signal relative behaviour improvements.

6.7 Conclusion

NABERS is an accessible rating system available to all users, including design professionals through to householders (Vale, Vale et al., 2001). The system gives a broad brush stroke of what sustainability can mean for buildings. It can help as an educational device and on a specific project it can help guide specific design strategies.

For the householder it is an information tool that can both educate and direct initiatives for change. It can contribute as an educational tool and checklist to inform householders about all the key sustainability requirements that a new or retro-fitted home can contain. For instance, it alerts the public (and also professionals) that a home, or any building, that is situated in an existing inner urban location will potentially have a greater choice of transport options available, which will help reduce greenhouse gas emissions and running costs of vehicles. Other benefits that can arise from this reduced auto dependence, such as walking, cycling and personal fitness can become apparent. In
this way, NABERS is able to contribute to reducing, and eventually eliminating the negative impacts that stem from the built environment.

For the professional designer who is looking to increase the sustainability characteristics of their product, NABERS can guide, inform and measure key requirements. It is a diagnostic tool that can give sufficient analysis throughout a project's life-cycle whereby the design professional is able to pinpoint significant issues that may impede or block key sustainability characteristics. For further analysis of particular building elements and components the designer can then use the more specific assessment tools that are widely available (Lead Liew, Vale et al., 2001; CfD, 2001b; CfD, 2001c). NABERS is therefore a tool for design option appraisal.

The two case studies validate that the NABERS system achieves its desired aim, which is not so much to tell if a project is or is not environmentally sustainable, but rather to signal the degree of sustainability achieved, not as a number but as a percentage, and more importantly, where improvements can be made (Vale, Vale et al., 2001). The sustainability issues that are of concern in both case studies are made explicit by the NABERS assessment. In terms of the domestic site, the assessment shows where it can continually improve in particular areas. The ETC is affected mainly by its location and broader planning issues, over which, at this point, it has little control.

It is also suggested that there may be some conflict in the assessment criteria used in some sub-headings and therefore the message sent to the committed and active users as well as those becoming interested in reducing their impact, may not achieve the desired outcome, which is to improve both the built form and the user behaviour.

NABERS validates that environmental education must be given an important role at the earliest project stages if clients are striving to create and live in sustainable built environments. The NABERS rating system, although designed to be used to assess existing buildings, also indicates, without prescription how a building project can maximize the sustainability criteria at the earliest project stages. If these are ignored, not understood, or not factored in, some projects will always be impeded in attempting to improve their own sustainability characteristics.

There is however one qualifying comment to make about NABERS which applies to any universally applicable design guide. There are some local considerations that will not be well covered by the system. In this case, NABERS is not sufficiently tuned to the intricacies of water management in the xeric, sandy conditions of Perth. The narrow two sub-heading criteria and analysis did not assist with options on water nor did it provide aspirational assistance as it was too harsh. It is therefore important to allow enough flexibility in an assessment system to be able to respond and adjust to local or regional intricacies.

The next chapter will attempt to create a framework that can be used to implement green building practices into the building and construction sector in Western Australia. It sets out how a more localised system of appraisal could be developed which can also include NABERS, and will also draw on existing government and industry initiatives, including the framework and recommendations of the state sustainability strategy.

Chapter 7. Implementing Green Building in Western Australia

Sustainability will come as an evolution, not a revolution, and will be achieved through a series of steps, each of which contributes a small incremental improvement. Making everyone aware of the concept of sustainability is essential if it is to have an effect on day-to-day decision making and operations. Reaching and maintaining sustainability is a continuous process of re-examination and re-learning

(GSA, 2001).

7.0 Introduction

Thus far this thesis has presented the key themes of sustainable building and construction. It has determined what is required at an organisational and management level as well as the main elements of green building programmes, including assessment criteria for determining the depth of sustainability achieved in any project. It has also developed the case for green building by presenting a global picture of the sector and its strategies for achieving sustainability, as well as the benefits of green building for the occupants and users and also the environment.

This chapter will bring all the key elements together to develop the case for the implementation of sustainable building in Western Australia (WA). It will also suggest a framework within which all key stakeholders can develop more sustainable practice. The issue to be explored is how to build upon existing initiatives and government and industry association policy statements and programmes to gain comprehensive and lasting implementation. Currently there is increased interest in sustainability in WA, helped by the development of the State Sustainability Strategy (SSS) (SPU, 2002). There are also programmes within government and industry that are supporting moves towards sustainability in the built environment, and there are many policy and position statements issued by industry associations and government agencies that give in-principle support to sustainability and ecological health.

The first part of this chapter will use the framework of the SSS as a basis for determining recommendations for a sustainable built environment. The second part will give an overview of sustainability initiatives in the building and construction sector in WA, including the role of key government agencies and industry associations in facilitating a more sustainable product. Building on both of these, that is, current initiatives and the SSS, a SWOT (strengths, weaknesses, opportunities and threats) analysis will be given to determine the viability for this sector to move into being more sustainable. Finally, a skeleton or sketch framework for green building will be presented. This will be a conceptual outline that can form the basis for guiding the whole sector and will use two existing programmes, one in California and another in NSW, for guidance.

7.1 State Sustainability Strategy Framework

Interest in developing a sustainability strategy for WA began when the Environmental Alliance, a community/NGO network, lobbied for a political commitment to sustainability in WA. The State Labor Party made this commitment prior to winning government in 2000. The SSS process began with the formation of the Sustainability Policy Unit (SPU) in July 2001, with the Consultation Paper being released in December 2001 (SPU, 2002). The draft strategy was released for public consultation in September 2002, and foundation programmes for implementation are being laid. As part of the development of this strategy, key stakeholders across all sectors made submissions on their position and recommended actions for sustainability. This included submissions by Government agencies, the local government association, industry associations and interested parties in the building and construction sector.

The draft strategy has been developed around seven foundation principles and four process principles which give a guidance framework for the development of sustainability in WA (SPU, 2002) (Refer Section 1.1). These eleven key principles can be adapted and applied to all types of building and construction. Figure 7.1 shows the eleven principles of sustainability that are applied to the building and construction sector. The eleven principles relate the sector holistically to the broadest aspects of ecological and social well-being. They connect the built form to critical issues of community, heritage and sense of place, thereby highlighting the inclusiveness that any full sustainability strategy requires.

The SSS has the key objective of encouraging the widespread adoption of sustainable building and construction. It calls for the integration and development of passive solar design, energy, water and resource efficiency, and accessible and more liveable environments. To achieve this, it suggests that a '*Sustainable Planning, Building and Construction Guide*' be produced through the State-Local Government Sustainability Roundtable and in close consultation with industry stakeholders (SPU, 2002; WALGA, 2002). It also sets out some fundamental requirements and actions for creating a more sustainable building and construction sector in WA.
These include:

- Sustainable building requires a sympathetic planning system and an enthusiastic market to achieve meaningful change.
  - Dispelling any myths or scepticism that industry or the public may have would require the efforts of government in partnership with key stakeholders to achieve a smooth and comprehensive transition.
- Planning and building development requires a rethinking of the existing approvals process to explicitly support sustainable building guidelines in terms of placement, access, shape and orientation.
  - This 'rethinking' may consider a 'model sustainability scheme' that gives guidance to achieve more sustainable outcomes throughout each stage of the development process. This would give building designers a huge boost in delivering a passive solar, energy efficient, accessible and more liveable environment.
- Building materials should be manufactured, produced and supplied within the framework of sustainability.
  - This will require increasing effort to develop guidelines for manufacturers and for the building and construction industry.

Figure 7.1. **Sustainability Principles for Building and Construction**

Sustainability, based on the 11 principles outlined by the WA State Sustainability Strategy, can be applied simply to building and construction to mean:

Principle 1: Long Term Economic Health

Construction is central to how the long-term future of the economy is being created. Building have a minimum 50 to 100 year operating life and thus we must consider all relative factors in ensuring long term needs are considered.

Principle 2: Equity and Human Rights

Current needs for the disadvantaged need to be a high priority for development.

Principle 3: Biodiversity and Ecological Integrity

The construction agenda cannot afford to neglect the source of its materials, e.g., structural timber should not be from old growth or vanishing forests. Embodied energy analysis and Life-cycle assessment (LCA) must be developed for the whole materials sector. There needs to be a far more ecologically sympathetic building and construction sector.

Principle 4: Settlement Efficiency and Quality of Life

The urban planning context is that land development and building design and construction, and the resulting urban form needs to be more eco-efficient (i.e. less resource consuming, less waste producing) and yet simultaneously provide better quality-of-life outcomes.

Principle 5: Community, Regions, 'Sense of Place' and Heritage

Critical social dimensions of development and building need to be considered so that people are part of a community and can belong to a 'place'. Car-dependent housing is increasingly seen as anathema to this. Urban renewal must be prioritised.

Principle 6: Net Benefit from Development

All developments need to be assessed by the criteria of 'net benefit' that applies to environmental, social and economic criteria. The ancient Athenians used to pledge: 'we will leave this city not less but greater, better and more beautiful than it was left to us.' We should aspire to no less in our development projects.

Principle 7: Common Good for Planning

Sustainability requires common good outcomes from development and construction such as open space, diversity, community services and public transport.

Principle 8: Integration of the Triple Bottom Line

Reporting and accounting, as well as assessment of development and construction, needs to show how the triple bottom line objectives are being met.

Principle 9: Precaution

Flexibility in design and building components to enable different future options to be achieved as an area ages are part of the precautionary principle, particularly how an area can cope in an oil-constrained world.

Principle 10: Accountability, Transparency and Engagement

Engaging the public in development and building choices needs to go beyond standardised projects (such as project homes) and their fashions, and beyond simplistic debates on infill, to community–based visions of how appropriate and affordable develpoment can be provided in each area.

Principle 11: Hope, Vision Symbolic and Iterative Change

Building and construction projects that are more sustainable need to be created so that the first steps can be demonstrated towards long-term visions.

Adapted from 'Sustainability and Housing: More than a roof over head'.
The 2002 Barnet Oration by Professor Peter Newman.

- The design and construction of sustainable building requires an understanding of the impacts of construction methods and resource use by the builder and contractor.
  - Specific training and short courses for builders in site and construction impacts and environmental management, including waste minimisation and recycling, could be provided through TAFE (Technical & Further Education) colleges and industry based training programmes.

- The development of a comprehensive 'sustainable home living package' that addresses the key elements of sustainability that homeowners can adopt would be beneficial.
  - Education for the public on all aspects of sustainability is essential to successful implementation.

In view of these recommendations and the current initiatives, it is suggested that the local WA sector has many possibilities for achieving significant advances in sustainable building and construction.

7.2 Overview of Sustainability Initiatives in Western Australia

This section highlights the many sustainability initiatives that provide a useful foundation for building a more comprehensive and unified 'all of sector' approach. There are a number of initiatives both within industry and government, as well as agencies or associations, whose purpose is to promote more sustainable development and building practice in WA.

Appendix 6 contains a more detailed review of existing initiatives for sustainable building and construction and can be read to complement this section.

The breadth of these initiatives covers all of the fundamental requirements for sustainable building and construction. Key examples of sustainability initiatives in WA include:
Planning- the 'Future Perth' planning process and the 'Liveable Neighbourhoods Community Design Code', as well as supporting environmental policies such as 'Statement of Planning Policy No 8' (DPI, 2000a; DPI, 2000b; DPI, 2001d).

Materials- Department of Environment, Water and Catchment Protection (DEWCP) has explicit policies for environmental protection and resource management as well as the Zero Waste 2020 programme (DEWCP, 2002). DEWCP is the most appropriate State Government agency for applying influence over the materials component of the building and construction sector, with one possible mechanism being a sustainability covenant.
There is also the Western Australian Sustainable Industries Group (WASIG), which is committed to the application of Cleaner Production and Eco-Efficiency for a clean and competitive WA (WASIG, 2002). The WASIG, which is facilitated through the Centre of Excellence in Cleaner Production, has a set of guidelines as defined within the WA Cleaner Production Statement, which calls on stakeholders in WA to seriously consider Cleaner Production and Eco-Efficiency and act accordingly.

Land Development and Housing Construction. The Housing Industry Association's (HIA) PATHE (Partnerships Advancing the Housing Environment) programme is being implemented through the GreenSmart initiative (HIA, 1999a; HIA, 1999b). GreenSmart is a significant initiative, in that it provides training for designers, builders and project managers, mainly within the residential sector. It also provides accreditation and promotion as well as issuing awards to selected projects. GreenSmart rewards appropriate land development for housing as much as it does individual design and construction. Through this partnership programme, the HIA is developing its commitment to sustainability and has laid a foundation for further and deeper change. However, as indicated in Chapter 5, it is a voluntary tool that lacks rigorous compliance or assessment criteria.

Both Liveable Neighbourhoods and GreenSmart are progressively being used by the land development and housing construction industries. Examples of this are Ellenbrook and Harvest Lakes at Atwell South (Ellenbrook, 2000; Landcorp, 2002a). Within the Atwell South subdivision, the WA Department of Education is constructing a primary school that is designed to include key green building criteria. The Department for Housing and Works (DHW) and Landcorp, the State Government’s land development agency, have committed to both these initiatives, as evidenced in their submissions to the SSS, and also acknowledge the requirement of appropriate materials procurement and use (Landcorp, 2002b; DHW, 2002c). DHW has responsibility for the provision of affordable housing in WA and is therefore crucial to any built environment initiatives. Government agencies are key to providing and showing leadership in the built environment and most importantly in the revitalisation of areas affected by urban decline.

The Western Australian Local Government Association (WALGA) is an active participant in developing and implementing the recommendations of the SSS, including in the area of building and construction. It also has clear policies relating to building and land use (planning) as well as a Sustainability and Environment Policy (WALGA, 2002). Many local governments have been at the forefront of sustainability through Local Agenda 21 initiatives and are seen as important players in developing reform in building and construction, especially through the approvals process.

Industry associations have signalled support for greater sustainability initiatives throughout the sector. These are mainly in the form of educational and resource tools for industry professionals, and policy statements and position papers. The Royal Australian Institute of Architects (RAIA), including the WA chapter, has a stated commitment to sustainability and has a number of policy and educational initiatives to support its position, including the quarterly Environment Design Guide, which is produced by the Australian Council of Building Design Professions (BDP) (RAIA, 1999; RAIA, 2001; BDP, 2002). The Property Council of Australia (PCA) has recently released a Sustainable Development Guide for the commercial property industry (PCA, 2001). This guide includes useful information and resource links for aspects of green building within the commercial sector. The Planning Institute of Australia (PIA) and the Urban Development Institute of Australia also strongly support a sustainable urban form. In addition to GreenSmart, the HIA has a number of position papers including Better Living Environments, and Housing Australians (HIA, 1999b; HIA, 2001).

All of these initiatives and programmes are useful to help promote sustainability in the built environment and can therefore be complementary to a more integrated approach. Many were tabled in submissions to the SSS. The critical issue, though, is the depth of understanding of what it means to be truly sustainable and therefore the extent to which these initiatives aim to achieve fundamental change. There is widespread recognition of the need for complete integration of economic, environmental and social criteria to achieve true sustainability in the built environment, and the combination of programmes in both government and industry provide a useful foundation for creating a more comprehensive and unified strategy.

7.3 Current Status Analysis of the Sector in WA

This SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of the status of the sector in WA is written from the perspective of the current initiatives and in recognition of the interest and possibilities presented through the SSS. It is written as a brief overview based on the author's research.

It is useful to determine the current state of the building and construction sector in attempting to understand the requirements for moving towards a more sustainable product. By highlighting the strengths, weaknesses, opportunities and threats that currently exist within this sector, a deeper understanding can be gained of the gaps and impediments as well as possibilities and motivations for change.

Strengths. The inclusion of the 'Liveable Neighbourhoods Community Design Code' as the preferred development model, as well as GreenSmart, provide a useful foundation for a more comprehensive action. The many other programmes that are in existence in the Eastern States, as well as overseas, are also supportive, both conceptually and in terms of practice, to making greater advances in green building in WA.

Weaknesses. All sustainable building initiatives are being implemented through voluntary processes, which is the preferred option of both government and industry (HIA, 1999a; ABCB, 2001; MBA, 2001; PCA, 2001). Whilst it is acknowledged that the voluntary uptake of the new programmes allows greater flexibility and creativity than the imposition of regulatory or mandatory requirements, nonetheless, there is an issue with the depth and degree of implementation that these programmes achieve (CIB, 1999; Cass, 2001).

The weakness of these voluntary initiatives is that there is no way of determining the strength or depth of implementation. For example, while many builders and developers are able to gain GreenSmart accreditation, there are no clear assessment criteria by which to measure the outcomes of individual projects in terms of sustainability. Therefore, while builders may be able to display their GreenSmart credentials, their product delivery might be no more than a 'soft green' option, that is, the actions undertaken do little more than improve on minimum requirements as defined in planning and building codes.

It is suggested that this is an inappropriate outcome for an initiative that could be achieving significant conversion throughout the residential sector. Lack of criteria by which to assess or at least inform is also a critical issue for the public or the client in deciding on the ecological credentials of a building, and relates to the stated objectives of the NABERS rating system, which is designed to inform both professionals and the public about the sustainability characteristics of a building or project.

Opportunities. The interest in sustainability brought about by the SSS, as well as government and industry programmes, provides a tremendous opportunity for moving towards a more green product. As part of the sustainability strategy process, all key stakeholder organisations, from government, industry and community, submitted papers to the strategy. All of these affirmed 'in principle' commitment to developing more sustainable practices in terms of planning, development, design and construction. Whilst some of these policies, principles, practices, and objectives have been in place for a number of years, this is a unique time for achieving a unified approach for implementation from all key stakeholder groups.

Threats. There is much in place that can support the implementation of sustainability in the built environment in WA. Nonetheless, the greatest threat comes from a sense of apathy or intransigence from the bureaucracy and industry professionals to the benefits of green building (CIB, 1999). The CIB report 'Agenda 21 on Sustainable Construction' cites key barriers to progress as professional and institutional inertia, lack of understanding of the problem among construction professionals, and inadequate or defective vehicles for participation by the stakeholders (CIB, 1999, Sect3.2.2) (refer Section 4.1.1).

As has been stated, a key requirement for the implementation of sustainability initiatives is integration, both at an organisational level and throughout the design process. Unless sector professionals work in an integrated and supportive capacity to achieve a sustainable outcome, the individual programmes and processes will be severely impeded. Without an integrated participation from all key stakeholders they will also lack the credibility of being truly sustainable.

Another threat lies in the issue of depth of compliance. If these initiatives are to remain voluntary, there must still be some process for assessing the depth of 'greenness' for each project, that is, how does a project rate within a sustainability assessment rating system. Whilst it is acknowledged that change generally happens in an incremental manner, nonetheless, care must be taken that the end result has achieved significant or substantial and beneficial change, that is, the outcome is closer to best practice, and not merely beyond minimum practice. This refers to Section 1.1.

This analysis of the current status of the WA sector shows that there are initiatives that provide useful opportunities for moving forward. It also shows that the mechanism and strength of implementation is weak and that this can ultimately threaten the success of achieving a product that can justifiably be called sustainable. It is therefore critical that all key stakeholders are fully able to appreciate what it means to be sustainable in terms of building and construction and how that can be achieved.

It is also necessary that the sector has a shared and unified vision that is both aspirational and ultimately achievable. This vision does not necessarily need to be treated as a lofty ideal; rather it can create and indicate the necessary pathways by which to achieve an appropriately high performance sustainable outcome.

7.4 Implementation Framework

The SSS calls for the development of a 'sustainable building and construction guide and toolkit' to encourage thermal efficiency, solar orientation, accessible and universal design and other sustainable building practices in new and renovated buildings (SPU, 2002). Such a guide and tool kit can easily be extended to include all buildings, including residential, commercial, institutional and industrial. The success of this guide would rest on its market penetration and acceptance by industry professionals. It is therefore important that such a guide be developed in close consultation, or partnership, with all stakeholder groups in government, industry and community, and would necessarily be embedded in the principles and practices of sustainability (refer Figures 1.1 and 7.1). Such a commitment is evident in a number of green building programmes, including those of the ‘California Sustainable Building Task Force’ and the ‘NSW Sustainability Advisory Council’.

The ‘California Sustainable Building Task Force’ was created in response to the State Governor’s executive order D-16-00 calling for state buildings to be sustainable and cost-effective (CIWMB, 2001) (refer Chapter 4). This strategy, and a similar one in British Columbia (BCBC, 2002), are state government initiatives that are specifically aimed at *all* state facilities, and includes the involvement of *all relevant* state authorities and agencies in achieving a sustainable outcome. These initiatives will have significant and beneficial influence on the broader building and construction sector in terms of stimulating market change.

The NSW Government created the Sustainability Advisory Council in August 2001, as the peak advisory committee on issues of sustainable building design and construction (SAC, 2001). The brief of the Council is:

> *‘to explore innovative ways to apply design and construction practices across the commercial, residential and industrial development sectors. Its aim is to make buildings healthier and affordable for people. It also aims to reduce the impact of new buildings on the environment by reducing water and energy demand and reducing pollutants and greenhouse gas emissions’*
> (SAC, 2001, Introduction).

The Council has key projects, which aim to address the guidance, research, market based initiatives, monitoring and educational aspects of sustainable building design and construction. These include:

- Establish Sustainable Building Guidelines
- Study of Constraints for Sustainable Building Design
- Financially Packaging Sustainability
- Australian Green Building Council
- Local Government Implementation
- Community Training

A dedicated Sustainability Unit has been set up within the NSW Department of Planning to ensure that the Council achieves its outcomes (SAC, 2001). This unit is currently developing the BASIX - Building Sustainability Index, which will be a comprehensive tool for sustainable building design and construction and will encompass a wide range of sustainability themes.

7.5 Implementation Strategy for WA

It is suggested that a local initiative that extends beyond state government agencies and facilities to include all stakeholders in the sector should be initiated. Such an initiative might take the form of a taskforce, such as in California, an advisory council, such as in NSW, or a working group that aims to build inter-organisational partnerships to achieve more synergistic outcomes. Critical to achieving success in such an initiative are the following:

1. The purpose is to create a truly sustainable building and construction sector in WA. Therefore, the aims and objectives of the programme are guided by the principles and practices of sustainability.
    - This is designed to ensure that the process is not derailed by tokenism or individual agendas.
2. All participants, including executives, must understand sustainability and commit to its principles.
    - This would aim to ensure that all stakeholders and their respective organisations are working to achieve meaningful sustainability outcomes.
3. An established vision and mission must be clearly stated and get translated into specific long-term improvement objectives and targets with high-level visibility.
    - This is designed to ensure that the process is transparent and accountable to all stakeholders who can benefit from such a strategy, specifically individual clients, the broader community, and the ecology as a whole.
4. Commitment must be binding within government and industry.
    - This is designed to ensure the process remains integrated and holistic, and all interests are represented.
5. A formalised process must be enacted for identifying the environmental aspects and impacts of the sector's operations, products and services.
    - This would aim to ensure that appropriate project initiatives are selected to achieve the greatest good.
6. Awareness, understanding, education and training are crucial to attaining transformation into a sustainable development culture.
    - This is designed to ensure that skills are able to be transferred throughout the local sector and also into areas that require further development.
7. All initiatives and programmes must be assessed or measured to determine their achievements, both in relative and aspirational terms.
    - This would aim to ensure that progress is being made and in the most significant areas.

These requirements set out a skeleton of what would be a comprehensive strategy. It is important that the processes and workings of such a strategy, while being guided by the principles and practices of sustainability, are determined by the key stakeholder membership. Even so, such a strategy might include the following as a basis for further development:

Vision.

To facilitate the implementation of an active ‘action orientated’ process that is working towards an envisioned state of sustainable urban settlements.

Aim.

To implement sustainable planning, development, design, construction and operation throughout the whole built environment in WA.

Plan.

To seek wide spread and meaningful government, industry and community involvement in establishing a comprehensive sustainable building and construction initiative that is charged with achieving sustainable human settlements in WA, and is considered ‘world’s best’.

7.6 Conclusion

This chapter has highlighted that Western Australia is well positioned to create a truly sustainable building and construction sector. The combination of existing initiatives, policy and position statements as well as the interest and recommendations generated by the SSS undoubtedly give the local sector a strong foundation from which to create a more unified initiative.

The existence of other strategies and initiatives throughout the world that are firmly embedded in, and committed to, the principles and practices of sustainability can be used as inspiration, motivation, and reassurance, and also as guidance frameworks for our own local strategy to achieve a truly sustainability outcome. The global resource pool for sustainability initiatives is profound, which not only removes major impediments, both perceptual and real, for the instigation of sustainable building and construction, but also gives acknowledgement and validation to initiating a local strategy.

With the existence of international and national programmes, the State Sustainability Strategy, and local initiatives, it is suggested that there are few impediments to implementing a comprehensive sustainable building and construction strategy for WA.

It is therefore fundamentally an issue of willingness to commit to what other sectors have already begun.

Chapter 8 Conclusion

This thesis has been written to give the reader an understanding of the building and construction sector and to determine what is required to achieve substantial steps towards sustainability in this sector. While there has been a focus on Western Australia, the criteria and strategies are universally relevant and applicable as a guiding framework. This conclusion will firstly give a synopsis of what was determined throughout this thesis, and secondly what would be required for implementation of sustainable building and construction.

This thesis has determined that there is recognition of the need, and requirements, for the sector to deliver a sustainable product, as evidenced by the many reports that have analysed the structure of the sector and its impacts, both direct and indirect (Chapters 2 and 4).

It has shown that there are benefits from green building to the occupants and users, to community and society, and also to the environment. Specifically it shows that green building does not need to be more costly than traditional building, and that there are direct financial benefits in terms of reduced operating costs, improved health and higher productivity (Chapter 3).

It has shown that at the organisational and management level, both within government and industry, there are many opportunities for change with no significant impediments, although the depth of sustainability achieved is dependent on, and dictated by, issues associated with urban form and availability of materials. There are some barriers that relate mainly to lack of understanding and awareness of the requirements of green building and the ability to create an integrated and holistic approach. It has been demonstrated through a number of existing programmes that impediments or barriers are overcome as part of the processes and strategies of implementation, and that these strategies were initiated due to a commitment to creating a sustainable sector (Chapters 2, 4 and 7).

This thesis has highlighted the structure and key elements of green building programmes. It has shown the importance of assessment to determine the depth of sustainability achieved in a project, and that without assessment, initiatives and individual projects may achieve only minimal or shallow improvements (Chapter 5).

Through the use of case studies it has assessed key sustainability criteria for urban buildings and user behaviour patterns. It also gives an assessment of the assessment system itself. This has shown that while many of the issues and criteria for sustainable building and construction are relevant globally, there are often local or regional situations that necessitate specific requirements (Chapter 6).

The need for sustainability in the building and construction sector is validated by the development, and take-up, of green building programmes that are aimed at delivering an improved product throughout elements of the sector. These programmes contribute to a more sustainable built environment, but there are critical issues that have emerged:

- While many programmes cover a broad array of sustainability factors, they are not able to be fully sustainable without full integration (Chapter 4).
- While many programmes are achieving beneficial change, there is currently little understanding of the depth of sustainability that is actually achieved (Chapter 5 and 7).

It has been shown that, while these programmes have the right intent, and their strategies are valid (e.g. education, training and promotion), the final product may fall well short of what could be justifiably called sustainable. There is a strong possibility that these programmes will deliver little more than a token (pale green) level of sustainability. This is because of two main reasons:

1. Many of the programmes are undertaken by 'elements' within the sector, and although they have some 'partnership' that provides links to other 'elements' within the sector they are not sufficiently integrated to achieve the holistic response that is required, i.e. the sum of the individual parts is never as full as the integrated whole (Chapter 4 and 7).
2. The programmes are voluntary initiatives that have no (or very little) mandatory requirements and no mechanism by which to assess or rate the depth or degree of sustainability achieved within projects (Chapter 5).

In view of these findings, there are a number of observations that can be made about the future development of the sector.

It is suggested the current initiatives that are being implemented are the first steps of what will become more detailed and institutional programmes. These programmes would be guided by the specific objective to which the sector is aspiring, that is achieving a sustainable outcome. As outlined on previous pages, there are some programmes that are explicit in their sustainability objectives and have an integrated framework, which have been incorporated into the sector through a combination of political, industry and community commitment (Chapters 4 and 7).

It is also suggested that an assessment system be incorporated into green building programmes to determine the 'depth of greenness' of individual projects. This would achieve a greater understanding of sustainability issues in the built environment, and would also create a measurable level of achievement that can be used to determine the success of individual projects, as well as the programme itself (Chapters 5, 6 and 7).

New strategies or programmes that would encompass all the main elements of the sector would require compelling arguments that clearly demonstrate the benefits to be gained. They would also have to demonstrate that the strategy would not adversely effect or impact negatively upon the day-to-day operations of the sector and that any strategies undertaken will enhance the viability of the sector.

It is suggested that research of green building projects that can monitor and evaluate changes in occupant health and productivity, and financial costs is required. Further investigation of residential housing to assess design and construction methods would be useful to determine how and where improvements can be made. This research might focus on future housing needs and size and layout of both housing developments and buildings. Linked to this would be issues associated with urban infill and revitalisation of existing suburbs as well as evaluation of materials. An assessment rating system, such as NABERS, would be a useful tool to monitor and evaluate changes in building product, both in terms of delivery and also operation.

It is suggested that government agencies and industry associations need to investigate how to create new, and 'join-up' existing, initiatives and create programmes whereby sector professionals, clients, occupants and users, and the community in general, could gain awareness and a working understanding of sustainable building and construction.

This thesis has provided sufficient critical information to prove the benefits of green building, as well as providing relevant examples of green building programmes that are being implemented throughout the world. It has also shown the pathways, at both an organisational and process level, by which to implement sustainability initiatives throughout the building and construction sector.

It is suggested that a sustainability strategy that is designed to promote green building throughout the sector (in WA) would have specific and very obvious benefits. It would also be the most important manifestation of the sector's acknowledgement of sustainability as the key to human/ecological prosperity. The only impediment to developing sustainable building and construction initiatives is a lack of willingness to commit by key stakeholders.

Human destiny lays in each individual's power to affect.

A power achieved by understanding, and above all

by practice, translated in terms of personal willingness, will and effort

(Buddhist Proverb).

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Appendix 1

The Hannover Principles

By William McDonough and Michael Braungart

Five Principles of Ecological Design

From Sim Van Der Ryn and Stuart Cowan: *Ecological Design*

The Hannover Principles

William McDonough and Michael Braungart 1992

1. **Insist on rights of humanity and nature to co-exist** in a healthy, supportive, diverse and sustainable condition.
2. **Recognize interdependence**. The elements of human design interact with and depend upon the natural world, with broad and diverse implications at every scale. Expand design considerations to recognizing even distant effects.
3. **Respect relationships between spirit and matter**. Consider all aspects of human settlement including community, dwelling, industry and trade in terms of existing and evolving connections between spiritual and material consciousness.
4. **Accept responsibility for the consequences of design** decisions upon human well-being, the viability of natural systems and their right to co-exist.
5. **Create safe objects of long-term value**. Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creation of products, processes or standards.
6. **Eliminate the concept of waste**. Evaluate and optimise the full life-cycle of products and processes, to approach the state of natural systems, in which there is no waste.
7. **Rely on natural energy flows**. Human designs should, like the living world, derive their creative forces from perpetual solar income. Incorporate this energy efficiently and safely for responsible use.
8. **Understand the limitations of design**. No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not as an inconvenience to be evaded or controlled.
9. **Seek constant improvement by the sharing of knowledge**. Encourage direct and open communication between colleagues, patrons, manufacturers and users to link long term sustainable considerations with ethical responsibility, and re-establish the integral relationship between natural processes and human activity.

The Hannover Principles should be seen as a living document committed to the transformation and growth in the understanding of our interdependence with nature, so that they may adapt as our knowledge of the world evolves.

Source: http://www.virginia.edu/arch/pub/hannover_list.html (Accessed Oct 2002)

FIVE PRINCIPLES OF ECOLOGICAL DESIGN

from

Sim Van Der Ryn and Stuart Cowan: *Ecological Design*

1. SOLUTIONS GROW FROM PLACE.

Ecological design begins with the intimate knowledge of a particular place. Therefore, it is small-scale and direct, responsive to both local conditions and local people. If we are sensitive to the nuances of place, we can inhabit without destroying.

2. ECOLOGICAL ACCOUNTING INFORMS DESIGN.

Trace the environmental impacts of existing or proposed designs. Use this information to determine the most ecologically sound design possibility.

3. DESIGN WITH NATURE.

By working with living processes, we respect the needs of all species while meeting our own. Engaging in processes that regenerate rather than deplete, we become more alive.

4. EVERYONE IS A DESIGNER.

Listen to every voice in the design process. No one is participant only or designer only. Everyone is a participant designer. Honor the special knowledge that each person brings. As people work together to heal their places, they also heal themselves.

5. MAKE NATURE VISIBLE.

De-natured environments ignore our need and our potential for learning. Making natural cycles and processes visible brings the designed environment back to life. Effective design helps inform us of our place within nature.

Source: http://www.vanderryn.com/va/methods-principles.html (Accessed Oct 2002)

Appendix 2

Environmental Management System
Proposal for the Hypothetical Eco Building Company of WA.

By David Beyer

Environmental Management System
Proposal for the
Hypothetical Eco Building Company of WA

Introduction

This report deals with Environmental Management Systems (EMS). The first section will discuss the company and why it requires its own EMS. Following this is the body of the report, which is the design of the EMS. The third section will discuss the difficulties that the company may encounter in developing, implementing, and maintaining an adequate EMS. The conclusion will attempt to link this EMS to the building sector as a possible tool for achieving a better environmental performance throughout the whole sector.

Section 1 Why an EMS for this Company

The hypothetical building company of WA specialises in the design and construction of ecologically sound and energy efficient residential homes. Its aim is to use the EMS as a tool for managing its activities' impacts on the environment.

This company desires an EMS for two main reasons.

1. The EMS will help it define its values and policies, its objectives and goals, and how it implements and monitors its activities in a written document that is available for stakeholder and public scrutiny.
2. An EMS can help this company clarify the distinction of its activities and impacts; and the activities, actions, and impacts of its suppliers and contractors.

If an EMS is essentially 'a tool for managing the impacts of an organisation's activities on the environment' (Environment Australia, 2001), then it is valid to ask the questions:

- How far do any company's or organisation's activities extend?
- Does this company's responsibility for the design and construction of residential homes extend back to the manufacture and supply of building materials and forward to the practices of building contractors and possibly the occupants?

In undertaking an EMS, this company does accept that it has an 'extended responsibility' or 'some degree of stewardship' over all activities that result from its own business activities. It sees that by identifying preferred manufactures, suppliers and contractors, and by working closely with the homebuyer, it can better manage the extended or discrete environmental impacts of its activities. If it chose to ignore these as being irrelevant to its activities it would be negating its own vision and responsibility of being a truly sustainable building company. It is from this premise that this company desires its own EMS and believes that it will provide real benefit to its operations and long-term viability.

Section 2 The Environmental Management System (EMS)

This EMS is based on the Environment Australia guidelines and its listed case studies, and also draws from N521unit readings and notes.
It is structured under the following headings:

1. **ENVIRONMENTAL POLICY**
2. **PLANNING**
   - **Environmental Aspects and Impacts**
   - **Objectives and Targets**
3. **IMPLEMENTATION AND OPERATION**
   - **Responsibility**
   - **Awareness, Training and Competence**
   - **Communication**
   - **Monitoring, Documentation and Reporting**
   - **Compliance**
4. **EVALUATION, and EMS REVIEW**
5. **IMPEDIMENTS TO IMPLEMENTATION**
6. **MONITORING**
7. **EMS MANAGEMENT REVIEW**

1.0 ENVIRONMENTAL POLICY

The hypothetical building company of WA is committed to being environmentally responsible and is prepared to investigate all its undertakings, both direct and discrete, to ascertain whether they are being done or used in the most efficient and least harmful manner, and to then make any improvements or adjustments where necessary. It sees itself as essentially a parent company in that it aims to have positive influence on, and reduce, all aspects of its environmental activities and impacts. Company policy directives include:

- Recognizing environmental management as being integral to all company activities.
- Working within the principles of ecologically sustainable development (ESD).
- Being an agent for change and an industry leader in design and building practice within the home residential sector (HRS) by influencing manufactures, suppliers, contractors and sub-contractors to improve their own environmental standards.
- Continuous improvement through research, education and training in the management of its environmental performance.
- Complying with and exceeding all relevant building codes and rating systems to achieve quality sustainable homes in terms of design and construction.
- Maintaining legitimacy and competitive edge by providing an annual Public Environmental Report (PER) of its operations to all relevant stakeholders including, employees, investors, contractors and sub-contractors, suppliers, clients, local governments and the community.

2.0 PLANNING

2.1 Environmental Aspects and Impacts

The environmental impacts from the design and construction of residential homes can be grouped in two main categories. There are the internal or direct aspects, those that relate directly to company operations, and the external or discrete aspects, those that result from the design and construction of homes.

Therefore in planning the EMS, the environmental aspects and impacts are separated into two distinct groups, internal and external.

Internal

The aspects of the internal operations have relatively small impacts but are seen as morally and integrally important to overall EMS policy and company image.

- Office site. The buildings efficiency and performance are an obvious statement of the company's commitment to sustainable building.
    - Impacts include; materials manufacture, method of construction, energy use, and waste disposal.
- Office furniture and hardware
    - Impacts include; materials used and method of manufacture, energy use
- Office equipment, drawing and copy paper, inks, etc.
    - Impacts include; materials used and method of manufacture, energy use

External

The nature of the company's business means that the majority of its environmental impacts are discrete, i.e. are not caused directly by the company but resulting from the company designing and supervising home construction.

The external operations are morally and integrally important to overall EMS policy within this company. The aspects of these operations can be grouped into two broad areas; the materials used in construction and fittings, and the method of construction.

Materials

These come either directly from the manufacturer (i.e. Brick companies, timber mills, metal fabricators etc) or from suppliers (i.e. Hardware).
Main environmental aspects are associated with:

- Mining operations and timber logging.
  Impacts include:
    - Habitat or eco-system destruction
    - Air, water and land pollution
    - Associated resource use and energy intensity
- Manufacture, fabrication and distribution.
  Impacts include:
    - Habitat or eco-system destruction
    - Air, water and land pollution
    - Associated resource use and energy intensity, including transportation

Construction Methods

These aspects and impacts result from materials selection and method of construction. Materials impacts result from:

- High embodied energy and poor recyclability
- Poor thermal qualities
- High labour cost

Construction impacts result from:

- Large material use and waste
- Poor workmanship
- High resource use and waste, i.e. Energy and water
- Destruction of existing vegetation and habitat
- Associated land, air, and water pollution

2.2 Objectives and Targets

Internal

These are relatively to easy to influence in an environmental sense but do have financial constraints.

- Office site. The companies own building to meet EMS criteria in terms of construction and performance.
    - Target. Construction or purchasing of an appropriate office building is considered a high priority for the company's image but is beyond its financial capacity at this time. Until this option can be fulfilled an appropriate leased location shall be used.
- Office furniture and hardware to meet EMS criteria.
- Office equipment, Drawing and copy paper, and inks to meet EMS criteria.
    - Target. Appropriate office furniture and equipment that meets EMS criteria are available and being used.

External

Materials

In recognising that it can have little or no individual effect on methods of mining or production, none the less the company aims to exert whatever pressure it can.

- Only use buildings material that come from renewable or low impact sources. These can be materials that have been subject to the principles of industrial ecology including; eco-efficient design and manufacture, Life Cycle Analysis (LCA), environmental impact assessment. Many of these materials can be categorised under 'green' building materials.
- Identifying manufacturing and supply companies that have their own EMS or at least some form of environmental management and awareness.
- Compile a preferred manufacturer and supplier list of companies that are prepared to answer a series of questions on environmental management.
- Raise awareness and promote education of these environmental management issues with peak bodies (i.e. HIA, MBA) and industry associates and peers.
    - Target. To maintain an annual increase of 10% to finally achieving100% 'green' materials in all homes within 10 years.

Construction Methods

- Identifying building contractors that have their own EMS or at least some form of environmental management, awareness, and training, i.e. GreenSmart accreditation.
- Compile a list of preferred contractors that have answered or are prepared to answer a series of questions on environmental management.
- Raise awareness and promote education amongst building contractors of environmental issues with assistance from peak bodies (i.e. HIA, MBA) and industry associates and peers.
    - Target. Use only contractors with appropriate training or with a proven performance standard within 4 years.

3.0 IMPLEMENTATION AND OPERATION

3.1 Responsibility

All company staff and employees are responsible for implementation of the EMS.

- Environmental values and close staff interaction are part of the company culture, which allows the EMS to be included in overall operations and daily practice.

3.2 Awareness, Training and Competence

All staff are required to understand EMS policy, the principles of ESD, and sustainable building practices.

- Appropriate training and updating are essential to company operation and staff.

3.3 Communication

Through preferred manufactures, suppliers, and contractors close communication is maintained as part of good business practice.

- Building partnerships is the best way to create and maintain a sustainable building sector.

3.4 Monitoring, Documentation and Reporting

All projects require design plans, details and specifications. Included with these are additional details of materials, quantities, and preferred manufactures and suppliers. All preferred contractors are supplied with additional construction briefs appropriate to particular job requirements. Much of this documentation can be a standardised checklist similar to specification lists, which will facilitate easier implementation. Some of the documentation for environmental standards may include:

- Materials
    - Appropriateness to ESD Principles
        - Life cycle assessment (LCA)
        - Life cycle costs (LCC)

        - Embodied Energy
        - Renewable vs. resource depleting. i.e. Plantation timbers
        - Reusability or Recyclability
        - Locally produced
    - Appropriateness to design requirements and energy efficiency
        - Structural strength
        - Thermal and auditory qualities
        - Construction requirements, i.e. ease of construction
        - Internal Fittings, inc. appliances, furnishings, fittings
        - Aesthetics
- Construction Processes
    - Environmental impact, i.e. land clearing, destruction of habitat
    - Energy use, i.e. electricity and fuel
    - Water use
    - Materials waste
- If occupant behaviour were to be included:
    - Awareness
    - Efficiency
    - Appliance use, water conservation
    - Over-consumption and material waste minimisation and reduction

3.5 Compliance

Contractor compliance is ensured by a signed contract and through project specifications and review checklist. Monitoring and enforcing of site activities may be difficult but is supported by prior training and proven record.

4.0 EVALUATION and EMS REVIEW

A detailed annual Public Environmental Report (PER) will be used as an EMS Review. It gives an evaluation of the company’s environmental performance, including operations, targets and achievements, a compliance audit, and verification.

5.0 IMPEDIMENTS TO IMPLEMENTATION

Internal

Financial constraints for the desired office site.

Finding appropriate staff and drafters that can work to the company's EMS framework.

External

It is anticipated that the EMS criteria for external objectives will meet with differing amounts of difficulty, at least initially. The company recognises that its credibility and the credibility of its EMS is strongly linked to fulfilling these objectives. Impediments may be;

- Inability to find companies with similar environmental standards.
- Difficulty to attract interest by companies and contractors in their environmental management questionnaire.
- Difficulty to monitor and regulate contractor behaviour.

6.0 MONITORING

All construction projects shall be assessed against a standardised checklist to assess their degree of sustainability in terms of;-

- Construction Materials (and suppliers) to meet ESD principles including:
    - LCA
    - LCC
    - Embodied Energy
    - Renewable vs. resource depleting
    - Reusability or Recyclability
    - Locally produced
    - Thermal and auditory qualities
    - Ease of construction
    - Internal Fitting, inc. appliances, furnishings, fittings
    - Aesthetics
- Construction processes and contractors compliance with EMS standards including:
    - Environmental impact, i.e. Land clearing, Destruction of existing habitat
    - Energy Use, i.e. Electricity, generators
    - Water Use
    - Materials Waste
- All homes subject to home efficiency rating including:
    - Passive Solar principles
    - Renewable Energy
    - Waste management
    - Fittings to be high efficiency rating
    - Planting of drought resistant biota
- If Occupant behaviour were to be included
    - Awareness
    - Efficiency

- Appliance use, Water conservation
- Over-consumption and material waste minimisation and reduction

7.0 EMS MANAGEMENT REVIEW

In-house review shall be undertaken every six months

Section 3 Rationale and Realism of the EMS

This EMS has been developed to contain the ISO 14000 key guidelines of commitment and policy, planning, implementation, measurement and evaluation, and review and improvement. Although the planning stage contains much detail, this will ultimately assist in maintaining clarity and ease of reporting. The development of standardised checklists that could be used for each project is the key to the success of this EMS. These will allow the company to have a simple system that would give useful data that could be used for documentation, measurement and compliance reporting. Once this system has been put in place its operational aspects should become fairly routine.

Implementation does have some challenges that have not been tested by a building company in Western Australia. Although the objectives and targets for implementation may be ambitious at this point in time, particularly for a small company going it alone, none the less they are valid in that they are directly related to aspects of environmental performance of the HRS.

Any new EMS for an organisation or a company must be realistic, viable, and achievable. To ensure that the EMS is attainable, seven key challenges are suggested that need to be to overcome. These seven points are paraphrased below:

1. This proposal has a simplicity in that its application may ultimately compact into lists of preferred manufactures, suppliers, and contractors and is supported by usable specifications and monitoring checklists.
2. This company was begun with and built upon ‘ownership’ of environmental management.
3. Finding knowledge and commitment in employees is an issue that can be resolved in training, support and research. It is also committed to creating sector change by promoting and supporting green or sustainability initiatives.
4. Communication of the EMS will be through the company’s promotion including its Internet site, directly to clients, and through an annual PER.
5. The successful implementation of the EMS will be an incremental process dependent upon attracting appropriate manufactures, suppliers, and contractors.
6. Reviews will be facilitated and assessed with the use of project checklists and through an annual PER.
7. The company supports industry initiatives and is an active participant in the ‘GreenSmart’ program.

(Dingle, 2001)

Conclusion

This proposal has attempted to include all possible aspects of the company's environmental impacts. Much attention has been given to the discrete or external aspects because of their large range and also because they are recognised as being integrally connected to the company's impacts.

This EMS proposal would be challenging in the short term because of the discrete or external nature of many of the environmental impacts and as a consequence the difficulty in implementing the objectives. It is still unclear if full implementation by the set target dates is achievable, but there is much scope, especially in identifying 'green' manufactures and suppliers that are attempting to improve their own environmental performance.

Additional and timely support will be found in the new 'GreenSmart' partnership program that is currently being promoted by the Housing Industry Association (HIA, 2001). This EMS and the GreenSmart initiative are both mutually supporting. If GreenSmart hopes to raise awareness of energy efficient design and construction, this EMS takes environmental performance and responsibility within this company further toward achieving true sustainability. This is an objective that could be furthered throughout the sector as a whole with greater application of environmental management systems.

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This paper has been adapted from
Assignment 4. Environmental Management System by David Beyer
N521. Organisational Strategies for the Environment.
Third Trimester, 2001. School of Environmental Science. Murdoch University. Perth Australia

Appendix 3

Sustainable Building Tool Kit

Created by the California Sustainable Building Task Force

Guide to Green Buildings Resources

From Green Buildings BC

Sustainable Building Tool Kit

http://www.ciwmb.ca.gov/GreenBuilding/Toolkit.htm

This tool kit was created by the California Sustainable Building Task Force to assist project managers and provide quick, direct access to helpful information and documents.

- **Case Studies**
- **Fact Sheets and Virtual Tours**
- **Financing**
- **Links**
- **Performance Standards**
- **Product Directories**
- **Programs**
- **Publications**
- **Sample Construction Documents**
- **Training**

Case Studies	• California Sustainable Building Profiles • Sustainable Building Case Study Links • Demolition and Deconstruction

Fact Sheets and Virtual Tours	**Life Cycle Building Phases**
	
	• Design and Construction/Renovation
	  § Sustainable Building Basics
	  § Construction and Demolition (C&D)
	  § Project Design
	• Post-Occupancy
	• Commissioning
	
	Environmental and Public Health
	
	• Air
	• Energy
	• Materials
	• Waste Reduction and Recycling
	• Toxics
	• Water

Financing	**Funding Opportunities** • California Fiscal Resources for Sustainable Building (Excel, 67 KB) • CIWMB Green Building Grants and Contracts **Cost Issues**
Links	• Other Green Building Web Sites • Sustainable Building Task Force Stakeholders
Performance Standards	• Sustainable Building Guidelines • Rating Systems (LEED™) • Specifications

Product Directories	• Environmentally Preferable Purchasing Guide • EPA's Comprehensive Procurement Guideline • Green Building Materials Resource Guide • Recycled-Content Products Database: Searchable by the Construction Specifications Institute (CSI) MasterFormat™ • Recycled-Content Construction Products Manufacturers Database: Searchable by product type and location. • oikos® Green Product Directory: Searchable by product category and company name.
Programs	**Existing Sustainable Building Programs and Partnerships** • Government Programs • Industry and Government Unite • Home Builder Programs • Organizations • Schools **Starting a Government Program** • What Every State Executive Should Know About Sustainable Building (Power Point, 1.6 MB) • WorldBuild Toolkit for Sustainable Development, A Presentation for the City of Oakland (Power Point, 2.2 MB) **Green Building Policies** • State of California • City of Los Angeles • City of San Francisco • City of San Jose • City of Santa Monica • City of Oakland • San Mateo County
Publications	**California Sustainable Building Task Force Documents** • Blueprint • Blueprint Action Items **CIWMB Green Building Publications**
Sample Construction Documents	...in the following categories: • **Design and Construction/Renovation** • **Building Occupancy** • **Construction/Renovation/Deconstruction/Demolition** **Design and Construction/Renovation** • Capital Outlay Budget Change Proposals • Project Scopes and Goals

	§ Sustainable Building Goals for Laguna Honda Hospital (MS Word, 240 KB) • Advertisements § Capital Area East End Complex (MS Word, 27 KB) • Request for Qualifications (RFQ) § Department of General Services (DGS) Science Center (Adobe PDF, 19 KB) § Natural History Museum of Los Angeles County § Scoring sheets for RFQ applicants (Excel, 106 KB) • Request for Proposals (RFP) § RFP Scoring Sheets (Excel, 56 KB) • Contract Language • Specifications • Reference Specifications for Energy and Resource Efficiency **Building Occupancy** • Building Performance § DGS Postoccupancy Evaluation (POE) Strategic Plan • Leasing § Leasing Policy § Management Memo issued by DGS: Written Policy for the Location of State Owned and Leased Offices § Leasing Contract § DGS, Exhibit B: Outline Specifications (MS Word, 2.5 MB) • Maintenance § Environmentally Preferable Janitorial Chemicals Tool Kit § Environmentally Preferable Janitorial Chemicals Specification (MS Word, 105 KB) § Environmentally Preferable Cleaning Products Lists • Waste Prevention and Recycling § State Agency § Local Government § Schools § Business **Construction/Renovation/Deconstruction/Demolition** • Construction and Demolition (C&D) Debris Recycling • C&D Ordinances for California Local Government
Training	**State Sustainable Building Training Programs**

GUIDE TO GREEN BUILDINGS RESOURCES

Green Buildings BC - New Buildings Program

http://www.greenbuildingsbc.com/

Last Updated March 16, 2002

Table of Contents

Appendix 4

YourHome Technical Manual Contents Page

Produced for the Commonwealth of Australia

By the Institute for Sustainable Futures, University of Technology.

Principal Author Chris Reardon

Minnesota Sustainable Design Guide

Regents of the University of Minnesota, Twin Cities Campus,

College of Architecture and Landscape Architecture your Home

Technical Manual
DESIGN FOR LIFESTYLE AND THE FUTURE

CONSUMER GUIDE | TECHNICAL MANUAL | TOOLS
ABOUT | SEARCH | UPDATES/LINKS | ORDER

contents

http://www.yourhome.gov.au/technical/index.htm (Accessed Oct 2002) Commonwealth of Australia - Last modified 10 April 2002 A joint initiative of the Commonwealth government and the design and construction industries.

MINNESOTA SUSTAINABLE DESIGN GUIDE
SCORING SUMMARY
DATE:

PROJECT:

		PREDESIGN		DESIGN			FINAL
	STRATEGY	Points Possible	Target Points	Schem. Design	Design Dev.	Const. Docs.	End of Const.
1.1	Direct Development to Environmentally Appropriate Areas	3					
1.2	Maintain and Enhance the Biodiversity and Ecology of the Site	3					
1.3	Use Microclimate and Environmentally Responsive Site Design Strategies	2					
1.4	Use Native Trees, Shrub, and Plants	2					
1.5	Use Resource Efficient Modes of Transportation	2					
	SITE STRATEGIES TOTAL	12					
2.1	Manage Site Water	5					
2.2	Use Gray Water Systems	2					
2.3	Use Biological Waste Treatment Systems	1					
2.4	Conserve Building Water Consumption	1					
2.5	Conserve Cooling Tower Water Consumption	1					
	WATER STRATEGIES TOTAL	10					
REDUCE LOADS							
3.1	Optimize Building Placement and Configuration for Energy Performance	2					
3.2	Optimize Building Envelope Thermal Performance	2					
3.3	Provide Daylighting Integrated with Electric Lighting Controls	2					
DESIGN EFFICIENT SYSTEMS							
3.4	Provide Efficient Electric Lighting Systems and Controls	2					
3.5	Maximize Mechanical System Performance	2					
3.6	Use Efficient Equipment and Appliances	1					
USE ENERGY SOURCES WITH LOW ENVIRONMENTAL IMPACT							
3.7	Use Renewable or Other Alternative Energy Sources	3					
SIMULATE TOTAL BUILDING ENERGY USE							
3.8	Integrate All Systems and Reduce Total Energy Use	12					
	ENERGY STRATEGIES TOTAL	26					
INDOOR AIR QUALITY							
4.1	Provide a Clean and Healthy Environment	3					
4.2	Control Moisture to Prevent Microbial Contamination	3					
4.3	Provide Ample Ventilation for Pollutant Control and Thermal Comfort	6					
HUMAN FACTORS							
4.4	Provide Appropriate Thermal Conditions	3					
4.5	Provide Effective Lighting	3					
4.6	Provide Appropriate Building Acoustic and Vibration Conditions	3					
4.7	Provide Views, Viewspace and Contact with the Natural Environment	3					
	INTERIOR ENVIRONMENTAL QUALITY STRATEGIES TOTAL	24					
RAW MATERIAL EXTRACTION							
5.1	Use Materials with Low Impact During Their Life Cycle	3					
PRODUCTION							
5.2	Use Salvaged and Remanufactured Materials	2					
5.3	Use Recycled Content Products and Materials	1					
5.4	Use Materials from Renewable Sources	1					
DISTRIBUTION							
5.5	Use Locally Manufactured Materials	1					
INSTALLATION							
5.6	Use Low VOC-emitting Materials	3					
USE							
5.7	Use Durable Materials	1					
EVENTUAL REUSE OR RECYLING							
5.8	Use Materials that are Reusable, Recycleable or Biodegradable	2					
	MATERIALS STRATEGIES TOTAL	14					
CONSERVING RESOURCES							
6.1	Reuse Existing Buildings	3					
6.2	Design for Less Material Use	2					
6.3	Design Buildings for Adaptability	2					
6.4	Design Buildings for Disassembly	2					
WASTE MANAGEMENT							
6.5	Salvage and Recycle Demolition Waste	1					
6.6	Reduce and Recycle Construction Waste	1					
6.7	Reduce and Recycle Packaging Waste	1					
6.8	Reduce and Recycle Waste from Building Users	1					
6.9	Reduce and Properly Dispose of Hazardous Waste	1					
	WASTE STRATEGIES TOTAL	14					
	GRAND TOTAL	100					

Source: http://www.sustainabledesignguide.umn.edu/MSDG/text/scoring.pdf

Appendix 5

The NABERS *Commercial* Rating Assessment of the new
Environmental Technology Centre (ETC) Buildings Complex
Murdoch University
Perth Western Australia

By David Beyer

NABERS *Domestic* Rating Assessment of
42 Snook Cres Hilton
Perth Western Australia

By David Beyer

The NABERS *Commercial* Rating Assessment of the new Environmental Technology Centre (ETC) Buildings Complex.

David Beyer.
Summer 2002.

The new buildings complex at the Environmental Technology Centre (ETC), known as 'The Waalitj' is located at the South Western corner of this 1.7ha site, adjacent to and south of an existing teaching/seminar room. All buildings have been given a name of local birds in Nyungar, the language of the local indigenous people.
The new buildings consist of:

- New office building and administration centre: ***Waalitj Mia.*** 100m^2.
- New wet laboratory: ***Dilaboot Mia.*** 50m^2.
- New dry laboratory***: Wardung Mia.*** 50m^2.

As part of the new complex the three buildings have been interlinked by a courtyard which is intended to be used as an activities area and meeting place. This 'outdoor' site will make use of Perth's moderate climate. The total outdoor area is 200m^2.

For the purposes of this assessment a site area that bounds the newly constructed buildings and linked courtyard will be considered. The area 45m x 24m, runs from the south side of the existing classroom to the granite retaining wall south of ***Dilaboot Mia,*** and from the edge of the car park planting edge to the granite retaining wall east of ***: Wardung Mia.*** This has been done for a number of reasons.

- The new buildings and courtyard were built as an integrated complex. Although they are not in any way separate from the existing buildings or the ETC site as a whole, none the less they were designed and constructed as a single project.
- Also, the intention of this rating is to assess only the new buildings, which were built on sustainable principles, as a commercial site. If the existing buildings or the transportable were to be included there would be an inherent conflict with what this project is attempting to assess.
- Finally, this assessment aims to closely mimic a commercial rating for new buildings designed and built on the principles of sustainability. As such this is as a role model and case study for future projects that may be located in an inner urban location.

Total building area.

- New buildings = 200m^2 + Courtyard area = 200m^s = Total built area 400m^2.
- Total Site area is 45m x 24m = 1080m^2.

NABERS score for Heading 1: LAND.

Total score. 25 stars (<3yr old), 20 stars (>3yr old).

LAND deals with issues related to land use and biodiversity. Biodiversity is a measure of the variety of plants, animals and other organisms that live around the building – high biodiversity suggests a development that has not caused undue damage to the natural environment.

Score for 1a) Nature of site	
Inner urban/ suburban/rural infill:	3 stars
Score for 1b) Total site area per m^2 of building	
More than 2.0 m^2 of site per m^2 of floor area	nil stars
Score for 1c) Total site area per person	
More than 50 m^2 per person	nil stars
Score for 1d) Area of site planted with beneficial plants	
Above 80% any trees, shrubs and bushes	4 stars
Score for 1e) Impermeably paved area of the site	
Impermeably paved area 0%	5 stars
TOTAL for Heading 1: LAND	**12 Stars**
Divide by 5 subheadings	
NABERS score for Heading 1: LAND	**2.4 Stars**

NABERS score for Heading 2: MATERIALS.

Total score. 10 stars (<3yr old), 15 stars (>3 yrs old)

MATERIALS covers some of the environmental impacts of the materials of which the building is constructed, and ways in which these impacts may be reduced. There are key issues for choosing materials that MATERIALS does not cover, of which the most significant are:

Materials with a long life,
Materials with a short distance for transport to your site,
Materials that are as close as possible to their natural state, or least refined.

Score for 2a) Cost of building per m^2	
Cost up to $750 per m^2 or EE less than 12.5 GJ/m^2	4 stars
Score for 2b) Materials types for structure, walls, floors and roof	
At least 90% of materials from "best" option	5 stars
TOTAL for Heading 2: MATERIALS	**9 Stars**
Divide by 2 subheadings for buildings **under** three years old	
NABERS score for Heading 2: MATERIALS	**4.5 Stars**

NABERS score for Heading 3: ENERGY.

Total score 25 stars.

Energy consumption in NABERS is measured in terms of the greenhouse gas emissions created by the operation of the building

Score for 3a) Energy efficiency	
Total energy consumption 0 kWh/m^2	5 stars
Score for 3b) Greenhouse emissions of the whole building	
Emissions up to 135 kg CO_2/m^2/year	5 stars
Score for 3c) Greenhouse emissions for high performance buildings	
Emissions 0 kg CO_2/m^2/year	5 stars
Score for 3d) Renewable electricity use	
100% renewable energy use	5 stars
Score for 3e) Homes that produce more energy than they consume	
Score	5 stars
TOTAL for Heading 3: ENERGY	**25 Stars**
Divide by 5 subheadings	
NABERS score for Heading 3: ENERGY	**5 Stars**

NABERS score for Heading 4: WATER.

Total score 10 stars.

Water is increasingly a scarce resource in Australia and the rest of the world. The provision of water supplies has major impacts on the environment. Collecting water from the roof is one way of reducing the demand for water from reserves below the ground which are in increasing danger of becoming depleted

Score for 4a) Water consumption from mains or borehole	
Mains water up to 20 m^3/person/year - 55 litres/person/day	4 stars
Score for 4b) Source of on-site water supply	
Score	nil stars
TOTAL for Heading 4: WATER	**4 Stars**
Divide by 2 subheadings	
NABERS score for Heading 4: WATER	**2 Stars**

NABERS score for Heading 5: INTERIOR.

Total score 20 Stars.

INTERIOR covers issues that affect the quality of the indoor air. Since people spend about 95% of their time in buildings, it is important that the quality of the air in buildings is high. Indoor air quality (IAQ) is directly related to the kinds of materials and systems used in the building. There is as yet no simple way of measuring IAQ, so this subheading has to be prescriptive, a list of things that should either be there or not be there to achieve good IAQ

Score for 5a) Indoor air quality	
Ceramic tile flooring or linoleum fixed with non-toxic adhesive	2 stars
Water based paints/varnish to floors, walls and ceilings (site applied)	1 star
Local air extraction in kitchens, toilets and photocopy areas	1 star
Opening windows to all workplaces	1 star
Mechanical ventilation for fresh air supply	1 star
No smoking allowed in the building	1 star
All furniture and fittings of solid wood from sustainable sources, metal, and/or glass	1 star
Score for 5b) Workplaces close to window	
100% of workplaces within 5 metres of a window	5 stars
Score for 5c) Individual control of Lighting	
100% of workforce with individual lighting control	5 stars
TOTAL for Heading 5: INTERIOR	**18 Stars**
Divide by 3 subheadings	
NABERS score for Heading 5: INTERIOR	**6 Stars**

NABERS score for Heading 6: RESOURCES.

Total score 15 stars.

The large amount of resources put into the provision of buildings means that efficient use of resources should be acknowledged as having lower environmental impact.

Score for 6a) Total building area per person occupying the building	
more than 30 m^2 per person	nil stars
Score for 6b) Use of the building – number of hours per day	
up to 12 hours per day	2 stars
Score for 6c) Use of the building – number of weeks per year	
up to 260 days a year (ie. 5 days a week, 52 weeks a year)	4 stars
TOTAL for Heading 6: RESOURCES	**6 Stars**
Divide by 3 subheadings	
NABERS score for Heading 6: RESOURCES	**2 Stars**

NABERS score for Heading 7: TRANSPORT.

Total score 25 stars.

The location of buildings can encourage or discourage the use of more environmentally benign forms of transport

Score for 7a) Distance to nearest local shop	
More than 500 metres walk from building entrance	nil stars
Score for 7b) Distance to nearest urban centre	
Up to 4 kilometres	4 stars
Score for 7c) Number of car parks provided on site	
More than 1 space per person	nil stars
Score for 7d) Distance to public transport	
More than 500 metres walk from building entrance	nil stars
Score for 7e) Provision for bicycle facilities	
Bicycle parking for 100% of building workforce	4 stars
TOTAL for Heading 7: TRANSPORT	**8 Stars**
Divide by 5 subheadings	
NABERS score for Heading 7: TRANSPORT	**1.6 Stars**

NABERS score for Heading 8: WASTE.

Total score 20 stars.

This heading covers the emissions to the environment (apart from greenhouse gases) resulting from the use of the building

Score for 8a) Provision of on-site recycling facilities	
provision of facilities on-site for collecting paper and card	1 star
provision of facilities on-site for collecting metals	1 star
provision of facilities on-site for collecting plastics	1 star
provision of facilities on site for collecting glass	1 star
provision of facilities on-site for collecting organic materials	1 star
Score for 8b) Provision of local collection of recyclable materials	
Local provision for collecting paper and card	1 star
Local provision for collecting metals	1 star
Local provision for collecting plastics	1 star
Local provision for collecting glass	1 star
Local provision for collecting organic materials	1 star
Score for 8c) 100% of waste water treated on site	5 stars
Score for 8d) Use of more sustainable sewage treatment systems	
connection to a sewage treatment system that has no waste outputs (eg. Methane gas, if produced, is used as a fuel; sludge is used for fertiliser; etc.)	3 stars
TOTAL for Heading 8: WASTE	**18 Stars**
Divide by 4 subheadings	
NABERS score for Heading 8: WASTE	**4.5 Stars**

Totals by Heading.

Main Heading	Sub-Headings	Total Possible Score.	Measured Score	Percentage	Average Stars for Main Heading.
1. Land	5	25 Stars	12 Stars	48%	2.4
2. Materials	2	10 stars	9 Stars	90%	4.5
3. Energy	5	25 Stars	25 Stars	100%	5
4. Water	2	10 Stars	4 Stars	40%	2
5. Interior	3 (+1)	20 Stars	18 Stars	90%	6
6.Resources	3	15 Stars	6 Stars	40%	2
7. Transport	5	25 Stars	8 Stars	32%	1.6
8. Waste	4	20 Stars	18 Stars	90%	4.5
Totals	30	150 Stars	100 Stars	66%	

The NABERS Rating System

Fill in your total scores under each Heading in the list below (the scores from the line marked TOTAL in the scoring box at the end of each Heading). Then add all eight scores to get your basic NABERS score.

TOTAL for Heading 1: LAND	12
TOTAL for Heading 2: MATERIALS	9
TOTAL for Heading 3: ENERGY	25
TOTAL for Heading 4: WATER	4
TOTAL for Heading 5: INTERIOR	18
TOTAL for Heading 6: RESOURCES	6
TOTAL for Heading 7: TRANSPORT	8
TOTAL for Heading 8: WASTE	18
BASIC TOTAL	100

Convert to a percentage:

BASIC TOTAL divided by 150, then multiplied by 100

%NABERS SCORE 66%

Calculate your NABERS Medal Rating:

You need only to have five stars in four Headings to qualify for NABERS Platinum, but in all other cases the stars must be earned in all eight headings.

Stars ®	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	0.5	0
1:						X					
2:		X									
3:	X					X					
4:							X				
5:	X										
6:							X				
7:								X			
8:		X									

NABERS Green

A building must earn at least one star in each main heading to have the right to a "NABERS Green" rating

NABERS *Domestic* Rating Assessment of Snook Residence Hilton WA

David Beyer
Summer 2002

Overview

This residential house is situated in the suburb of Hilton, in the City of Fremantle. It is ~5km east of Fremantle, which is a large commercial and entertainment centre, and ~25km south west of Perth CBD. There are small local shopping and commercial areas; supermarkets, post offices, banks/ATM[s], as well as bus public transport options within 5 minutes walk, or 2 minutes bike ride of the house.

The original house design and materials are typical of this suburb, which was developed through the 1950[s]. The floor design is; two bedrooms and entrance to south side, kitchen/dining/living to centre and north west, and bathroom/laundry to north east. Materials are; timber frame, including stumps, floors, stud walls, ceiling and roof structure. The walls have asbestos cladding and plaster board lining. The roof is concrete tiles, which are not original. There was no insulation installed in the original building. There is a brick open fireplace situated with the house structure.

This type of building has extremely poor thermal capacity; the indoor temperature fluctuates with the ambient outdoor temperature, with very little thermal lag. The raised suspended floor contributes to this situation, as does the local topography, which had the west wall exposed to full summer sun.

Many of these poor design characteristics have since been rectified by an extensive retrofit and renovation of the existing home by the owner. Included in this is a two-room extension along the full west side of the original dwelling. The dwelling was purchased for three main reasons.

- o Location and Community. The suburb is located inner urban with sufficient public transport, primary school and shops nearby. It also has a strong and active community that support environmental and sustainability initiatives and many of the lots are being planted with native plant.
- o Site and House features. Due to its favourable orientation for solar access, including sloping topography inclining to the north west, and appropriate room zoning.
- o Landscaping. The site also had some established native trees and shrubs as well as an undulating topography.

Recent sustainability improvements to the original house include:

- Improving the passive solar capacity by installing additional windows to the north side of the house. Insulating the walls was also undertaken as well as removal of asbestos during this process.
- New R3.5 cellulose fibre insulation has been installed in the ceiling cavity.
- A whirlybird heat extractor installed in the roof tiles.

- Aesthetic improvements with the installation of CSR weathertex (reconstituted wood) exterior cladding to the walls, which also included installation of R1.5 thermofoil reflective insulation.

A recent home extension saw two new rooms along the western wall of the original house. A living room is situated on the northern end which has extensive solar access, and a bedroom/study to the south side A single carport was also added, which also shades the west wall from summer sun.. The floor is ~1.2m below existing floor level and is accessed by stairs constructed from reused timber. Externally the extension is blended with the original house in terms of cladding and rooflines. The extension to the western side of the house has been undertaken using environmentally sustainable principles where possible. These include:

- Extensive re-use of existing windows and doors;
- Reused jarrah door frames, window frames and roof and carport timbers;
- Collection of excess clay bricks from building sites for walls;
- Re-use of hardiflex cladding from the original western wall.

Thermal improvements include:

- Bulk insulation in the original west wall, which is now the internal wall, to improve thermal mass and as a sound barrier;
- Insulation of all the external walls using bulk insulation to the south wall and reflective foil to the west and north walls.
- Bulk insulation and astro-foil reflective insulation to the ceiling cavity.

New materials include:

- Concrete footings and slab
- Cement for brick mortar and wall render
- Gyprock lining
- Zincalume custom orb roof metal
- Electrical wiring. Many fits are reused

The estimated cost of the entire renovation from maximising the use of recycled and demolition materials as well as the major labour component by the owner amounted to approx. $A5,000.

HOUSE SPECIFICATIONS

House area 126 m^2.
Lot area 790m^2.

Original House

Floor area; ~92 m^2.

Age ~50 years old. Hilton Park was developed and constructed as post war, returned service state housing.

Description

- Topography / Elevation
  - Dwelling is built on sloping ground, declining to northwest.
  - Floor to ground: east side is approx 0.3m, west side is approx 1.2m.

Floor Plan

- Open plan to Living/Dining/Kitchen to centre and north. ~50% of floor area.
- Two Bedrooms and entrance/passageway to south side.
- Bathroom/Laundry to north east side.

Construction

- Timber framed on timber (Jarrah) stumps,
- Timber flooring, (Jarrah). No insulation under floor boards.
- Asbestos cladding,
- Plaster board (gyprock) lining,
- Concrete roof tiles.
- Ceiling and some wall insulation R4 rating.

- North Wall.
  - Rear of home faces to approx north at bearing ~345^o.
  - The back veranda has a metal roof that is reversed pitched to allow greater winter solar penetration.
  - 40% glass area including French doors and windows.
  - Walls have been re-cladded with hardiflex and insulated with R2.0 glass batts.
- East and South walls
  - Both have significant natural shading and do not attract significant summer sun.
  - Neither wall is insulated.
  - East wall has one window in kitchen, 2.0m^2 or 8% of total area.
  - South wall has windows to bedrooms and glass panelled front door equalling ~30% of wall area.

- Roofing
    - Tiles, being dark blue concrete attract and hold both summer and winter heat.
    - There is no reflective anticon under the tiles, which allows much heat transference to the roof cavity.
    - Ceiling has R3 cellulose fibre insulation.
    - A passive hot air suction vent (Whirly-bird) has been installed.

New Extension

Floor area, $34m^2$.

Construction.

- Flooring:
    - Concrete slab on ground, ~1.2m below original house floor.
    - Finished with Calmarc concrete paint.
- Walls:
    - Reverse brick veneer. Internal walls constructed of salvaged verticore bricks with cream cement render and finished with clear Calmarc sealer.
    - Hardiflex and weathertex cladding over 50mm pine battens, finished with commercial acrylic paint.
    - Cavity is lined with R1.5 thermo-foil reflective insulation (with double air cavity) to west and north. South wall is insulated with R2.0 reused glass batts.
- Roof / Ceiling.
    - Ceiling is pitched with the roof ~16^o with 230mm cavity
    - Ceiling has Gyprock lining with R2.0 reused fiberglass batts.
    - Roof is custom orb zincalume.
    - R2.5 Astro-foil insulation to underside of roof battens. Note: there are air cavities between the bulk insulation, the astro-foil and the roof sheets.

- Walls.
    - South wall has reused aluminium sliding door, ~ 45% of wall area. The aluminium gaps have been sealed with insulation.
    - West wall has one door opening that is shaded from summer sun. This door was included for the dual purpose of access and to allow cross flow ventilation. ~ 6% of wall area.
    - South wall has reused timber casement window to maintain consistency with existing house, ~25% of wall area.

NABERS score for Heading 1: LAND.
Total score 25 Stars (<3yr old) or 20 Stars (>3yr old).

LAND covers the impact that the building has on the land, and on the possible variety of animal and plant species that live there. Any building takes land away from the natural environment, the LAND heading looks at how the building's impact is minimised.

Score for 1a) Nature of site (buildings under three years old only)	N/A
Score for 1b) Total site area per m^2 of building	
More than 5 m^2 of site per m^2 of floor area	nil stars
Score for 1c) Total site area per person	
Up to 75 m^2 per person	nil stars
Score for 1d) Area of site planted with beneficial plants	
Above 80% local plants or food plants	5 stars
Score for 1e) Impermeably paved area of the site	
Up to 20%	4 stars
TOTAL for Heading 1: LAND	**9 Stars**
Divide by 4 subheadings for buildings over 3 years old	
NABERS score for Heading 1: LAND	**2.3 Stars**

NABERS score for Heading 2: MATERIALS.
Total score.15 Stars (>3yr old).

MATERIALS covers some of the environmental impacts of the materials of which the building is constructed, and ways in which these impacts may be reduced. There are key issues for choosing materials that MATERIALS does not cover, of which the most significant are:

Materials with a long life,
Materials with a short distance for transport to your site,
Materials that are as close as possible to their natural state, or least refined.

Score for 2a) Cost of building per m^2	
Cost up to $750 per m^2 **or** EE less than 12.5 GJ/m^2	4 stars
Score for 2b) Materials types for structure, walls, floors and roofs	N/A
Score for 2c) Age of building	
Up to 60 years	2 stars
Score for 2d) Time since last major renovation	
Less than 1 year	nil stars
TOTAL for Heading 2: MATERIALS	**6 Stars**
Divide by 3 subheadings for building **over** three years old	
NABERS score for Heading 2: MATERIALS	**2 Stars**

NABERS score for Heading 3: ENERGY.
Total score 25 Stars.

ENERGY measures the energy-related emissions that are caused by the building. The emissions of greenhouse gases as a result of the burning of fossil fuels to supply energy to buildings are a large part of Australia's contribution to climate change. Homes cause a greater proportion of these emissions than do commercial buildings. Fuels may be used directly, (gas, coal or oil), or they may be burned in power stations to make electricity.

Score 3a) Energy efficiency	
Total energy consumption up to 50 kWh/m^2	4 stars
Score 3b) Greenhouse emissions of the whole building	
Emissions up to 135 kg CO_2/m^2/year	5 stars
Score 3c) Greenhouse emissions for high performance buildings	
Emissions up to 30 kg CO_2/m^2/year	4 stars
Score 3d) Renewable electricity use	
No renewable energy use	nil stars
Score 3e) Homes that produce more energy than they consume	
	nil stars
TOTAL for Heading 3: ENERGY	**13 Stars**
Divide by 5 subheadings	
NABERS score for Heading 3: ENERGY	**2.6 Stars**

NABERS score for Heading 4: WATER.
Total score 10 Stars.

WATER considers the impact of a home's water consumption, and the sources of the water used. Water is increasingly a scarce resource in Australia and the rest of the world. Supplies are being taken from reserves below the ground, which are becoming depleted as they are not refilled as fast as the water is being extracted.
Perth average consumption = 335,000 Litres = 367 Lt/day/person (2.5 people/house)
Snook average (1999-2002) = 126,000 Litres = 173 Lt/day/person

Score for 4a) Water consumption from mains or borehole	
Consumption above 50 m^3/person/year - 135 Lt/person/day	nil stars
Score for 4b) Source of on-site water supply	
No water supplied from on-site sources	nil stars
TOTAL for Heading 4: WATER	**Nil Stars**
Divide by 2 subheadings	
NABERS score for Heading 4: WATER	**Nil Stars**

NABERS score for Heading 5: INTERIOR.

Total score 10 Stars.

INTERIOR covers issues that affect the quality of the indoor air. Since people spend about 95% of their time in buildings, it is important that the quality of the air in buildings is high. Indoor air quality (IAQ) is directly related to the kinds of materials and systems used in the building. There is as yet no simple way of measuring IAQ, so this subheading has to be prescriptive, a list of things that should either be there or not be there to achieve good IAQ.

Score for 5a) Indoor air quality	
Water based paints/varnish to floors, walls and ceilings (site applied)	1 star
Extractor fans + door and window vents in kit, bathrm, toilets	2 stars
No smoking allowed in the home	2 stars
TOTAL for Heading 5: INTERIOR	**5 Stars**
NABERS score for Heading 5: INTERIOR	**5 Stars**

NABERS score for Heading 6: RESOURCES.

Total score 10 Stars.

Society uses a large amount of resources to create its buildings. Resources considers how effectively it exploits these resources in terms of overall efficiency of use.

Score for 6a) Total building area per person living in the building	
Up to 60 m^2 per person	1 star
Score for 6b) Use of the building – number of weeks per year	
365 days a year (7 days a week, 52 weeks – full-time)	5 stars
TOTAL for Heading 6: RESOURCES	**6 Stars**
Divide by 2 subheadings	
NABERS score for Heading 6: RESOURCES	**3 Stars**

NABERS score for Heading 7: TRANSPORT.
Total score 30 Stars.

The impact of transport on the environment in Australia is greater than that of buildings in terms of day-to-day greenhouse emissions. Much of society's demand for transport is created by the way we build and locate our buildings and settlements. The first 3 subheadings look at the ways in which demand for transport could be reduced by appropriate decisions on location. The next 3 look at ways in which a household might try to reduce its transport-related greenhouse emissions in terms of behaviour.

Score for 7a) Distance to nearest local shop	
Up to 400 metres walk from front door	2 stars
Score 7b) Distance to nearest local supermarket/bank/post office	
Less than 2 kilometres	5 stars
Score for 7c) Distance to nearest urban centre	
Up to 4 kilometres	4 stars
Score for 7d) Percentage using alternative transport	
More than 50% using bus/tram	4 stars
Score for 7e) Total engine capacity	
More than 1000 cc per person	nil stars
Score for 7f) Total km per year driven by the household	
Up to 7,500 kms per year	3 stars
TOTAL for Heading 7: TRANSPORT	**18 Stars**
Divide by 6 subheadings	
NABERS score for Heading 7: TRANSPORT	**3 Stars**

NABERS score for Heading 8: WASTE.
Total score 20 Stars.

Score for 8a) Use of on-site composting facilities	
All organic garden waste and food waste appropriately composted	5 stars
Score for 8b) Provision of on-site recycling facilities	
Use of on-site recycling facilities	5 stars
Score for 8c) Provision of local collection of recyclable materials	
Provision of local collection of recyclable materials	5 stars
Score for 8d) Use of more sustainable sewage treatment systems	
Use of more sustainable sewage treatment	nil stars
TOTAL for Heading 8: WASTE	**15 Stars**
Divide by 4 subheadings	
NABERS score for Heading 8: WASTE	**4 Stars**

Totals by Heading.

Main Heading	Sub-Headings	Total Possible Score.	Measured Score	Percentage	Average Stars for Main Heading.
1. Land	4	20 Stars.	9 Stars.	45%	2.3
2. Materials	3	15 stars.	6 Stars.	40%	2
3. Energy	5	25 Stars.	13 Stars.	52%	2.6
4. Water	2	10 Stars.	0 Stars.	0%	Nil
5. Interior	1(1+1)	10 Stars.	5 Stars.	50%	5
6.Resources	2	10 Stars.	6 Stars.	60%	3
7. Transport	6	30 Stars.	18 Stars.	60%	3
8. Waste	4	20 Stars.	15 Stars.	75%	4
Totals	28	140 Stars.	72 Stars.	51%	

The NABERS Rating System

Fill in your total scores under each Heading in the list below (the scores from the line marked TOTAL in the scoring box at the end of each Heading). Then add all eight scores to get your basic NABERS score.

TOTAL for Heading 1: LAND	9 Stars
TOTAL for Heading 2: MATERIALS	6 Stars
TOTAL for Heading 3: ENERGY	13 Stars
TOTAL for Heading 4: WATER	0 Stars
TOTAL for Heading 5: INTERIOR	5 Stars
TOTAL for Heading 6: RESOURCES	6 Stars
TOTAL for Heading 7: TRANSPORT	18 Stars
TOTAL for Heading 8: WASTE	15 Stars
BASIC TOTAL	**72 STARS**

Convert to a percentage:

BASIC TOTAL divided by 140, then multiplied by 100

51 %NABERS SCORE

Calculate your NABERS Medal Rating:

You need only to have five stars in four Headings to qualify for NABERS Platinum, but in all other cases the stars must be earned in all eight headings.

Stars ®	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	0.5	0
1:						X					
2:							X				
3:						X					
4:											X
5:	X										
6:					X						
7:					X						
8:			X								

NABERS Basic

Your NABERS Basic score is the total sum of all your stars earned, as calculated above

Appendix 6

Sustainable Planning, Building, Design and Construction Sector in Western Australia.

Background Discussion Paper for the

State Sustainability Strategy (SSS)

Pages 8 - 12

By David Beyer

SUSTAINABLE BUILDING and CONSTRUCTION.

Initiatives and Regulatory Options towards a Sustainable Planning, Building, Design and Construction Sector in Western Australia.

Background Discussion Paper for the Western Australia State Sustainability Strategy (SSS)

David Beyer
July 2002

This discussion paper concerns the processes and essential elements of the built environment and suggests that they can operate in a supportive and synergistic manner to achieve a sustainable living environment. In recognition that there are already moves within various parts of the building and construction sector to create a sustainable built form, and that there is strong community interest in sustainable living, the main focus is on the role of the Western Australian State Government in supporting these moves.

(Note. This paper is abridged from the original document, and only contains Pgs 8-12)

There is a very clear commitment to sustainability from elements of all stakeholder groups including government agencies. Many industry and community associations have strategies and plans that specifically suggest government support for initiatives to promote change for sustainability in their sector. Although many of the programs and initiatives are targeting energy efficiency and consumption as a response to global warming, nonetheless they contain many of the broad principles of sustainability as well. This section will highlight the key initiatives and programs from key stakeholder groups that are currently in operation.

Government (Federal)

There are many programs that have resulted from the work of the federally funded Australian Greenhouse Office [1] and Environment Australia[2], which are aimed at achieving attitudinal, behavioural and operational change in government, industry and the community.

The AGO is assisting to reform the Building and Construction Sector (BCS), including the Home Residential Sector (HRS). The primary focus of this reform is to reduce carbon emissions by creating more energy efficient buildings as well as improving occupant behaviour within the home.

Although many of their initiatives are greenhouse related, they link directly into the principles of ecological sustainable development (ESD). Relevant information in regards to BCS includes:

- Building Efficiency (http://www.greenhouse.gov.au/energyefficiency/building)
- Appliances and Equipment. (http://www.greenhouse.gov.au/energyefficiency/appliances)

[1] Australian Greenhouse Office. http://www.greenhouse.gov.au
[2] Environment Australia. http://www.ea.gov.au

Environment Australia (EA) is closely aligned to the work of the AGO in the context of building and construction. Their Sustainable Industries Branch[3] has a strong focus on the construction industry as a key way of introducing sustainability principles into mainstream society. To date some of its programs include:

- Waste Wise Construction Program
  http://www.ea.gov.au/industry/waste/construction/wastewise
- HIA PATHE Program (see below) http://www.hia.asn.au
- LCA Project with RMIT (see below) http://buildlca.rmit.edu.au/
- National Australian Building Environmental Rating System (NABERS).
  http://www.ea.gov.au/industry/waste/construction/abers
- Recycled Concrete and Masonry
  http://www.ea.gov.au/industry/waste/construction/concrete
- Your Home - The Good Residential Design Guide (see below)
  http://www.yourhome.gov.au/

Its also has numerous publications which promote sustainable practice including:

- Environmental Management System (EMS) model guide for Commonwealth Agencies
  http://www.ea.gov.au/industry/sustainable/greening-govt/ems.html
- Environmental Management System for private sector businesses
  http://www.ea.gov.au/industry/eecp/tools/tools2.html
- Green Procurement Guide http://www.ea.gov.au/industry/sustainable/greening-govt
- Eco-efficiency.
  http://www.ea.gov.au/industry/eecp/tools/tools12.html
- Environmental Labeling.
  http://www.ea.gov.au/industry/eecp/tools/tools8.html
- Framework for Public Environmental Reporting to suit Australian organisations and local requirements.
  http://www.ea.gov.au/industry/eecp/publications/per.html
- A Green Office Guide to assist in the purchasing of energy efficient office equipment.
  http://www.ea.gov.au/industry/sustainable/greening-govt/green-office-guide.html

The CSIRO Division of Building Construction & Engineering [4]also have initiatives for sustainable building and construction.

Three key programs that link all areas of the BCS are Your Home, GreenSmart, and Cool Communities.

- The Your Home technical manual developed and produced by Environment Australia (EA) and Australian Greenhouse Office (AGO) in 2001 is a definitive design and construction kit that gives comprehensive information on all aspects of sustainable housing and is appropriate for use by both professionals and the public. (http://www.yourhome.com.au)

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[3] Environment Australia, Sustainable Industries Branch. http://www.environet.ea.gov.au

[4] CSIRO Building Construction & Engineering. http://www.dbce.csiro.au/index.cfm

- GreenSmart is an industry based initiative that resulted from a partnership involving the Housing Industry Association (HIA)[5], the AGO and EA. Its aims are to promote increased energy efficiency, minimise waste and encourage better environmental management at each stage of manufacture, design, and construction process. GreenSmart includes professional training and accreditation, which requires a code of conduct and compliance with an annual update, industry networking through forums, and newsletters, and best practice awards and case studies. (See Landcorp below.). GreenSmart is an example of appropriate implementation achieving recognisable change. (http://www.greensmart.com.au)
- Cool Communities, an AGO sponsored program, is a public focused greenhouse initiative that aims to bring greater awareness and behavioural change into the residential home.. (http://www.greenhouse.gov.au/coolcommunities).

Government. (State).Western Australia

The Department for Planning and Infrastructure (DPI)[6], has developed the Liveable Neighbourhoods community design code. Recognised internationally as a model of best practice in planning and subdivision development, this performance based code can be used as a more sustainable alternative to the existing 'development control policies' in that it has the potential to create a structural urban framework that should help to reduce car dependence, increase lot and housing variety, and facilitate access to Perth's public transport system. A trial Liveable Neighbourhoods policy will be evaluated in late 2002. Statement of Planning Policy No.8 (SPP8) draws together existing state and regional planning policies in a guidance framework that aims "to provide for the fair, orderly, economic and sustainable use and development of land"[7] although within the context of sustainability the level of implementation is not explicit.

Residential Design Codes or R-codes are used to guide and plan residential development are incorporated in local government town planning schemes. The R-Codes have been under review since 1999. Draft changes include; greater reliance on performance criteria, moderate density increases and distinctions for inner and outer urban living, restrictions on overshadowing, limits on building heights. The Future Perth project aims to give a strategic planning direction for the metropolitan region for the next 10-20 years.

The DPI is a critical player in facilitating a more sustainable urban and built form and can play a more dynamic role in defining both green field and infill development in a more sustainable way.

The Department of Housing and Works (DHW)[8], through its Office of Policy and Planning (OPP)[9], is currently writing the Housing Strategy WA. This document has yet to address specific sustainability criteria though it states that "the Housing Strategy has embraced the three areas of

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[5] Housing Industry Association (HIA). http;//www.hia.asn.au

[6] Department for Planning and Infrastructure (DPI). http://www.planning.wa.gov.au/

[7] WAPC, 2000 ***Statement of Planning Policy No.8 : State Planning Framework Policy (variation No.1)*** Prepared under section 5AA of the Town Planning and Development Act 1928 (as amended) by the WAPC and Issued with approval of the Minister for Planning and His Excellency the Governor.

[8] Department of Housing and Works (DHW). http://www.dhw.wa.gov.au

[9] Office of Policy and Planning (OPP). http://www.ohp.dhw.wa.gov.au

the triple bottom line approach i.e. social, economic, and environment."[10] Landstart is charged with the development of surplus government land predominately for first homebuyers who often take advantage of the government sponsored Keystart home loan scheme.

These agencies within DHW have great potential to influence sustainable housing for the socially disadvantaged in terms of location and housing product.

Landcorp[11] is creating a more sustainable approach to housing development. The main interest of Landcorp is the development of surplus government land whilst attaining social and financial returns to the state. A current Landcorp project, located at Atwell South in the City of Cockburn is being developed with many sustainability principles. Atwell South has been designed to Liveable Neighbourhoods and GreenSmart principles.

Accordingly Landcorp, being an agency similar to DHW, is well positioned to become a market leader in setting higher standards of sustainability for land development and building.

The Department of Environment, Water and Catchment Protection (DEWCP)[12], has attempted to influence waste management through WAste 2020 which outlines a programme to eliminate waste to landfill by 2020.

Sustainability covenants that cover the entire production and user life cycle stages from mining to post consumer are recent developments that DEWCP should develop for implementation.

DEWCP is most appropriate State Government agency for applying influence over the materials component of the BCS. One possible mechanism is a sustainability covenant.

Sustainable Energy Development Office (SEDO)[13] provides technical, financial and educational support for a variety of programs, including those associated with and similar to the AGO and EA. SEDO is also aiming to implement First Rate which is a Victorian based home energy rating system.

In terms of the energy component of sustainability SEDO can promote initiatives for change in this state within other government agencies, and in industry and the community.

The Department of Local Government has the Building Control Section, which is mainly responsible for issues in building regulation and in light of current and proposed reviews within the BCA, this agency may take on a more influential role in supporting the sustainable building and construction transition.

The Western Australian Local Government Association (WALGA)[14] is the representative voice in W.A. and exerts influence on how policy decisions are made that affect Local Government. It has a number of policies relating to building and land use (planning) and a Sustainability and Environment policy. It also has a document which set out Proposals for a Building Act for Western Australia that proposes the concept of private certification of building surveyors for housing approvals.

WALGA, like many associations, can play both a representative and an influential role by clearly enunciating policies and initiatives for change.

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[10] Office of Policy and Planning 2001 *Housing Strategy WA: Conceptual Framework and Methodology*, published by the Department of Housing and Work. http://www.ohp.dhw.wa.gov.au

[11] Landcorp. http://www.landcorp.wa.gov.au

[12] Department of Environment, Water and Catchment Protection (DEWCP). http://www.environ.wa.gov.au

[13] Sustainable Energy Development Office (SEDO). http://www.sedo.energy.wa.gov.au

[14] Western Australian Local Government Association (WALGA). http://www.walga.asn.au

Government. (State) Eastern

Similar to SEDO in W.A, other state government agencies offer a number of energy related programs and initiatives. Specific to the HCS are various information packages that detail the process for designing, constructing and occupying a dwelling. As yet no government based initiative such as these exists in W.A. The key programs include;

- Energy Smart Building (Sustainable Development Authority of Victoria)
  - http://www.seav.vic.gov.au/building/index.html
- GetSmart Homes.(Housing Tasmania.)
  - http://www.dhhs.tas.gov.au/housing/partners/builderscontractors/
- Smart Housing.(Dept of Housing) Queensland)
  - http://www.smarthousing.qld.gov.au/
- ESD Fit-out Guide for Office Accommodation.(Dept of Public Works, Queensland)
  - http://www.build.qld.gov.au/aps/aps.htm
- Environmental Performance Guide for Buildings (Dept of Public Works and Services, NSW)
  - http://asset.gov.com.au/environmentguide/ehp/frameset.htm

Industry

Industry based initiatives are usually resultant from either government support or a more individual ethical response to ecological issues as well as an attempt to stimulate best practice. Some of these initiatives fall into the category of action based, whilst others are position papers or vision and mission statements.

The Housing Industry Association (HIA)[15] is a national body that is actively involved in sustainable housing through programs and recommendations. Amongst its recent position statements and documents are its National Housing Plan (2001) and the Better Living Environments (2002). Both these papers propose a national housing approach to deal with economic and social impacts of housing. Better Living Environments sets out a reform agenda for the planning approval systems for residential development. The HIA has an action-orientated initiative in GreenSmart. Although voluntary, this program requires a commitment from accredited participants but has no mechanism to enforce compliance other than non-renewal of accreditation. The HIA also offers a reduced interest rate home loan in conjunction with the Macquarie bank for new and existing homes. The GreenSmart Home Loan offers clients a reduced home loan interest rate, up to 0.4%less than major banks, plus other incentives if the home has proven energy efficiency features, such as those included in the GreenSmart and Your Home guidelines. (See financing below.)

The Royal Australian Institute of Architects (RAIA)[16] is committed to sustainability and has a number of policy and educational initiatives to support its position. Its Code of Professional Conduct, Environmental Policy, and Sustainability Policy reaffirm the responsibility of the architectural profession to contribute to the quality and sustainability of the natural and built environments. They also publish a quarterly Environment Design Guide, which is produced by the Australian Council of Building Design Professions (BDP). This publication aims to increase

[15] Housing Industry Association (HIA). http://www.hia.asn.au/
[16] Royal Australian Institute of Architects. http://www.raia.com.au/

awareness on environmental design for a wide-ranging audience including architects, engineers, landscape architects, planners and quantity surveyors, in addition to local government and educational bodies.

The local Western Australian chapter recently published a 'Proposed Policy on the Built Environment for Adoption by the W.A. State Government" and calls on the government to "become a leader in policy toward the built environment."[17]

Similar positions, aims, visions and policy statements as these are held for the following associations. All support ESD principles and practices, including improvements in planning, sub-division development, and design.

- Australian Council of Building Design Professionals (BDP)
  http://www.bdp.asn.au
- Building Designers Association of Australia (BDAA)
  http://www.bdaa.com.au
- Australian Building Energy Council (ABEC)
  http://www.abec.com.au
- Royal Australian Planning Institute (RAPI).
  http://www.rapi.com.au
- Australian Housing and Urban Research Institute Limited (AHURI)
  http://www.ahuri.edu.au

This is not intended to be a definitive list of organisations that are involved in sustainability. Similarly, there are numerous educational and community groups that are active in sustainable housing in W.A including;

- UNEP-IETC Environmental Technology Centre, Murdoch University.
  http://wwwies.murdoch.edu.au/etc/
- Centre for Organic Waste Management, Murdoch University.
  http://cowm.murdoch.edu.au/
- Institute for Sustainability & Technology Policy, Murdoch University.
  http://wwwistp.murdoch.edu.au/
- Centre for Cleaner Production, Curtin University.
  http://cleanerproduction.curtin.edu.au/
- School of Architecture, Construction and Planning, Curtin University.
  http://www.humanities.curtin.edu.au
- School of Architecture and Fine Arts. University of Western Australia.
  http://www.safa.uwa.edu.au/
- Conservation Council of WA. http://www.conservationwa.asn.au/
- Permaculture Association of W A. http://www.eepo.com.au/perma/pawa/

[17] (Royal Australian Institute of Architects, W.A Chapter, 2002. *Proposed Policy on the Built Environment for Adoption by the W.A. State Government.*