SUSTAINABILITY AND THE BUILDING CODE OF AUSTRALIA

Report 2001-013-B

The research described in this report was carried out by

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Research Program B:
Sustainable Built Assets

Project 2001-013-B :
Sustainability and the Building Code of Australia (BCA)

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PREFACE

This report is the culmination of a scoping study intended to inform participants of the Australian Cooperative Research Centre and the property and construction industry regarding sustainability trends and provisions in property and construction, and in particular whether sustainability should be an objective of the Future Building Code of Australia (BCA21). The scoping study was made up of two parts: the Stage 1 report (the literature review) and the Stage 2 report (the workshops). The findings of these two stages underpin the overarching conclusions and recommendations.

This work is part of the Cooperative Research Centre for Construction Innovation's program in collaboration with the Australian Building Codes Board and Environment Australia.

EXECUTIVE SUMMARY

This report is the culmination of a two-stage research project to inform the Australian property and construction industry generally, in addition to providing the Australian Building Codes Board (ABCB) with information to allow it to determine whether or not sustainability requirements are necessary in the Future Building Code of Australia (BCA21). The Australian Building Codes Board is a joint initiative of all levels of government in Australia. The Board's mission is to provide for efficiency and cost effectiveness in meeting community expectations for health, safety and amenity in the design, construction and use of buildings through the creation of nationally consistent building codes, standards, regulatory requirements and regulatory systems.

The Stage 1 (literature review) and Stage 2 (workshops) reports are intended to be read in conjunction with one another. These reports and the Database are provided as appendices. The Conclusions of this, the final report, are the result of the overall program of work.

The research was defined by the following objectives:

- To examine overseas sustainability requirements for buildings and outline the reason why it is controlled and regulated (i.e., political, environmental etc) in the particular country, state, principality etc.;
- To examine studies focusing on sustainability developments in buildings in Australia and overseas; and
- To identify potential issues and implications associated with sustainable building requirements; and
- To provide advice on whether provisions are necessary in the BCA21to make buildings sustainable; and
- If the study determines there is a need for sustainability requirements in the BCA21, the study is to demonstrate the need to control and regulate along with the method to control and regulate.

The research found that regulating sustainability becomes complex when making trade offs between environmental, social and economic concerns. Key points include:

- Building construction and associated activities impose significant impacts on the environment.
- Local and State Governments are introducing their own sustainability regulations for building and land use.
- The community is increasingly voicing concerns on environmental issues.
- For sustainability to be regulated there must be a demonstrated case of 'market failure'.
- The Building Code of Australia is just one of many tools available to governments of all levels for implementing sustainability.
- Many major sustainability issues are well outside the scope of the current BCA. Whether the scope of the BCA needs to be extended so that it can manage sustainability more effectively is a question that needs to be considered.

Based on the views of the workshop participants, the research concluded the following recommendations:

1. That a definition of sustainability be agreed upon in the context of building and construction (for the purposes of development of the BCA21).
2. That the ABCB considers the four following options:
   (a) The ABCB adopts sustainability as a theme and a goal for the BCA21.
   (b) The ABCB adopts sustainability as a theme only for BCA21.
   (c) The ABCB considers introducing sustainability as a goal only for the BCA21.
   (d) The ABCB not address sustainability in any capacity at this time.

3. That the considerations for undertaking Regulatory Impact Statements (RIS) be reviewed.
4. That the ABCB considers introducing criteria for selecting which specific sustainability issues to be included in the BCA21.
5. That the ABCB draws up a list of sustainability issues to be considered for regulation in the BCA21.
6. That the ABCB draws up a list of sustainability issues which are not suitable for regulation but where National consistency is desirable.
7. That the ABCB be prepared to act as the National coordinator on all regulatory matters regarding sustainability in building construction, bearing in mind that other regulators may also be involved.
8. That the ABCB considers monitoring overseas developments on sustainability in building and construction, particularly those associated with policy, regulation, standards and consequences of adopting specific sustainability practice.
9. That the ABCB considers undertaking an educational / informational program to keep the building and construction industry and the Australian community up to date with building-related sustainability issues.

In understanding the implications of the above recommendations, further research topics were identified. A brief outline of these is as follows:

- Design of a generic framework (management strategy). A generic framework for establishing the context, identification, analysis, evaluation, treatment, monitoring and communication of sustainability needs to be developed so that its implementation can be made effective.
- Development of an education strategy. All workshop participants agreed on the importance of education in introducing sustainability considerations into buildings. However, the details of what a nationally consistent education and information program on sustainable construction might consist of needs to be developed.
- Monitor international developments. Sustainability is a worldwide movement; literature on the subject as well as other activities such as policy and standard development are occurring at a very rapid rate. In order to benefit from these international activities, a strategy for monitoring these developments needs to be devised.
- National coordination. Almost all workshop participants acknowledged that activities concerning sustainability are occurring at all levels of government as well as industry, and recognise the need for national coordination. Who is best to carry out this work, what would a national co-ordination framework look like, and what role the ABCB could play in its establishment and maintenance?
- Understanding the regulatory implications of adopting sustainability. The regulatory implications of adopting sustainability as a theme and as a goal for the BCA21 need to be fully understood.
- Model for Regulatory Impact Statement (RIS). The current model for regulatory impact assessment is based mainly on financial cost-benefit analysis. This model might need to be further elaborated if sustainability is to be considered in an RIS.
- Benchmarking. Establishing appropriate benchmarks for monitoring the progress of any specific sustainability issue as well as the overall progress of the sustainability program is an essential part of any sustainability management strategy.

The final decision rests with the Australian Building Codes Board and is likely to be made by February of 2004.

INTRODUCTION

The Australian Building Codes Board (ABCB) is currently developing a Future Building Code (BCA21) that will replace the Building Code of Australia 1996 (BCA96). The purpose of this research is to provide the Australian Property and Construction Industry and the ABCB with information that will allow it to determine whether sustainability requirements are necessary in the BCA21. To make this decision, the ABCB requires information on overseas sustainability requirements for buildings, sustainable building developments in Australia and overseas, identification of issues and implications associated with sustainability requirements for buildings and advice on how sustainability requirements for buildings should be regulated.

The ABCB is a joint initiative of all levels of government in Australia. The ABCBs mission is to meet community expectations of safety, health and amenity in design, construction and use of buildings through nationally consistent, efficient and cost effective technical building requirements and regulatory systems. Research in support of regulatory reform is a key activity in the achievement of this mission.

The need for sustainable buildings is a recurring theme at both national and international levels. For example, the National Australian Building Environment Rating System (NABERS) project currently being undertaken by Environment Australia is a clear signal from the Federal Government of its intention to lift the bar of environmental performance of Australian buildings. National conferences being convened by the ABCB in conjunction with the Institute for International Research (Green Buildings, 23-25 June 2003) and the Australian Institute of Building Surveyors (Building for a Global Future, 15-17 September 2003) are complementary signals of changing attitudes to sustainable development in general and buildings in particular. Both the International Council for Research and Innovation for Building and Construction (CIB) and the International Standards Organisation (ISO) hold regular meetings and conferences on sustainable building issues and have various working groups and technical committees on elements of sustainable construction.

METHOD

This research was broken down into two stages. Stage 1 was a literature review of international requirements as well as current thinking and practice for sustainable building developments. An interim report (the Stage 1 report) was submitted at the end of this stage.

Stage 2 identified issues and implications of sustainability requirements for buildings and advice on whether provisions are necessary in the BCA21. If the study determined there was a need for sustainability requirements it also was to demonstrate the need and method to control and regulate. To achieve these objectives, Stage 2 included workshops in all capital cities and involved key stakeholders, such as regulators, local government and representatives from key associations. The marketing and delivery of all workshops emphasised the partnership that the Australian Cooperative Research Centre for Construction Innovation and ABCB have formed in the shaping of Australia's Future Building Code. The Australian Cooperative Research Centre is a national research, development and implementation centre focused on the needs of the property, design, construction and facility management sectors.

This final report brings together the work of both stages, along with a searchable internet database of references.

CONCLUSIONS

While it is not appropriate for this report to advise the Board on the 'best' course of action the recommendations provide supporting argument and outline the implications of a range of decisions. Preferences are implied throughout the supporting documentation (Stage 1 and 2 reports), but are not of significance to indicate support for one particular outcome over another. The final decisions and subsequent course of action will be a policy decision made by the Australian Building Codes Board throughout late 2003 and early 2004.

Recommendations

Nine recommendations have been drafted for consideration with recommendation 1 a pre-requisite to the decision-making process. Following this, there are four specific recommendations to choose between (2a, b, c, d): to adopt sustainability as a theme and a goal; to adopt sustainability as a theme only; to adopt sustainability as a goal only; or to adopt neither. The adoption of recommendations 3, 4, 5 and 6 are dependent on which of the four specific recommendations are selected.

Recommendations 7, 8 and 9 are generic recommendations that can be adopted regardless of which option is selected. These generic recommendations were derived from the major common themes that emerged from the workshop sessions. They are not mutually exclusive with recommendation 2 or any of their implications. (See Figure 1 for further clarification). Each recommendation has a number of considerations which need to be taken into account; these have been discussed based on the views put forward by the workshop participants.

Note: BCA21 is the name given to the Future Building Code of Australia.

1. That a definition of building and construction sustainability be agreed (for the purposes of development of the BCA21).

The choice of definition has an important bearing on whether the BCA21 should consider sustainability in its development and in what capacity. For example, some definitions may require that the scope of the Code be reviewed and changed (which will require the agreement of all States and Territories), whereas other definitions may not.

Most workshop participants favoured a 'triple bottom line' perspective i.e., the inclusion of ecological, economic and social concerns. An example they derived is *'a way of building or construction which is economically affordable, socially acceptable, and reduces the negative health and environmental impacts caused by the design and construction process or by buildings or by the built environment'.*

2. That the ABCB considers one of the four following options:

(a) That the ABCB adopts sustainability as a theme and a goal for the BCA21.

Most of the workshop participants had difficulty in distinguishing the meaning and implications of the terms 'theme' and 'goal' in the regulatory context. While the majority strongly thought that sustainability should be in the BCA21, this lack of clarity meant that there was no clear preference for a goal or theme or both.

Adopting sustainability as a *theme* would mean that **all** provisions of BCA21 should be examined for their impact on sustainability. In practice this means that each requirement of the BCA21 would be subject to sustainability principles. What these principles are will depend on the definition of sustainability chosen, but are likely to be along the lines of the following:

- recognising the carrying capacity of the earth
- improving the quality of life for all, and
- taking into account future generations.

Applying these principles to each provision of the BCA21 would be conceptually challenging, but would deliver a clear signal to the industry that an integrated approach to sustainability is desirable.

Goals are different from *themes* in that they define the **scope** of the BCA21. Adopting sustainability as a goal would allow provisions to address specific sustainability issues to be added in the future. With the addition of sustainability as a goal, the provisions of BCA21 would then be grouped as three basic categories: safety, health and amenity, and sustainability.

(b) That the ABCB adopts sustainability as a theme only for BCA21.

The same implications arise for this option as in recommendation 2a, but are limited to those discussed based on its adoption as a theme. Some workshop participants thought that adopting sustainability as a theme only would be interpreted by industry as a token gesture, and would be too easily 'watered down'. Others thought that the theme approach would be a good 'first step'; a way of testing the practical implementation issues/problems in a less rigorous/binding manner than that required if it was adopted as a goal.

(c) That the ABCB considers introducing sustainability as a goal only for the BCA21.

The same implications arise for this option as in recommendation 2a, but are limited to those discussed based on its adoption as a goal. The general consensus from the workshop participants was that to adopt sustainability as a goal is a 'more robust' signal from Government that sustainability is an issue that needs to be taken seriously in the building and construction Industry. It would also (more easily) allow the addition of sustainability issues as the need arises in the future.

NB: The existing objectives of 'safety', and 'health and amenity' are currently regarded as both themes and goals in BCA96. To avoid confusion, it is suggested that sustainability be adopted in the same capacity as the existing objectives will be in the BCA21.

(d) That the ABCB not address sustainability in any capacity at this time.

A minority of workshop participants were not comfortable with sustainability becoming a core business issue for the ABCB. In particular, there are potential conflicts at the interface of building regulation with planning and plumbing legislation. It was noted that a rejection of sustainability could have negative political implications in light of growing community, state, national and international expectations.

3. That the considerations for undertaking Regulatory Impact Statements (RIS) be reviewed.

If sustainability is to be adopted (2a, b or c), the current considerations for determining whether an issue be regulated needs to be reviewed. It is 'optional' for recommendation 2c as it is possible to introduce sustainability issues under the goal–only approach that comply with the current RIS criteria. The argument for review is based on the premise that the current established process for drafting building code provisions/requirements (using the economic evaluation model agreed to by COAG) already addresses economic and social concerns, whereas the ecological dimension is not explicit.

The Office of Regulation Review (ORR) has already indicated to the ABCB that both economic and environmental impacts need to be included in the RIS. Hence, there may be a conflict between the requirements of COAG and ORR. A process for assessing the costs and benefits of ecological impacts both now and in the future using the current economic model is still to be rigorously established.

Most workshop participants agreed that the RIS considerations be reviewed. Suggestions included: the adoption of a new model altogether; a review of how to incorporate environmental issues into the current model; and that the assessment be introduced much earlier in the process before decisions to regulate are made.

4. That the ABCB considers introducing criteria for selecting which specific sustainability issues are to be included in the BCA21.

If it is decided to introduce sustainability as a goal (acceptance of recommendation 2a or 2c), then to avoid introducing sustainability provisions on an *ad hoc* basis, criteria for selecting sustainability issues need to be established. The Stage 1 report discusses a range of issues, but these are only starting points for more thorough feasibility studies. Suitable criteria could include the following:

Generic criteria

- Be part of the global sustainability agenda.
- Have national and industry benefits (needs to be considered in the context of political and economic imperatives: growth, development, social advancement).
- Enhances industry rather than handicapping it (if the actions are out of step with global sustainability agenda).
- Establish the case that there is a market failure according to the COAG agreement
- Have a well defined objective.

Technical criteria

- Be within the scope of the BCA21.
- The requirements must be expressed in performance-based terms.
- Must not be in conflict with other requirements in the BCA21.
- Means of compliance must be provided, including paths for innovative solutions.
- Must establish some sustainability indicators to assess the effectiveness of the measures.
- Need clear governance and implementation strategies.
- Need technical and educational support systems.

5. That the ABCB draws up a list of sustainability issues to be considered for regulation.

Based on the criteria for selection (as a result of recommendation 4), a list of potential sustainability issues to be considered for regulation should be compiled. There are many potential topics that could be included under the mantle of sustainable construction, some of which were elaborated upon in the workshops. Examples include:

- Durability
- Embodied energy
- Operating energy
- Use of renewable energy
- Choice of materials (material selection)
- Use of hazardous substances (wood preservatives, storage for hazardous materials)
- Choice of appliances
- Construction & Demolition waste (reuse, recycling, reduction)
- Operating waste (organic vs. inorganic)
- Climate change
- Adaptability (renovation vs. deconstruction)
- Accessibility
- Indoor air quality
- Noise
- Water quality

- Water efficiency
- Urban salinity
- Soil quality
- Site selection
- Biodiversity
- Security (lighting, smoke alarms)

Views of the workshop participants varied as to which issues should be regulated or not, and at what level (local, state or national). The establishment of criteria should assist the selection process and ensure that it is undertaken in a structured and consistent manner.

6. That the ABCB draws up a list of sustainability issues which are not suitable for regulation but where national consistency is desirable.

Based on the criteria for selection (as a result of recommendation 4), many major issues in sustainability may not be suitable for regulation at the current time. It may be appropriate for the ABCB to establish a process for their staged introduction starting with non-mandatory measures, such as guidelines. Workshop participants supported the use of non-mandatory measures as starting points to allow industry time to get used to the ideas and design professionals to develop appropriate tools/incentives.

7. That the ABCB considers undertaking a role in the national coordination of all regulatory matters regarding sustainability in building and construction, bearing in mind that other regulators may also be involved.

Many initiatives for implementing sustainability in building and construction have been, and are being, undertaken by Local, State and Federal Government in Australia, often independently (Section 2.7 and Appendix 3 of the Stage 1 report indicates the level of activity being undertaken).

Workshop participants identified 'institutional fragmentation' as a key barrier to progressing sustainability in a coherent and integrated manner. Participants identified a risk that the ABCB may be "left behind" on this issue and face similar recriminations to those voiced with the introduction of the energy efficiency provisions.

Workshop participants clearly stated that it is desirable for all sustainability activities to be coordinated in a general framework for the whole of Australia. The ABCB has an infrastructure network covering all levels of government and it should consider using its unique ability to coordinate all these activities for the benefit of Australia. The ABCB exists to bring consistency to national building regulation and sustainability is one area where workshop participants stated that national consistency is highly desirable. One such approach may be the use of the National Planning and National Building Forums, or the Development Approvals Forum to actively assist and cooperate with other regulatory bodies.

8. That the ABCB considers monitoring overseas developments on sustainability in building and construction, particularly those associated with policy, regulation, standards and consequences of adopting specific sustainability practice.

Sustainability is a worldwide activity with a UN mandate. Considerable development has taken place in areas such as policy (OECD) and international standards (ISO). The workshop participants stated that monitoring (and participation when possible) of these activities is desirable for developing appropriate regulation. The research project has identified a number of international activities that are relevant to building construction. By becoming involved in these activities, there are opportunities to capitalise on international knowledge and expertise, and avoid 'reinventing the wheel'.

In addition, overseas experience shows that there might be unintended consequences associated with the adoption of certain sustainability practice. For example, energy efficiency requirements may lead to the practice of better sealing of buildings which might cause long

term durability and health problems. Keeping tabs on this kind of information means that Australia can make informed decisions and avoid the mistakes that other countries may have made.

9. **That the ABCB considers undertaking an educational/informational program to keep the building and construction industry and the Australian Community up to date with building-related sustainability issues.**

Much activity is going on in Australia and internationally with regard to sustainability and the built environment. This knowledge is poorly disseminated across the key stakeholders and the ABCB can have a substantive role to play in educating the industry.

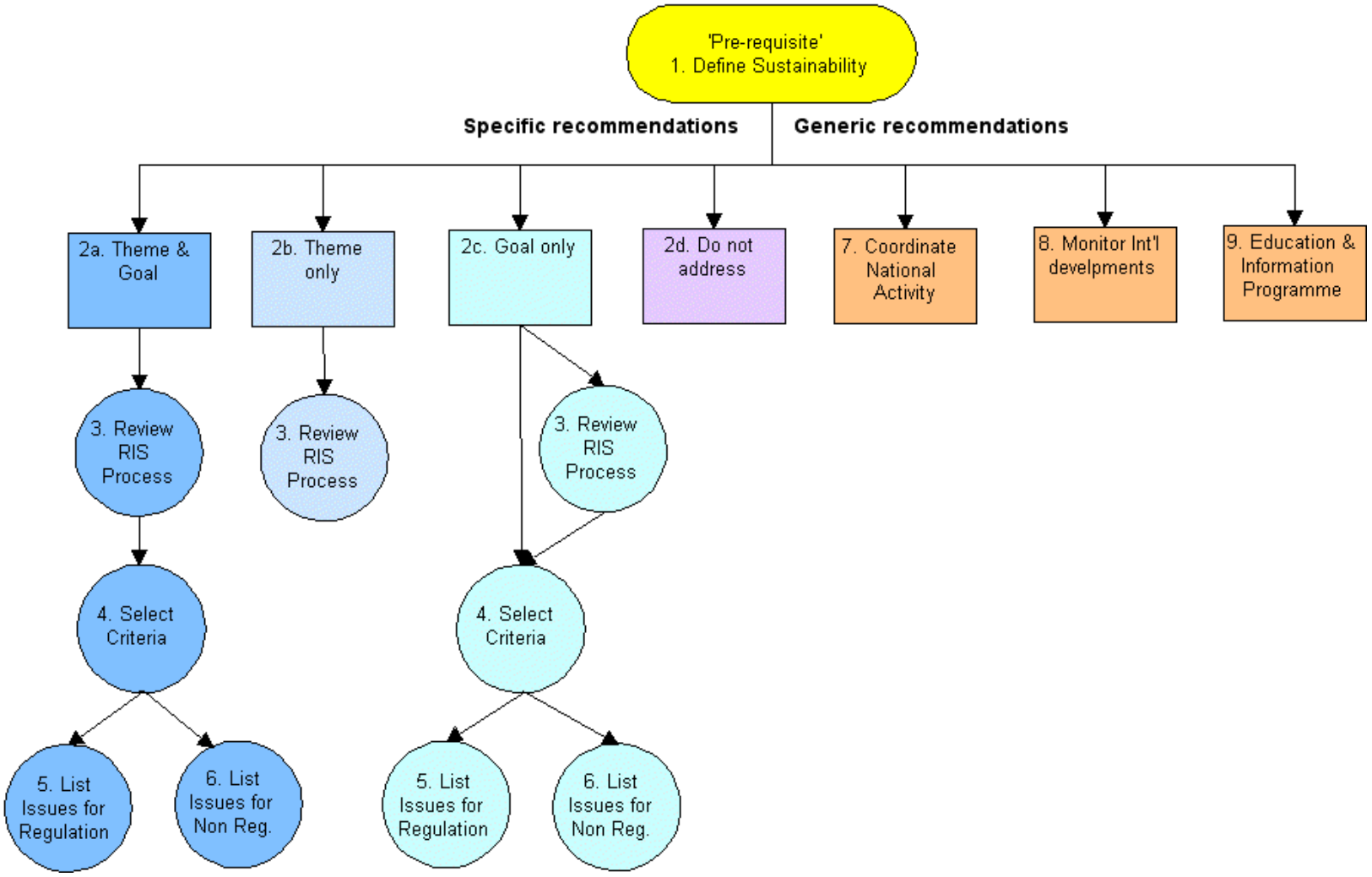


Figure 1: Recommendation Framework

Further Research

The results of this project have highlighted further areas of research that may need to be undertaken. It is important that decision-makers be made aware of these. These research topics have largely been derived from perceived gaps in knowledge required in the adoption and implementation of any of the listed recommendations.

Research topics identified:

Design of a generic framework (management strategy)

A generic framework for establishing the context, identification, analysis, evaluation, treatment, monitoring and communication of sustainability needs to be developed to support better decision making, in effect ensuring implementation is both practical and beneficial. Sustainability is such a wide ranging issue that without proper management could become unproductive and ineffective. A framework is particularly valuable in developing regulation or guidelines on specific sustainability issues.

Development of an education strategy

All workshop participants agreed on the importance of educating the industry and the public about sustainability and buildings (not just in a regulatory capacity). The details of what a nationally consistent education and information program on sustainable construction might consist of needs to be developed. The current ABCB process for developing educational programs focuses mainly on the task of explaining the implementation of regulatory requirements. A sustainability education program would need to be wider than this, and as such the role of the ABCB in providing the program needs to be carefully thought through. The development of an overall education strategy would define the role that the ABCB, and others, could take.

Monitor international developments

Sustainability in all its guises is a massive world-wide movement; literature on the subject, as well as other activities such as policy and standard development are occurring at a very rapid rate. In order to benefit from these international activities, a strategy (more than a 'watching brief') for monitoring these developments needs to be devised. There may be opportunities for participation in international committees and other processes to strengthen linkages between the ABCB and international building and construction bodies.

National coordination

Almost all workshop participants acknowledged that activities concerning sustainability are occurring at all levels of government, as well as industry, and recognise the need for national coordination. Who is best to carry out this work? What would a national coordination framework look like? What role the ABCB could play in its establishment and maintenance? These are some of the questions that require further investigation.

Understanding the regulatory implications of adopting sustainability

The regulatory implications of adopting sustainability as a theme and as a goal (i.e., in the same capacity as the existing objectives of 'health and amenity' and 'safety') in the BCA21 requires further investigation.

Model for Regulatory Impact Statement

The current model for regulatory impact assessment is based mainly on financial cost-benefit analysis. This model might need to be further elaborated if sustainability is to be considered in an RIS. For example, it is not clear how future benefits can be assessed or traded off against current costs. Considerable work needs to be done to convert the principles into a working model for sustainability assessment.

Benchmarking

Benchmarking is important for the implementation of any sustainability measure. Establishing appropriate benchmarks for monitoring the progress of any specific sustainability issue as well as the overall progress of the sustainability program is an essential part of any sustainability management strategy. At present there is little consensus on which benchmarks are to be established, and what base line levels are acceptable.

APPENDICES

Appendix A: Project Brief

PROJECT SCHEDULE

PART A: PROJECT DESCRIPTION

NOTE: Fill in only information indicated by shading

when using this form for project scoping/proposal

PROJECT PERSONNEL AND BUDGETS

	Program Title:	Environmental Sustainability
	Program Leader:	Peter Newton

	Project Number:	2001-13-3	**Project Title**	Sustainability and the Building Code of Australia (BCA)	
	Project Leader:	Brian Ashe			
	Start Date:	1/1/2002		**Finish Date:**	1/1/2003
	Budget:	**Total:** $ 24,000		**Year 1:** $ 24,000	**Year 3:** -
				Year 2: -	**Year 4:** -
	Project Researchers:	Commonwealth Scientific & Industrial Research Organisation			
		Queensland University of Technology			
	Project Participants and Project Interests:	**Organisation**			**% Contribution of Organisations**
		Australian Building Codes Board			37.1%
		Commonwealth Scientific & Industrial Research Organisation			49.3%
		Building Commission			0.8%
		Queensland University of Technology			2.6%
		Queensland Department of Public Works			4.3%
		Ove Arup			5.9%

PROJECT INFORMATION

Background:	The ABCB is a joint initiative of all levels of government in Australia. The ABCBs mission is to meet community expectations of safety, health and amenity in design, construction and use of buildings through nationally consistent, efficient and cost effective technical building requirements and regulatory systems. Research in support of regulatory reform is a key activity in the achievement of this mission. The need for sustainable buildings was a recurring theme at the recent ABCB, and International Council for Research and Innovation for Building and Construction (CIB) conferences. The National Australian Building Environment Rating System (NABERS) project currently being undertaken by Environment Australia is a clear signal from the Federal Governments of its intention to lift the bar of environmental performance of Australian buildings. National Conferences convened by NSW Government (Sustainable Sydney Conference, 16-17 Nov 2001) and the Property Council of Australia (Sustainable Development Leadership Summit, 11-13 Nov 2001) are complementary signals by State Governments and the private sector of changing attitudes to sustainable development in general and office building in particular. The BCA does not have any specific provisions that are intended to make buildings sustainable.
	The 2001 State of Environment Report for Human Settlements Australia revealed that the nation was leading the world in terms of the [per capita] rate at which it was consuming resources. Foremost among these are: • energy: Australia is largest per capita emitter of CO_2 (27 tonnes per person per year) • materials: Australia extracts 180 tonnes per person per year (several times that of other OECD countries) • transport: Between 1981 and 1997, vehicle Kms travelled increased by 58% (vs. 20% population increase). • water: Australia is largest per capita consumer of water internationally: 1540 kL/yr (vs. 1510 for N. America; 665 for Europe; 650 for Asia and 670 for the world). At 8.1 ha/capital, Australia's ecological footprint is 5 times the global average. Australia is also characterised by low levels of waste utilisation, re-cycling and re-use e.g: • less than 7% of wastewater re-used • 1.2 tonnes per capita/year of solid waste disposed to landfill each year (in top ten of OECD) • 8 million tonnes of construction and demolition waste dispersed to landfill each year (25% concrete) The ABCB is currently developing a Future Building Code (BCA21). Whether sustainability should be an objective of the BCA21 is currently being considered.

Business Basis:	The project is focused on public good outcomes and therefore environmental and social concerns are the basis driving it. Although it should be noted that the Property Council of Australia recently convened a Sustainable Development Summit, 11 - 13 November 2001. There are a number of potential business opportunities that will come out of the research and development if the research contributes to building regulatory reform. These opportunities will become clearer once the extent of sustainable building requirements is identified and decided. Potential business opportunities could include: - development of building products with lower amounts of embodied energy, lower emissions from products and improved reparability and recyclability. - increased use or renewable and recyclable materials. - development of products that use water more efficiently in buildings. - increase demand for practitioners (builders, designers, consultants etc.) specialising in sustainable building developments. - marketing and promotional opportunities associated with sustainable buildings, products etc.
Project Statement:	The ABCB is currently developing a Future Building Code (BCA21) that will replace the Building Code of Australia 1996. The purpose of this research is to provide the ABCB with information that will allow it to determine whether sustainability requirements are necessary in the BCA21. The ABCB requires information on overseas sustainability requirements for buildings, sustainable building developments in Australia and overseas, identification of issues and implications associated with sustainability requirements for buildings and advice on how sustainability requirements for buildings should be regulated.
Objectives:	At the end of the project the ABCB require a study that: - examines overseas sustainability requirements for buildings and outlines the reason why it is controlled and regulated (ie political, environmental etc) in the particular country, state, principality etc.; and - examines studies focusing on sustainability developments in buildings in Australia and overseas; and - identifies potential issues and implications associated with sustainable building requirements; and - advice on whether provisions are necessary in the Future Building Code (BCA21) to make buildings sustainable; and - if the study determines there is a need for sustainability requirements in the BCA21, the study is to demonstrate the need to control and regulate along with the method to control and regulate. The study will allow the ABCB to determine if sustainability should be an objective of the BCA21.

Deliverables and Non Deliverables:	**Stage 1** Stage 1 of the project is a literature review to collect information regarding international sustainability requirements for buildings as well as current state-of-the-art thinking and practice concerning sustainable building developments. It is expected this stage will take approximately 6 months. An interim report will be submitted at the end of this stage. The interim report will highlight the following areas: 1. Executive Summary 2. Introduction 3. Objectives 4. Methodology 5. Results of literature review 5.1 United Nations Agenda 21 Kyoto Protocol 5.2 New Zealand 5.3 United Kingdom 5.4 European Union 5.5 United States 5.6 Japan 5.7 Australia 5.8 ISO 5.9 Assessment Tools 6. Discussion 7. Conclusions 8. References **Stage 2** Stage 2 of the project will identify issues and implications associated with sustainability requirements for buildings, advice on whether provisions are necessary in the Future Building Code (BCA21) to make buildings sustainable and if the study determines there is a need for sustainability requirements in the BCA21, the study is to demonstrate the need to control and regulate along with the method to control and regulate. Stage 2 will include workshops in all capital cities. An objective of the workshops is to identify issues and implications associated with regulating sustainability. These workshops will involve the key stakeholders such regulators, local government and representatives from key associations. The marketing and delivery of all workshops will emphasise the partnership that the CRC CI and ABCB have formed in the shaping of Australia's Future Building Code.

	Deliverables and Non Deliverables:	It is expected stage 2 will take approximately 6 months. A final report will be submitted at the completion of this stage along with a searchable internet-based database of references. The 'shell' of this internet-based reference database will be made freely available to other CRC CI projects for future customisation. The final report will highlight the following areas: 1. Executive summary 2. Introduction 3. Objectives 4. Methodology 5. Results 6. Discussion 7. Conclusions 8. Recommendations 9. References
		The CRC CI requires three levels of reporting outputs for each of its projects: (1) A 100 – 200 page detailed academic research report at the projects conclusion. (2) A 20 – 40 page industry-focused research summary suitable for an industry-wide information booklet. (3) A shorter brochure with a maximum of four pages for promotional and marketing purposes. The CRC CI also requires three levels of administrative reporting for each of the projects: (1) Informal and ongoing monthly reporting to the Development Manager. This reporting is to enable the Development Manager to compile his monthly internal report. (2) Quarterly Board Progress Reports, reporting on academic, technical and project management progress. (3) Project reviews, every six months or as determined by the CRC CI.

KEY ASSUMPTIONS

Not Applicable

BACKGROUND INTELLECTUAL PROPERTY FROM PROJECT PARTICIPANTS

The study is a scoping study which is unlikely to require the use of participants background intellectual property.

BACKGROUND INTELLECTUAL PROPERTY TO BE ACQUIRED FROM OTHER SOURCES

The study is a scoping study which is unlikely to require background intellectual property that is acquired from other sources. It will rely primarily on published works and interviews with key industry and research individuals.

PROJECT PARTICIPANTS RIGHTS

There will be no commercialisation rights from the outcomes of the study.

COMMERCIALISATION / IMPLEMENTATION / TECHNOLOGY TRANSFER STRATEGY AND ISSUES

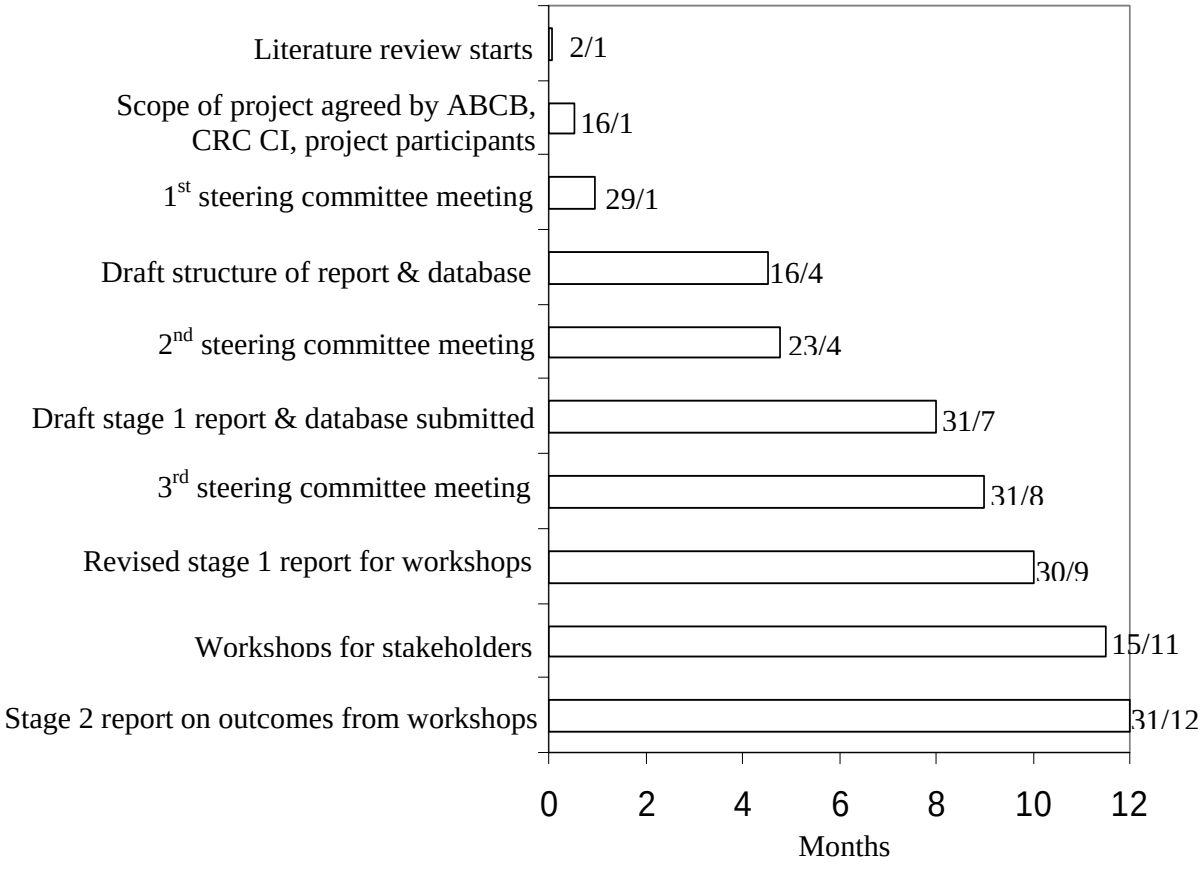
The study is a scoping study which it is intended to allow the ABCB to make informed decisions regarding whether sustainability should be an objective of the BCA21. It's unlikely any of the outputs could have direct commercial benefits.

SUMMARY OF POTENTIAL OPPORTUNITIES AND PROBLEMS

Potential Opportunities	Potential Problems
The potential for the project is high. The study is likely to have a large influence on the decision of whether sustainability should be an objective of Australia's Future Building Code.	The potential risks are considered low.

PART B: PROJECT PLAN

PROJECT MILESTONES



Appendix B: Stage 1 Report (Literature Review)

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B5. CONCLUSIONS

APPENDICES

SUMMARY

The Cooperative Research Centre for Construction Innovation Project 'Sustainability and the Building Code of Australia' is a scoping study aimed at providing the Australian Building Codes Board with:

- Current information on sustainable construction
- An identification of the issues and implications of sustainability
- A preliminary exploration concerning if and how it should be regulated in the building and construction sector

The Project consists of two stages. Stage 1 is a review of national and international literature on "what is" the 'current state of play' of sustainability principles and objectives within current national, state or local building codes. Stage 2 is a series of workshops in all States and Territories to solicit opinions of major stakeholders on the issues and implications of sustainability and if and how it should be regulated. It offers a perspective on "what could be". In addition, a database has been constructed to provide easy access to the referenced materials.

This Report summarises the findings of Stage 1. Geographical coverage of the review is limited to: (a) international developments, (b) New Zealand, (c) United Kingdom, (d) European Union (including some specific countries within the EU), (e) United States of America, and (f) Japan. Developments in Australia include separate sections for National developments and State and Territory developments. Issues reviewed are limited to: (a) durability, (b) energy, (c) waste, (d) climate change, (e) adaptability of buildings, (f) indoor air pollution, (g) noise, (h) water, (i) salinity, (j) assessment tools, and (k) benchmarking. This is followed by a discussion of possible paths for incorporating sustainable construction into the building and construction sector, and concludes with a series of points on the relationship between the Building Code of Australia (BCA96) and sustainable construction.

The key points/arguments put forward for deliberation are:

1. The current Building Code of Australia (BCA96) is neutral with regard to ecologically sustainable development (ESD). As a 'performance-based' code, innovative sustainable solutions are always acceptable as alternative solutions. Some proposed provisions such as energy efficiency are oriented toward ESD. On the other hand, it could also be argued that BCA96 does not facilitate ESD by not specifically addressing ESD issues such as reuse/recycling, design for disassembly, etc.

2. The case for inclusion of ESD in the BCA21 as a theme or as a goal can be made on the following grounds:

- To facilitate the implementation of Commonwealth and State Government policy regarding the protection of the environment. This policy has already been enshrined in various regulations. Building construction and associated activities are having the most impact on the environment.
- To prevent fragmentation of building regulations as Local and State Governments may introduce their own ESD regulations on issues for which national consistency is desirable.
- To respond to community expectations on health and productivity of building occupants as well as to increasing community concerns on environmental issues.

One desirable outcome of regulation is that it will provide industry with certainty and a "level playing field" in implementing ESD measures. National consistency is highly desirable from an industry point of view. Industry may also gain some economic spin-offs from ESD measures.

3. The Council of Australian Governments (COAG) has set specific criteria for the introduction of regulation. Essentially, it must be proven that there is a case of 'market

failure'. Criteria for developing ESD provisions should be formulated. The impacts of any proposed provision need to be assessed. Tools need to be developed to prove the case as well as to facilitate the implementation of the provisions. Less stringent is the introduction of nationally endorsed but non-mandatory Guidelines. These can also serve as a preliminary step before the introduction of regulation.

4. Successful implementation of ESD requires actions from all three levels of government: national, state and local. What activities, appropriate for each level of government, need to be established to create a coherent national framework?

5. The BCA is just one of many tools available to governments of all levels for implementing ESD. Many major issues in ESD are well outside the scope of the current BCA. Whether the scope of the BCA needs to be extended so that it can manage ESD more effectively is a question that needs to be considered. A key criterion might be whether national consistency is necessary or desirable for a particular ESD issue.

In light of these key points/arguments and based on the issues under investigation, a number of preliminary recommendations were made. These were used as the starting points for discussions in the workshop deliberations (Stage 2 of the Project). They are tabulated as follows (see Table 1):

Table 1: Summary of Preliminary Recommendations

ISSUE Current status	**PRELIMINARY RECOMMENDATIONS**
National Policy Framework The National Strategy for Ecologically Sustainable Development (NSESD) that provides the policy framework and has been agreed to by all Australian Governments.	• Adopt ESD as both a goal and a principle for developing the BCA21. • Develop criteria for the adoption of sustainability measures in the BCA21 in accordance with COAG agreement. • Review ABCB Economic Evaluation Model to ensure the tool is effective in dealing with ESD issues in the Regulatory Impact Statement (RIS) process.
Definitions of ESD/ Sustainable construction Many definitions of ESD from UN, Australian Governments, other national governments, ISO, CIB etc. Many definitions of 'Sustainable construction' but none officially from Australian Governments.	• Adopt ESD definition from NSESD i.e. *'development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends'.* • Develop a suitable workable definition of sustainable construction for the BCA.
Scope of the BCA The current scope of the BCA96 is limited to mainly the design and construction of buildings. Many issues in ESD are currently considered as outside the scope of the BCA96.	• Develop selected ESD measures within current scope. • Develop argument for possible extension of BCA scope on selected areas, for more effective ESD implementation. • Establish co-ordination process with other bodies regulating buildings to determine which areas are best regulated by the ABCB, or by others, e.g., State Planning agencies.
International Activities International collaboration on ESD is happening in a number of areas such as ISO, CIB and the development of rating tools.	• Participate in ISO activities to keep abreast with international development.

Durability Durability is not dealt with directly in the BCA96 but indirectly through its referenced standards. It is treated as a means for fulfilling the primary requirements of health, safety and amenity and not specifically targeted at sustainability.	• A Guideline on Durability.
Embodied energy The BCA (and its referenced documents) does not address the issue of embodied energy at present. However, the selection of materials is considered to be within the scope of the current BCA.	• Some form of non-mandatory guidance for the selection of materials/components from ESD point of view could be developed.
Operating energy Currently two jurisdictions, the ACT and Victoria, have energy efficiency measures in their BCA96 Appendices. New energy efficiency measures for Vol.2 (Housing Provisions) of the BCA96 have been developed and will be adopted in Tasmania, South Australia and Northern Territory in 1 January 2003. Western Australia, New South Wales and Queensland are further considering the adoption of the provisions. Measures for other buildings are being developed by the ABCB.	
Renewable energy The BCA96 Deemed-to-Satisfy Measures are not intended to address the issue of renewable energy but does under the performance measures.	
Waste reduction All State and Territory Governments have some form of legislation related to waste management. Most States impose a levy on landfill. Some States/Territories have set target dates for removing C&D waste from landfill altogether. The waste generated in the manufacturing phase and demolition phase is considered to be outside the scope of the BCA96. Only the waste generated during the design and construction phase can be considered as being within the scope of the current BCA96.	• A Guideline on the subject of reducing waste on construction sites would be useful to industry and is within the scope of the current BCA96.
Reuse and recycling The BCA96 at present does not address the question of reuse of building materials and products. Implicit in some BCA96 reference documents is the assumption that materials are new. The disassembly of buildings at the end of their life, for reuse of materials and products has not been a design consideration in current practice.	• The BCA can facilitate sustainability by addressing the issue of reuse of materials and products with respect to product performance and durability requirements. • Design for disassembly could be introduced as a guideline.

Adaptability The BCA96 (and its referenced documents) does not address the issue of adaptability at present.	• The issue is new and difficult to regulate. A guideline on adaptability is recommended.
Climate Change The BCA96 (and its referenced documents) does not address the issue of the effect climate change will have on buildings, at present.	• Although there is a lack of data, the NSESD precautionary principle requires some action to be taken. A more detailed investigation on the likely impacts is needed.
Indoor Air Quality (IAQ) IAQ is within the scope of the BCA96. It is currently addressed through the ventilation requirements. There are no controls on volatile emissions from building materials.	• The case for increasing ventilation requirements or controlling volatile emissions for building materials needs to be established.
Noise The BCA96 currently has provisions for controlling noise within a building, (i.e., between apartments) but not from outside sources. A proposal to change the BCA96 sound insulation provisions was released in February 2002. The ABCB are continuing the development of the proposal.	• The case for regulation needs to be established.
Water The BCA96 (and its referenced documents) does not address the issue of water. All plumbing issues are considered outside the scope of the current BCA96.	• A case for inclusion of water efficiency in the BCA21 needs to be established.
Urban Salinity There have been a number of developments at Local and State/Territory levels to deal with the problem. The ABCB has developed a Discussion Paper on the subject.	

B1. INTRODUCTION

B1.1 Background

The Building Code of Australia (BCA96) is a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia. It is produced and maintained by the Australian Building Codes Board (ABCB) on behalf of the Commonwealth Government and each State and Territory Government.

The ABCB is a joint initiative of all levels of government in Australia. Its mission is to meet community expectations of safety, health and amenity in design, construction and use of buildings through nationally consistent, efficient and cost effective technical building requirements and regulatory systems. Research in support of regulatory reform is a key activity in the achievement of this mission.

Currently, the BCA96 does not have any specific provisions that are intended to make buildings sustainable. However, sustainability is being considered by the ABCB Code Review Committee as a possible additional goal for the Future Building Code (BCA21). The proposal put to and approved by the Board at its 41st meeting was as follows:

"It seems inevitable that sustainability will have to be considered by the ABCB. The ABCB should provide leadership in this area. This study will be a scoping study, which will put the ABCB on the map in terms of sustainability - on a national scale. The objective of this study is to provide information to the ABCB on developments overseas and identify the issues and implications of sustainability and if and how it should be regulated"

B1.2 Terms of Reference

The terms of references for the overall project are to:

(a) Examine the sustainable building literature
(b) Examine local and international sustainability requirements for buildings and outlining the reasons why they are controlled and regulated (i.e., political, environmental, etc.) in a particular jurisdiction
(c) Identify potential issues and implications associated with implementing sustainable building requirements
(d) Provide advice on whether provisions are necessary in the Future Building Code (BCA21) to enable sustainable building
(e) If the study determines there is a need for sustainability requirements in the BCA21, the study is to provide the rationale for regulation and control along with the method(s) to control and regulate.

The project is split into two stages. Stage 1 addresses (a) and (b). The major activity of this stage is to review international literature to identify sustainability measures that have been discussed within or introduced to the building and construction sector. The assembled information is to be retained in the form of a database for future reference. Stage 2 addresses (c), (d) and (e). The major activity of this stage is to hold a series of workshops in all States and Territories to gauge opinions of major stakeholders. The outcomes from this process will determine the final recommendations/options of this project.

This report is concerned with Stage 1 only.

B1.3 Key Concepts

This section outlines the background of the two basic concepts underlying this project, namely, 'sustainability' and 'building codes and regulation'. Such understanding is necessary to put the findings from this project in context.

B1.3.1 Sustainability

Over the past thirty years or so, all sectors of society have been developing and interpreting the principles of sustainability according to their specific context. In this time, sustainability and sustainable development has emerged as an increasingly influential driver of change in public policy, community attitudes and corporate governance. Some key landmarks in this 'sustainability journey' include the following:

1972: the United Nations holds its first world conference on the human environment (known as Stockholm 1972). This considered the need for a common outlook and for common principles to inspire and guide the people of the world in the preservation and enhancement of the human environment. (For more information see: http://www.unep.org/Documents/Default.asp?DocumentID=97&ArticleID=1503).

1987: the World Commission on Environment and Development (WCED) chaired by the Prime Minister of Norway, Mrs Gro Harlem Brundtland, publishes a report entitled *Our Common Future (also known as the Brundtland Report).* This brings the concept of sustainable development onto the international agenda. It also generates the most commonly used definition of sustainable development by describing it as *development which meets the needs of the present without compromising the ability of future generations to meet their own needs* (Brundtland, 1987).

1989: the issues raised by *Our Common Future* are discussed at the UN General Assembly, this leads to the passage of resolution 44/228 which called for a UN Conference on Environment and Development.

1992: Nearly 180 countries meet at the 'Earth Summit' (UN Conference on Environment and Development) in Rio de Janeiro to discuss how to achieve sustainable development. The Earth Summit agrees to five key environmental documents: the Rio Declaration on Environment and Development, Agenda 21, the Statement on Forest Principles, the UN Framework Convention on Climate Change (UNFCCC), and the Convention on Biological Diversity.

The Rio Declaration on Environment and Development sets out 27 principles supporting sustainable development. Agenda 21 is a 40 chapter action plan on specific issues relating to sustainable development Whilst Agenda 21 refers to aspects of sustainable construction in most of these chapters, it specifically refers to the built environment in Chapter 7 'Promoting sustainable human settlement development'. (For more information see: http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm; http://www.un.org/esa/sustdev/agenda21text.htm; and/or http://www.un.org/esa/sustdev/csd.htm).

After the Earth Summit, the UN set up the UN Commission on Sustainable Development to monitor the progress of nation states relative to the agreements made in Rio.

1992: the Australian Government, with endorsement of the Council of Australian Governments, releases its National Strategy for Ecologically Sustainable Development (ESD) (www.ea.gov.au/esd/national/nsesd/strategy/index.html). ESD is defined in this Strategy as *"using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased."* A range of recommendations are made to guide governments in policy development for ESD in relation to specific industry sectors.

1996: the UN holds its second conference on sustainable human settlements (HABITAT II), in Istanbul. This results in an action plan containing sections that deal specifically with the construction industry and how governments should encourage the industry to behave. This includes planning, design, construction, maintenance and rehabilitation, the procurement, use and the promotion of sustainable building materials and the production of sustainable materials.

1997: the Conference of the Parties to the UNFCCC adopts the Kyoto Protocol. This breaks new ground with its legally binding constraints on greenhouse gases and its innovative mechanisms aimed at cutting the costs of curbing emissions.

1999: Australia passes the Environmental Protection and Biodiversity Conservation Act, and releases the Productivity Commission Report on Implementation by Commonwealth Departments.

2001: the Australian Federal Cabinet Committee on Sustainable Environment is established and reflects the Government's commitment to ESD as '*one of our most important whole of government priorities*'. Similar commitments are also evident at State/Territory level; Sustainability Units are established in most State/Territory Governments of Australia.

2002: Secretary-General Kofi Annan identifies five themes for particular attention at the August 2002 Johannesburg Summit (also known as 'Rio + 10'): water, energy, health, agriculture and biodiversity. These are critical areas for long-term development, involving complex interactions among economic, social and environmental factors and involving different sectors, organisations and disciplines. (For more information see www.johannesburgsummit.org).

In summary, sustainable development (in all its guises) has emerged as a paradigm of development, integrating economic growth, social development and environmental protection as interdependent and mutually supportive elements of long-term development. Sustainable development also emphasizes a participatory, multi-stakeholder approach to policy making and implementation, mobilising public and private resources for development and making use of the knowledge, skills and energy of all social groups concerned with the future of the planet and its people. For a range of sustainability-related terms, see Appendix B1.

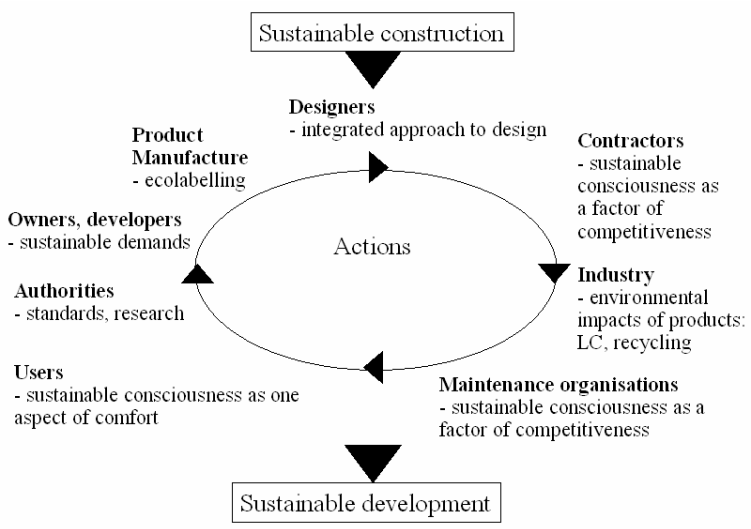
B1.3.2 Sustainable Construction

For the purposes of this Project, we are clearly most interested in the intersection where the principles of sustainable development meet building practices, codes and regulation. This can be described as 'sustainable construction' and can be defined as follows:

"Sustainable construction means that the principles of sustainable development are applied to the comprehensive construction cycle from the extraction and beneficiation of raw materials, through the planning, design and construction of buildings and infrastructure, until their final deconstruction and management of the resultant waste. It is a holistic process aiming to restore and maintain harmony between the natural and built environments, while creating settlements that affirm human dignity and encourage economic equity" (du Plessis, 2002).

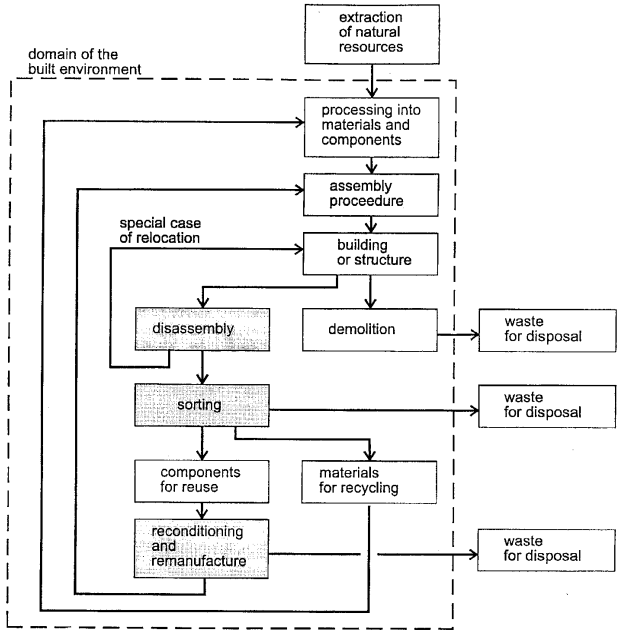
Sustainable construction demands an agent-based perspective which recognises that there are a range of stakeholders (see Figure 2) involved in the production and operation of a building across its life cycle (see Figure 3).

Figure 2: Range of stakeholders involved in sustainable construction



Source: CIB, 1999

Figure 3: Elements of the building life cycle and the production of waste

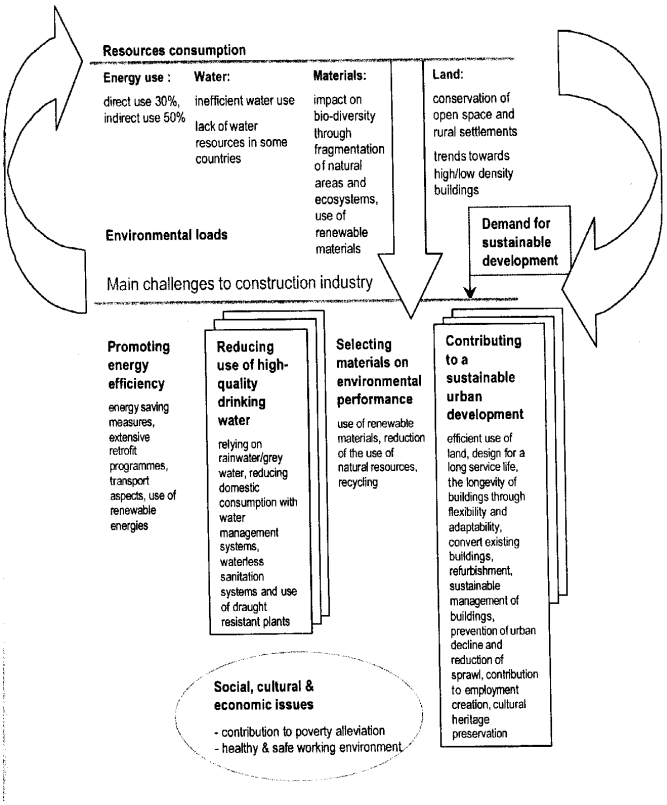


Source: Crowther, 2002

When placed in this context, a number of challenges emerge for the various players in the building and construction industry. A diagrammatic representation of some of these challenges can be seen in the following figure (see

Figure 4).

Figure 4: Challenges of sustainable construction



Source: CIB, 1999

Under 'Selecting materials on environmental performance' for example, building product manufacturers would need to be able to perform LCA on their products, and/or be able to prepare 'product declaration' sheets. The Architecture, Engineering and Construction (AEC) Industry would be required to develop environmental assessment methods. Designers would need to recognise that every object they assign to a building has an environmental impact; IT tools must be available to help them make the right choices. In summary, LCA/LCC would become standard procedure. The Government would need to establish benchmarks and targets. Authorities would need to include environmental considerations in tender documents. This would in turn require whole of life costing and analysis to replace capital cost assessment, and the development of indicators to monitor trends.

The ultimate objective of sustainable construction is the creation of the 'positive footprint' building that adds social, economic and environmental value. At the present time, however, the challenge is more realistically targeted at 'zero footprint' (i.e. no waste, pollution, etc). In order to align with this realistic approach, the focus for the issues of sustainability in relation to sustainable construction is limited to environmental domains – although linkages to economic dimensions (e.g. cost) and social dimensions (e.g. quality of the indoor environment and its relationship to such things as human health and productivity) are covered as appropriate.

B1.3.3 Building Codes and Regulations

An understanding of the roles and limitations of building codes and regulations is necessary for a discussion of the relationship between them and sustainability. A building code is a set of technical rules for the design and construction of buildings, which is given legal effect by building regulation or legislation. These rules are based on decisions about what aspects of our lives are deemed important in relation to the built environment, e.g., health, safety,

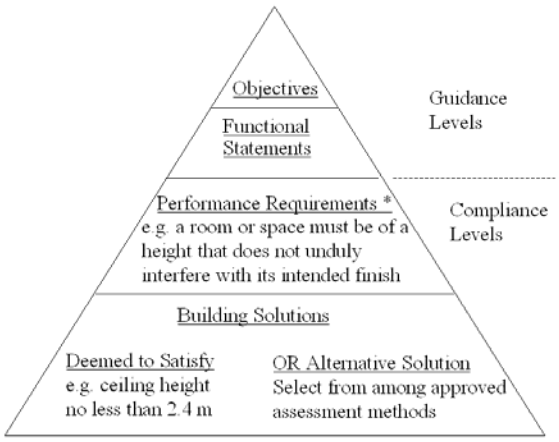
amenity etc. In this context, we are interested in ‘can building codes and regulation promote sustainability’ and ‘how does this relate to the Building Code of Australia’?

The **Building Code of Australia** (BCA96) is produced and maintained by the Australian Building Codes Board (ABCB), and is given legal effect by building regulatory legislation in each State and Territory. It is important to note that any provision of the BCA96 may be overridden by, or subject to, State and Territory legislation. **The Aim of the BCA96** (and of the ABCB) is to create national consistency and uniformity in building regulation, allowing only for variations in climate and geological or geographic conditions. **The Scope of the BCA96** is limited to ‘technical provisions for the design and construction of buildings’. Other aspects of building construction such as administrative provisions, procurement, planning, occupational health and safety, consumer protection, etc., are within the framework of building legislation but are outside the scope of the BCA96.

The Goals of the BCA96 are 'to enable the achievement and maintenance of acceptable standards of structural sufficiency, safety (including safety from fire), health and amenity for the benefit of the community now and in the future'. **The Structure of the BCA96** can be described as a pyramid (see Figure 5) with Objectives at the top, then Functional Statements, then Performance Requirements. At the bottom of the pyramid are the Building Solutions which are the core of the building code. Achieving a Buildings Solution and thereby complying with the BCA96 can be approached through 2 paths:

1. Deemed to satisfy provisions - the “prescriptive” outcomes and
2. Alternative solutions- any alternative which meets the performance requirements

Figure 5: BCA96 Structure



* Performance Requirements must have measurable, objective and verifiable criteria for building elements to reduce uncertainty. (For more information about the Building Code see http://www.abcb.gov.au/content/codes/main.cfm)

It all seems pretty straight forward thus far; where it gets interesting is in the application of sustainability to this system. Any new provisions proposed for the BCA21 are subject to two key processes. These are the Principles for Regulation, and the Regulatory Impact Statement.

Principles for Regulation: In introducing new regulations, certain principles must be observed. These principles have been agreed to and endorsed by, the Council of Australian Governments (COAG, 1997). Essentially, the need for regulation must be demonstrated by what economists term to be 'market failure'. The regulation then must extend no further than necessary in the public interest, must be consistent with the national competition policy and must be cost effective, easy to understand and is not needlessly onerous in its application. It is noted that in the COAG 'Principles and Guidelines for National Standard Setting and

Regulatory Action, 'regulations' refer to *'the broad range of legally enforceable instruments… as well as to those voluntary codes and advisory instruments for which there is a reasonable expectation of widespread compliance'*. In other words, for sustainability to be adopted there must be a demonstrated case that the 'market' has 'failed' in this regard.

Regulation Impact Statement (RIS): The Office of Regulation Review in its 'A Guide to Regulation', has decided that '*preparation of a RIS is mandatory for all reviews of existing regulation, proposed new or amended regulation and proposed treaties involving regulation which will directly affect business, have a significant indirect effect on business, or restrict competition'* (Office of Regulation Review, 1998). A RIS is a document prepared by the department responsible for a regulatory proposal following consultation with affected parties, formalising and evidencing some of the steps that must be taken in good policy formulation. It requires an assessment of the costs and benefits of each option, followed by a recommendation supporting the most effective and efficient option. In response to this requirement, the ABCB has developed its 'Economic Evaluation Model: Building Regulatory Change' (ABCB, 1997) to assess the impact of building code proposals on industry, government and the consumer, and the community as a whole. Sustainability would therefore need to be evaluated via this model; the key concern being that many sustainability benefits are difficult to quantify using traditional economic analysis.

B2. LITERATURE SURVEY

This section of the report provides a review of international and national literature on the current state of play in respect to the representation of sustainability principles and objectives within current national, state or local building codes. For the purposes of clarification and to assist in the organisation of the information found, literature on sustainability can be broadly classified into three categories:

(a) Key driver documents: These are documents issued by authoritative bodies such as United Nations Agencies or National Governments recommending certain initiatives, direction or actions to be taken.
(b) Tools, data and research documents: These are documents concerning the life-cycle impacts of building on the environment, case studies, proposed assessment tools, proposals for changes in practice etc.
(c) Implementation documents: These are documents issued by authoritative bodies such as national, state and local governments or national institutions either as mandatory regulation or non-mandatory guidelines or codes of practice.

Since this project is mainly concerned with issues of sustainability that are relevant to the Building Code of Australia, documents of type (a) and (c) are collected and reviewed while documents of type (b) are collected but not reviewed.

In terms of countries, the review is limited to the following:

(a) International Developments
(b) New Zealand
(c) United Kingdom
(d) European Union (including some specific countries within the EU)
(e) United States of America
(f) Japan
(g) Australia (the review of Australian activities is limited to Federal, States and Territory institutions).

In terms of issues, the review is limited to the following topics:

(a) Durability
(b) Energy
(c) Waste
(d) Climate change
(e) Adaptability
(f) Indoor air quality
(g) Noise
(h) Water
(i) Urban salinity
(j) Assessment tools
(k) Benchmarking

The review of the issues is provided in Section B3.
References that were reviewed are listed in Appendix B5.

B2.1 International Developments

B2.1.1 General Policy

AGENDA 21

Agenda 21 is a comprehensive plan of action to be taken globally, nationally and locally by organisations of the United Nations system, Governments, and major groups in every area in which human impacts on the environment. It was adopted by more than 178 governments at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, 3 to 14 June 1992.

Agenda 21 has many items that impact on building construction. Of particular relevance to the development of Building Codes are:

- Chapter 4:
  - Developing national policies and strategies to encourage changes in unsustainable consumption patterns
- Chapter 7:
  - Promoting adequate shelter for all
  - Promoting human settlements planning and management in disaster-prone areas
  - Promoting sustainable construction activities
- Chapter 9:
  - Promoting sustainable development and the protection of the atmosphere through energy development, efficiency and consumption
- Chapter 20:
  - Promoting the prevention and minimisation of hazardous waste
- Chapter 21:
  - Minimising waste
  - Maximising environmentally sound waste reuse and recycling
  - Promoting environmentally sound waste disposal and treatment
  - Extending the waste service coverage
- Chapter 30:
  - Promoting cleaner production
- Chapter 40:
  - Providing information for decision making (e.g. indicators for sustainable development)

The Commission on Sustainable Development (CSD) was created in December 1992 to ensure effective follow-up of UNCED, to monitor and report on implementation of the agreements at the local, national, regional and international levels. The CSD Work Program on Indicators of Sustainable Development (1995-2000) resulted in a description of key sustainable development themes and the development of indicators for use in the decision making processes at national level (United Nations, 2000). Indicators that are relevant to building construction are:

- Social
  - Floor area per person
- Environmental
  - Emission of greenhouse gases
  - Consumption of ozone depleting substances
  - Area of urban formal and informal settlements
- Economic
  - Intensity of material use
  - Annual energy consumption per capita
  - Share of consumption of renewable energy resources
  - Energy use per unit of GDP
  - Intensity of energy use in various sectors: commercial/service, manufacturing, residential and transport
  - Generation of wastes: Solid waste, hazardous waste
  - Waste recycling and reuse
- Institutional
  - National sustainable development strategy
  - Implementation of ratified global agreements
  - Human and economic loss due to natural disasters

This should be seen as a flexible list from which countries can choose indicators according to national priorities, problems and targets. Indicators are presented in a Driving Force - State -

Response framework. 'Driving Force' indicators indicate human activities, processes and patterns that impact on sustainable development. 'State' indicators indicate the 'state' of sustainable development and 'Response' indicators indicate policy options and other responses to changes in the 'state' of sustainable development. This system was designed to be used in the whole-society scale rather than in a product or building scale.

KYOTO PROTOCOL

At the Rio Earth Summit, Parties to the UN Framework Convention on Climate Change (UNFCCC) agreed to stabilise emissions of greenhouse gases at 1990 levels by the year 2000, in an attempt to mitigate the threat of global warming. Following this an historic agreement to actually cut emissions was agreed in December 1997 in Kyoto, Japan, at the third Conference of Parties (COP3) to the UNFCCC. Industrial nations agreed to reduce their collective emissions of greenhouse gases by 5.2% from 1990 levels by the period 2008 to 2012.

The Kyoto Protocol commits developed countries to make legally binding reductions in their greenhouse gas emissions. The six gases that were considered are carbon dioxide, methane, nitrous oxide, the hydrofluorocarbons (HFCs), the perfluorocarbons (PFCs) and sulphur hexafluoride.

The Kyoto Protocol was endorsed by 160 countries. It will become legally binding provided at least 55 countries sign up to it, including developed nations responsible for at least 55% of greenhouse gas emissions from the industrialised world. The global cut in emissions of 5.2% is to be achieved by differential reductions for individual countries. The European Union, Switzerland and the majority of Central and Eastern European nations will deliver reductions of 8%; the US will cut emissions by 7%; and Japan, Hungary, Canada and Poland by 6%. New Zealand, Russia and the Ukraine are required to stabilise their emissions, whilst Australia, Iceland and Norway are permitted to increase slightly, although at a reduced rate to current trends. Within the European Union, further differential reduction rates apply. The UK has committed itself to a 12% reduction, although it has also set its own domestic target of a 20% reduction by 2010.

Australia's commitment under the Kyoto Protocol is to limit the increase in green house gas emission to 8% of its 1990 emission level by the period 2008 to 2012.

HABITAT II

UN Agenda 21 is very broad and has been interpreted in several sectorial agendas. One of specific relevance to building construction is Habitat II Agenda (United Nations, 1996). This particular agenda sets out:

- Actions for government and construction industry regarding planning, design, construction maintenance and rehabilitation
- The procurement, use and promotion of sustainable building materials
- The production of sustainable materials

CIB AGENDA 21 ON SUSTAINABLE CONSTRUCTION

The International Council for Research and Innovation in Building and Construction (CIB) has co-operated with other international associations to produce Agenda 21 on Sustainable Construction (CIB, 1999). It is intended to be an intermediary between Habitat II Agenda and the National Agendas. It discusses:

- Concept of sustainable construction
- Issues and challenges of sustainable construction
- Resulting challenges and actions

The objective of this agenda is to define a global framework with a whole set of concepts from which each country will pick up its own priorities. Its main recommendations with respect to building codes are to render the environmental performance measurable and certifiable by providing more tools such as:

- Performance-based standards in the building codes
- 'Green' certification and eco-labelling systems based on life cycle analysis

Other reports issued by CIB:
- Sustainable development and the future of construction (CIB, 1998)
- Sustainable construction: A framework and international agenda for change (CIB, 2001a)

Current relevant CIB activities include:
- Development of a framework for implementation
- Development of 13 expert domains for Sustainable Construction of Built Environment (ScooBE) (CIB, 2001b)
- Task Group 39: Deconstruction - addresses '*the key technical, economic and policy issues needed to make deconstruction and reuse of building materials a viable option to demolition and land-filling'*

OECD POLICIES FOR ENVIRONMENTALLY SUSTAINABLE BUILDINGS

The Organisation for Economic Co-operation and Development (OECD) 'Sustainable Building Project' is aimed at providing guidance for the design of government policies to address the environment impacts of the building sector. The reduction of CO_2 emissions, minimisation of construction and demolition waste (C&DW) and prevention of indoor air pollution were selected as priorities for the project (OECD 2001a, OECD 2001b). The summary on the current environmental policies for the building sector in OECD countries is as follows (OECD 2002):

- A significant proportion of reported policy instruments for reducing CO_2 emissions from the building sector target new buildings. Building regulations have long played a central role in improving energy efficiency in most OECD countries. Although the use of information tools, such as environmental labelling, is increasing, the use of economic instruments remains limited; and government intervention for upgrading existing buildings has been modest.

- Most of the reported policy instruments for minimising C&DW are implemented at the demolition stage. A landfill tax and regulatory instruments, such as a ban on landfill and mandatory separation, are widely used in European countries. A smaller number of countries have introduced policy instruments at downstream stages, such as an aggregate tax, certification scheme, etc. Few instruments were identified at upstream stages. *(NB: Down stream stages refer to activities that will take place after the design and construction, upstream stages to activities before design and construction.)*

- The most widely used instrument for preventing indoor air pollution is the setting of target values for the concentration of pollutants. Regulations on the quality of building materials have been implemented in four European countries, and environmental labelling schemes covering the issue of indoor air quality exist in several countries.

B2.1.2 International Standardisation

Three series of ISO Standards and one ISO Guide are related to Sustainability:

ISO 15686 Building and constructed assets - Service life planning

Originally planned as a 5 part series, but only Part 1: General Principles has been issued as a Final Draft International Standard (FDIS) (ISO 1999). As indicated by the title, this Standard is not directly concerned with sustainability but a lot of discussion on sustainability is based on the concept of service life planning:

- ISO 15686-1 Buildings and constructed assets – Service life planning – Part 1: General principles
- ISO 15686-5 Buildings and constructed assets – Service life planning – Part 5: Service life prediction methods

- ISO 15686-6 Buildings and constructed assets – Service life planning – Part 6: Guidelines for considering environmental impacts

ISO 14000 Series on Environmental Management Systems
A series of voluntary standards that provide a structure for managing environmental impact.

- ISO 14001:1996, Environmental Management Systems – Specification with Guidance for Use.
- ISO 14004: Environmental Management Systems – Guideline on principles, Systems and Supporting Techniques.
- ISO 14020: Environmental Labelling - General Principles.
- ISO 14031: Evaluation of Environmental Performance.
- ISO 14040: Environmental Management - Life-Cycle Assessment – Principles and Guidelines.

ISO/TC59/SC3/WG17 - Sustainability in Building Construction
A series of drafts is being prepared by this Working Group WG17.

- ISO/TC 59/SC 3 N 449 - Sustainability in building construction – General principles
- ISO/TC 59/SC 3 N 4 - Sustainability in building construction – Terminology
- ISO/TC 59/SC 3 N 467 - Sustainability in building construction – Assessment of environmental impacts from buildings
- ISO/TC 59/SC 3 N 468 - Sustainability in building construction – Environmental declaration of building products

ISO GUIDE 64:1997
Guide for the inclusion of environmental aspects in product standards

B2.2 New Zealand

The Resource Management Act (RMA, 1992) and the Local Government Act (LGA, 1974)
The RMA and the LGA are the two key pieces of legislation that shape the NZ urban/built environment. While these Acts are not specific about sustainable building or construction, the Building Act must be co-ordinated with any controls relating to building use and with controls relating to the management of natural and physical resources.

The NZ Building Act (BA, 1991)
In New Zealand, building is controlled by the Building Act 1991 and the New Zealand Building Code (NZBC, 1992). The purposes of the Act provides for safety, health, amenity of people with specific reference to facilitating the efficient use of energy in the case of new buildings. It also states that 'due regard shall be had for…environmental costs and benefits'. However, while there is little to discourage sustainable building, the New Zealand building regulatory system does not specifically facilitate sustainability.

The Building Act is currently under review (see www.med.govt.nz)

The NZBC, 1992
The NZBC is a performance based code, which can be applied on its own, or applied by the use of prescriptive based Approved Documents to provide an immediate proof of compliance (Benge, 2002).

- Energy efficiency provisions

This provision requires buildings to be constructed to achieve adequate degree of energy efficiency when the energy is used for modifying temperature, humidity, for providing hot water or for providing artificial light. The requirements are limited to energy sourced from a network utility or a depletable energy source. There are also limitations on the application of the provisions.

- Durability provisions

This provision requires the life of the building to be not less than 50 years but the life of components or subsystems could be less (5 or 15 years) depending on the ease of access, replacement and detection of failure. The Building Act also allows the nomination of a specified intended life of less than 50 years for reasons such as temporary or experimental buildings.

Government Strategies

- Sustainable Development for New Zealand: Program of Action (Ministry of Economic Development, Jan 2003). Has a chapter on Sustainable Cities.
- National Energy Efficiency and Conservation Strategy (NEECS). Has a 'Buildings and Appliances' Program.
- The New Zealand Waste Strategy. Includes specific waste reduction targets for C&D waste.

Non-mandatory tools for improving the sustainability of the built environment:

- The Green Home Scheme (BRANZ, 1997), and the Green Office Scheme (BRANZ, under development)
- Easy guide to Eco-building (BRANZ, Auckland Regional Council, Hamilton City Council, 2001)
- Sustainable Home Guidelines (Waitakere City Council, 1997)
- Subdivision for People and the Environment (Standards NZ HB 44:201)
- The Better Building Code (Waitakere City Council, 2000)
- People, Places, Spaces (Ministry for the Environment, 2002)

B2.3 United Kingdom

National Strategy: 'A better quality of life - a strategy for sustainable development in UK'

Published in May 1999 (Department of Trade & Industry, 1999), this document sets out the UK Government strategy to achieve 'a better quality of life for everyone, now and for generations to come'. Two other follow-up reports were issued in 2000 and 2001:

- Building a better quality of life - a strategy for more sustainable construction (April 2000)
- Building a better quality of life - a strategy for more sustainable construction: report progress 2001 (Oct. 2001)

Measuring sustainability

The 15 headline indicators for sustainability include two which relate to the construction industry – 'H14 New homes built on previously developed land', and 'H15 Waste arisings and management'. These national indicators are reported in the Government's annual report on sustainability. For further information see the website at http://www.sustainable-development.gov.uk/ The construction industry is also developing its own indicators of progress in achieving sustainability. For more details see 'Key Performance Indicators'.

Implementing waste minimisation:

Annual amount of C&D waste in the UK is about 53 million tonnes, 55% of which is concrete/masonry, 15% plastic and paper, 5% timber with 24 million tonnes being recycled (McGrath et al. 2000).

CIRIA is currently working on project **RP582 Waste reduction, reuse and recycling in construction** – demonstration project. This project aims to demonstrate the financial and environmental benefits of waste minimisation for construction by developing and implementing good practice on ten demonstration projects. MACE, Laing Homes, AMEC Capital, Wren & Bell, Schal, Scottish Executive, Try Construction, the Environment Agency and Carillion have all worked with CIRIA to implement waste minimisation plans on their

projects. Waste minimisation on these sites has resulted in significant cost savings and environmental benefits. For example:

- recovery of 500,000 roof tiles for reuse in housing development, saving £80,000
- major house builder saved £600 waste disposal costs per housing unit built
- reduction in over-ordering by use of just-in-time deliveries
- minimisation of waste at the design stage of an office refurbishment
- segregation of waste on site, saving 20% on disposal costs
- better control of waste by use of rigorous procurement and contractual measures

A series of case study reports have been prepared detailing the environmental and financial benefits that were realised by each project. A good practice guidance document is also being prepared to summarise the initiatives undertaken and highlight the benefits; this report will provide practical information on how an organisation can develop and implement effective waste reduction measures on site. The case studies and project report will be available in late 2001. CIRIA is also working on a project, in partnership with Mandix and the Welsh School of Architecture, to deliver waste minimisation strategies for a number of small to medium sized construction companies in South Wales.

The publication ***Waste minimisation in construction – site guide (SP133)*** is full of practical tips for site personnel on how to reduce, reuse and recycle construction and demolition wastes. For designers, ***Waste minimisation and recycling in construction – design manual (SP134)*** provides information to enable them to improve the efficiency of their designs and use of recycled materials. ***Waste minimisation and recycling in construction – boardroom handbook (SP135)*** identifies key actions that management can take to facilitate waste minimisation.

Other earlier publications concerning sustainability include:

- Environmental Protection Act 1990, Waste Management, the Duty of Care - a Code of Practice HMSO London 1991
- Managing and Minimising Construction Waste - A Practical Guide - Institution of Civil Engineers (1995)
- Waste minimisation and recycling in Construction - Site handbook - CIRIA Funders report/CP/4 January 1997 London

<u>Achieving sustainability in construction procurement (OGC, 2000)</u>
This document suggests what can be done on sustainability issues within the value for money approach of the government procurement policy. Ten themes were selected for action:

- Reuse existing built assets
- Design for minimum waste
- Aim for lean construction
- Minimise energy in construction
- Minimise energy in use
- Do not pollute
- Preserve and enhance bio-diversity
- Conserve water resources
- Respect people and their local environment
- Set target

Comments:
UK has an overall strategy for sustainability; sustainability in construction is a sub-set of the overall plan. Implementation is not via building regulation but via procurement and the EPA.

B2.4 European Union

European Charter on Sustainable Design & Construction (1998, revised 2000)
The European Charter on Sustainable Design & Construction expands and strengthens, but preserves the legal intent of, the 1992 Rio Declaration on Environment and Development. It contains a guideline framework on 'social inclusion', and a glossary of terms and definitions.

The structure of the European Charter on Sustainable Design & Construction reflects the fundamental view that Sustainable Construction is the response, in built form, to the concept of 'sustainable development', and it's initial formal elaboration at global level - the Rio Declaration of 27 Principles, with Agenda 21 (detailed supporting guidance) - both agreed at the United Nations Conference on Environment and Development which was held in Rio de Janeiro, Brazil, during June 1992.

For the first time in the European Charter, a comprehensive scope of concern, relating to ethics and values, is outlined for the subject; a rational decision making framework is presented; human development, social injustice and inclusion, environment and energy issues are discussed in a coherent format; and finally, technical terms are defined for better communication.

The European Charter on Sustainable Design and Construction comprises 27 Principles, which derive from a straightforward process.

- Each principle of Agenda 21 was closely examined, re-drafted to suit an EU context and, on the basis of existing Union treaties, agreements and secondary legislation, was strengthened considerably in expression (ordinary typeface). Where appropriate, a clause (bold typeface) relevant to Sustainable Design and Construction was added.
- Unlike Agenda 21, references to 'energy' were included throughout.

European Construction Industry Federation (FIEC) Environmental Charter
The FIEC, an association that represents 1.9 million European construction firms and 11 million workers, has adopted an environmental charter that aims to promote sustainable development practices. FIEC represents 29 national member federations in 22 countries.

The Federation states that existing buildings are responsible for the use of about 40 percent of final demand for energy, and as a consequence, for a corresponding percentage of greenhouse gas emissions. By improving the energy efficiency of existing buildings, as much as a 12 percent reduction in the total amount of greenhouse gas emissions in Europe could be realized.

This charter constitutes a declaration of principles under 12 articles as listed below:
Article 1 - Improving environmental performance
Article 2 - Sustainable construction
Article 3 - Alternative proposals
Article 4 - Environmentally friendly site installations
Article 5 - Educational training programs
Article 6 - Energy efficiency in the built environment
Article 7 - Environmental management systems
Article 8 - Expansion of European Union
Article 9 - Waste management
Article 10 - Preserving Europe’s cultural heritage
Article 11 - International Declaration on Cleaner Production
Article 12 - United Nations Global Compact

Under the charter, FIEC proposes to:

- Encourage clients to invite contractors to propose alternative technical solutions that support European environmental policy.

- Encourage construction firms to minimize the nuisance that building sites inflict on adjoining neighbourhoods.
- Favour the promotion of education aiming to provide an 'environmental civic education' to young people being trained in construction skills.
- Encourage any political approach for the reduction of greenhouse gas emissions.
- Encourage construction firms to make more use of environmental management systems.
- Contribute to the spread of knowledge on the subject of the environment to building contractors of countries in Central and Eastern Europe at qualitative, statutory and normative levels.
- Encourage construction firms and their clients to use recyclable and/or reusable materials.
- Encourage the maintenance and renewal of European cultural heritage.
- Become one of the signatories to the 'International declaration for cleaner production', published by the United Nations Environment Program.

The FIEC states that the term 'sustainable construction' has different approaches and priorities in various countries. However, it seems to adopt the definition by Kibert (1994) that sustainable construction is 'the creation and responsible management of a healthy built environment based on resource efficient and ecological principles'.

BEQUEST Network

The broad aim of the Building Environmental Quality Evaluation for Sustainability through Time [BEQUEST] Network is to create a forum for concerted pan-European research, training and practical action in the quality assessment of the urban environment in order to identify the basis for common understanding and implementation of sustainable urban development.

The primary outputs include:

- An effective multi-professional, international, interactive built-environment quality evaluation and sustainability networked community.
- A directory of environmental assessment techniques and methods currently in use and emerging in the built environment sector, across the EU.
- A directory of professional advisors in the field.
- A procurement protocol for sustainable urban development.

In the later stages of the project participants in the network are to use the proposals in their normal work activities to provide essential feedback aimed towards improving the usability of the final output, which is of relevance to all those who are responsible for decision making in the built environment and in the infrastructure of towns and cities.

Software (a toolkit) has been developed to demonstrate a system to support decision makers concerned with urban sustainability. The toolkit is composed of 4 modules: the Protocol module, the Assessment Methods module, the Advisors module and the Glossary. The toolkit is available on the web: http://www.surveying.salford.ac.uk/bqtoolkit/index.htm

2.4.1 The Netherlands

The Netherlands defined sustainable construction as 'a way of building which aims at reducing negative health and environmental impacts caused by the construction process or by buildings or by the built-up environment' (CIB, 1999). These include:

- minimise the use of energy and water over the life span
- efficient use of raw materials
- minimise waste and pollution over the life span
- minimise the use of land and integrate with the natural environment
- meet its users needs now and in the future
- healthy indoor environment

After consultation with the building industry, the Dutch Government decided in February 1998 to implement sustainability requirements in the Dutch Building Decree by 2001. Energy performance requirements for buildings are already parts of the Building Decree. The new requirements will be based on an overall score for the environmental performance of the building as a whole, which will allow designers and builders considerable flexibility. A prototype model is developed before finalising as a Dutch Standard (Scholten et al., 2001).

With regard to waste, the Dutch Government has passed a law which states that 'dumping of reusable building waste is prohibited'. This law operates in 3 ways: reuse of buildings, reuse of elements or components and reuse of demolition and construction waste (Kristinsson et al., 2001).

2.4.2 Germany

Energy Saving Ordinance

The Energy Saving Ordinance became law on 1 February 2002. It introduces more stringent energy use requirements for new buildings and those undergoing renovation. Energy efficiency measures will be required on some existing buildings, which will involve the replacement of an estimated 2 million boilers. The new Ordinance combines and tightens two existing regulations: the thermal insulation and heating systems ordinances. The new ordinance applies to a range of buildings. Exemptions include buildings used to house animals, underground buildings, buildings that can be dismantled and glass houses used to grow and sell plants. The ordinance includes the following requirements:

New Buildings

- Standards will include transmission heat loss and a new method of calculation, the annual primary energy consumption. This will enable a better comparison of different heating systems and will give architects and builders the freedom to improve either insulation or boiler efficiency to meet the required energy saving target.
- The energy use standards for new, normal temperature buildings will be tightened by 30% compared to existing legislation. This will equate to a maximum of 7 litres of oil or $7m^3$ of gas per year per square meter of living space. Buildings where combined heat and power units or free-standing renewable energy units provide at least 70% of the heating requirement are exempt from this requirement.
- New buildings will be subject to compulsory energy labelling, which must be made available to prospective tenants.

Existing buildings

- Most energy efficiency standards in the ordinance do not apply to the existing building stock unless the building undergoes renovation or extension. In this case owners may either meet all the applicable standards or ensure that the primary energy requirement of the building as a whole does not exceed the standards for new buildings by more than 40%.
- The following three areas require action regardless of renovation work:
  - Boilers installed before October 1978 must be replaced by the end of 2006. This may be delayed until the end of 2008 if a new burner has been installed since November 1996. Efficient and low temperature boilers are however exempt. This will affect some 2 million boilers, according to Economic Ministry estimates.
  - Lofts which cannot be converted must be insulated by the end of 2006 to specified standards.
  - Boilers, equipment and pipes in unheated rooms must be insulated to specified standards by the end of 2006.
  - Buildings consisting of one or two flats, in which the owner is also resident, are exempt from the three requirements above, until two years after the property has changed hands.
- Where energy labelling is not mandatory, owners of residential buildings may take part in the scheme voluntarily.

The Bundestat (Upper Parliamentary Chamber) has requested that the Government review the impact of the ordinance by the end of 2006. The governing SPD party estimates that the ordinance would reduce carbon dioxide emissions by 10m tonnes per year by 2005 and the resulting investment would create up to 90,000 new jobs. It is predicted that the additional building construction costs of 1-2% could soon be offset by heating cost savings of Euros 100-200 per year.

Commercial Waste Ordinance

On 07 November 2001, the German cabinet adopted the Commercial Waste Ordinance that had been tabled by the German Environment Ministry. The ordinance increases the requirements for the recovery of commercial municipal waste as well as certain construction and demolition wastes by means of the commitment to better separation and more effective pre-treatment. This is geared towards enabling best possible safe and high-quality recovery of these wastes in terms of substances and energy. This should bring an end to “pseudo recovery”. Another target is to reach planning security for municipalities and the private economy.

In so-called pseudo recovery, commercial and industrial companies, but also private and public entities mix recoverable and non-recoverable waste and label them generally as waste for recovery. The disposal companies they commission hardly recover these mixed wastes, but to a larger extent dump them cost-efficiently in landfills. Thus sites get contaminated and need cost-intensive cleaning up in the future. Other ways of recovery that provide better ecological quality such as recycling and energy recovery are by-passed. The ordinance requires the separation of different waste groups such as paper, glass, plastics and metals, in order to achieve high-quality recovery. Pre-treatment facilities of commercial municipal waste are required to show proof of a recovery quota of a minimum of 85%. By this, pseudo recoveries are made impossible.

The Ordinance applies to producers and holders of, municipal wastes of commercial origin and of specific construction and demolition wastes (glass, plastics, metals, wood, concrete, bricks, tiles and ceramics), and to operators of pre-treatment facilities in which mixed municipal wastes of commercial origin or specific construction and demolition wastes (wood, glass, plastics and metals) are pre-treated. The Ordinance is being discussed in the Parliament at the moment and is likely to enter into force in 2003.

Ordinance on the Disposal of Waste Wood

On 06 February 2002 the German Government adopted the Ordinance on the Disposal of Waste Wood. At present the Ordinance is undergoing the parliamentary discussion procedures. This ordinance harmonises and specifies the requirements for recycling and energy recovery and the disposal of waste wood. The Closed Substance Cycle and Waste Management Act forms the basis for this Ordinance.

Germany is the first country to initiate an Ordinance on waste wood. There is no legislation for this as yet at European level. Presently there are no uniform requirements for the disposal of waste wood at a national level in Germany. Provisions exist only in individual Länder (states and city-states). There are various methods that are used for recycling and energy recovery, and waste for disposal is either incinerated or land filled. As there are doubts about the environmental compatibility of the different methods in use and due to the fact that the provisions in the Länder are not harmonious, a regulation is necessary at Federal level.

The new Ordinance covers the usual recovery ways for waste wood and sets binding ecological standards. It stipulates that waste wood should only thermally be disposed of, land filling is no longer an option. Waste wood that is contaminated with PCB has to be disposed of on the basis of the PCB/PCT Waste Ordinance. The requirements are particularly important for the recovery of waste wood for the purposes of producing wood feedstock which will eventually be used in commodities such as particle boards in pieces of furniture.

This is the reason regulatory limits are set for the content of pollutants in wood chips and particles generated from waste wood. The ordinance is awaiting approval from the Bundesrat. It is expected to enter into force in 2003.

Data on C&D waste is obtained from Schultman & Rentz, 2000 and Brooks et al. 1994, and Ruch et al. 1994: 45 million tonnes annually (60% of total national solid waste) of which 30% is recycled or reused.

2.4.3 Finland

Finland defines sustainable construction as '*in its own processes and products during their service life, aims at minimising the use of energy and emissions that are harmful for environment and health, and produces relevant information to customers for their decision making'* (CIB, 1999). These include:

- energy efficiency
- utilisation of renewable energy sources
- prolonged service life
- reduce waste and emissions
- recycling of building materials
- supporting the use of local resources
- implementation of quality assurance and environmental management systems

Comments:
OECD provides policy review and development, CIB provides research studies.

The Dutch Law is interesting in its directness. How it is going to be implemented will need further study.

The German Energy Saving Ordinance is significant as all new buildings will be subject to compulsory energy labelling, which must be made available to prospective tenants. A unified method is provided for calculating the annual primary energy consumption which is then used for comparisons. The new law extends to existing buildings undergoing significant renovations.

B2.5 United States of America

ASTM Standards related to Sustainability

- ASTM E2114, Standard Terminology for Sustainability Relative to the Performance of Buildings
- ASTM E2129, Standard Practice for Data Collection for Sustainability Assessment of Building Products.

Energy provisions of International Building Code (IBC)
Little is stated in the provisions for Energy Efficiency of the IBC apart from a reference to The International Energy Conservation Code as a prescriptive acceptable solution.

Regulations affecting Waste Management
(a) Federal Legislation:

- The Resource Conservation and Recovery Act
- The Comprehensive Environmental Response, Compensation, and Liability Act

These two Acts do not explicitly deal with, but are applicable to, construction and demolition waste. 'The Regulation of Solid and Hazardous Waste: A Builder's Guide' (NAHB, 1993) discusses their relevance to the building construction sector.

(b) Local and State solid waste regulations

One feature of Local and State regulation is the different definitions used in different States. Definition is important because it controls what kind of waste can be disposed.

STATE OF CALIFORNIA
Construction and demolition (C&D) debris includes concrete, asphalt, wood, drywall, metals, and many miscellaneous and composite materials. C&D debris is generated by demolition and new construction of structures such as residential and commercial buildings and roadways.

STATE OF FLORIDA
'Construction and demolition debris' means discarded materials generally considered to be not water soluble and non-hazardous in nature, including but not limited to steel, glass, brick, concrete, asphalt material, pipe, gypsum wallboard, and lumber, from the construction or destruction of a structure as part of a construction or demolition project or from the renovation of a structure, including such debris from construction of structures at a site remote from the construction or demolition project site. The term includes rocks, soils, tree remains, trees, and other vegetative matter which normally results from land clearing or land development operations for a construction project; clean cardboard, paper, plastic, wood and metal scraps from a construction project; effective January 1, 1997, except as provided in Section 403.707 13(j), F.S., unpainted, non-treated wood scraps from facilities manufacturing materials used for construction of structures or their components and unpainted, non-treated wood pallets provided the wood scraps and pallets are separated from other solid waste; and the commingling of wood scraps or pallets with other solid waste; and *de minimis* amounts of other non-hazardous wastes that are generated at construction or demolition projects, provided such amounts are consistent with best management practices of the construction and demolition industries. Mixing of construction and demolition debris with other types of solid waste will cause it to be classified as other than construction and demolition debris.

STATE OF HAWAII
'Construction and demolition waste' means solid waste, largely inert waste, resulting from the demolition or razing of buildings, of roads, or other structures, such as concrete, rock, brick, bituminous concrete, wood, and masonry, composition roofing and roofing paper, steel, plaster, and minor amounts of other metals, such as copper. Construction and demolition waste does not include cleanup materials contaminated with hazardous substances, friable asbestos, waste paints, solvents, sealers, adhesives, or similar materials.

STATE OF KANSAS
'Construction and demolition waste' means solid waste resulting from the construction, remodelling, repair and demolition of structures, roads, sidewalks and utilities; and solid waste consisting of vegetation from land clearing and grubbing, utility maintenance, and seasonal or storm-related cleanup. Such wastes include, but are not limited to, bricks, concrete and other masonry materials, roofing materials, soil, rock, wood, wood products, wall covering, plaster, drywall, plumbing fixtures, electrical wiring, electrical components containing no hazardous materials and non asbestos insulation. It shall not include asbestos waste, garbage, cardboard, furniture, appliances, electrical equipment containing hazardous materials, tires, drums and containers even though such wastes resulted from construction and demolition activities. Clean rubble that is mixed with other construction and demolition waste during demolition or transportation shall be considered to be construction and demolition waste.

STATE OF MINNESOTA
- Construction Wastes

'Building materials, packaging, and rubble resulting from construction, remodelling, repair, and demolition of buildings and roads'.

- Demolition Debris

'Solid waste resulting from the demolition of buildings, roads, and other manmade structures, including concrete, brick, bituminous concrete, untreated wood, masonry, glass, trees, rock, and plastic building parts. Demolition debris does not include asbestos'.

STATE OF NORTH CAROLINA
'Construction' or 'demolition' when used in connection with 'waste' or 'debris' means solid waste resulting solely from construction, remodelling, repair, or demolition operations on pavement, buildings, or other structures, but does not include inert debris, land-clearing debris or yard debris.

STATE OF NEW YORK
Construction and demolition (C&D) debris means uncontaminated solid waste resulting from the construction, remodelling, repair and demolition of utilities, structures and roads; and uncontaminated solid waste resulting from land clearing. Such waste includes, but is not limited to bricks, concrete and other masonry materials, soil, rock, wood (including painted, treated and coated wood and wood products), land clearing debris, wall coverings, plaster, drywall, plumbing fixtures, non asbestos insulation, roofing shingles and other roof coverings, asphalt pavement, glass, plastics that are not sealed in a manner that conceals other wastes, empty buckets ten gallons or less in size and having no more than one inch of residue remaining on the bottom, electrical wiring and components containing no hazardous liquids, and pipe and metals that are incidental to any of the above.

Solid waste that is not C&D debris (even if resulting from the construction, remodelling, repair and demolition of utilities, structures and roads and land clearing) includes, but is not limited to asbestos waste, garbage, corrugated container board, electrical fixtures containing hazardous liquids such as fluorescent light ballasts or transformers, fluorescent lights, carpeting, furniture, appliances, tires, drums, containers greater than ten gallons in size, any containers having more than one inch of residue remaining on the bottom and fuel tanks. Specifically excluded from the definition of construction and demolition debris is solid waste (including what otherwise would be construction and demolition debris) resulting from any processing technique, other than that employed at a department-approved C&D debris processing facility, that renders individual waste components unrecognisable, such as pulverizing or shredding. Also, waste contained in an illegal disposal site may be considered C&D debris if the department determines that such waste is similar in nature and content to C&D debris. *(See http://www.epa.gov/epaoswer/hazwaste/sqg/c%26d-rpt.pdf)*

(c) EPA and OHS regulations concerning the handling of hazardous waste
Data on C&D waste is obtained from Kibert et al. (2000): 136 million tonnes (33% of total national solid waste), of which 50% is concrete/masonry, 25% timber (Peng et al. 1994). 30% of waste is from residential, 70% from non-residential sector and 20%-33% of the waste is recycled or reused (Yost, 2000; Nesmith, 1993).

Materials and Water Conservation

- ***Construction Site Solid Waste and Recycling Collection****--Portland, Oregon; 1996.*

Mandates recycling of construction site waste for any building project with a total job cost over $25,000 as well as requiring recycling programs for businesses and multifamily dwellings.

- ***Straw-Bale Structures Building Code****--Tucson, Arizona; 1996.*

Establishes minimum construction requirements for buildings using straw bales in wall systems.

- ***Guidelines for Straw-Bale Structures****--State of California; 1995.*

Establishes minimum construction requirements for buildings using straw bales in wall systems.

- ***Voluntary Resource-Efficient Guidelines on New Construction and Building Renovation Projects****--San Diego, California; 1997.*

Establishes voluntary green building guidelines that focus on energy and resource efficiency, waste minimization, and protection of the environment.

Energy Efficiency Design Standards

- ***Energy Policy****--Portland, Oregon; 1990.*

Provides a 10-year plan to increase energy efficiency in all sectors of Portland by ten percent.

- ***Energy Performance Standards****--Montgomery County, Maryland; 1985.*

Establishes minimum energy performance standards for county buildings.

- ***Building Energy Design Standards****--Montgomery County, Maryland; 1985.*

Establishes design requirements for new or remodel construction of County buildings to ensure that the Energy Performance Standards are met.

- ***Energy Efficiency Standards****--State of California; 1995*

Establishes energy efficiency requirements for residential and non-residential building.

- ***Energy Conservation Ordinance****--Chapel Hill, North Carolina; 1997.*

Establishes energy-efficiency design and construction standards for new and renovated town buildings.

- ***Energy Conservation Retrofit Regulations****--Davis, California; 1994.*

Requires existing residential structures to conform to energy conservation requirements, with compliance monitoring applied to the sales of property.

- ***Energy Conservation Standards for Alterations and Remodels to Residential Structures****--Davis, California; 1994.*

Establishes minimum energy performance levels beyond state requirements, while allowing for innovation and flexibility of design.

Solar Access Protection

- ***Solar Energy Ordinance****--Port Arthur, Texas; 1979.*

Provides solar access protection as well as establishing requirements for street design in new building projects to maximize solar energy benefits.

- ***Solar Access: Summary of Ordinance****--Boulder, Colorado; 1991.*

Limits the amount of permitted shading by new construction and requires that new buildings be sited to provide good solar access.

- ***Solar Access Regulations****--Boulder, Colorado; 1991.*

Limits the amount of permitted shading by new construction and requires that new buildings be sited to provide good solar access.

- ***Solar Access, Thermal Performance, and Solar Heating Ordinances****--Soldiers Grove, Wisconsin; 1980.*

Establishes energy performance standards for new building, including a requirement that non-residential buildings receive a minimum of 50 percent of their heating from solar energy.

- ***Solar Codes and Ordinances****--New Pattonsburg, Missouri; 1996.*

Provides for protection of solar access, encourages alternative housing design, the use of wind energy conversion systems and other resource efficient technologies.

- ***Solar Rights Act****--State of New Mexico; 1978.*

Defines the right to use solar energy as a property right and provides for state encouragement of its use.

Department of Energy
Web Site: http://www.sustainable.doe.gov/buildings/gbcodtoc.shtml

Indoor Air Quality (IAQ)

- *Healthy Buildings, Healthy People (HBHP): A Vision for the 21st Century. Report by U.S Environmental Protection Agency, October 2001*

(Report available from http://www.epa.gov/iaq/hbhp/hbhptoc.html)
The HBHP report is the outcome of a cross-Agency effort to define a strategic vision and potential actions for improving the quality of indoor environment. Chapter 1 focuses on why human health indoors deserves the scrutiny, concern, and action of policy makers. These reasons are primarily health-related. Health risks associated with indoor environments include asthma, cancer, and reproductive and developmental effects. However, significant gaps still exist in the current state of knowledge about indoor environmental risks and exposures.

A particular emphasis is placed on children's health. Chapter 2 presents a vision statement and outlines goals, broad strategies, and guiding principles to achieve success in every sector of our society over the next 25 to 50 years. In short, the objective is to realize major human health gains over the next 50 years by upgrading indoor environments. Five goals or strategies have been set to accomplish this objective:
(1) Achieve major health gains and improve professional education
(2) Foster a revolution in the design of new and renovated buildings
(3) Stimulate nationwide action to enhance health in existing structures
(4) Create and use innovative products, materials, and technologies
(5) Promote health conscious individual behaviour and consumer awareness

In addition to providing information on actions and strategies that can be taken to protect people indoors, EPAs vision acknowledges the important role played by individuals in protecting their own health and the health of those around them. Chapter 3 lays out potential actions that EPA or others may pursue. Appendix A provides an overview of current indoor environmental program priorities in various offices within EPA. Appendix B examines the roles of the Agency's partners in indoor environmental protection, including federal, state, local, and tribal organisations, as well as stakeholders in the private sector. Appendix C provides a summary of the comments on the draft report and how the comments can be accessed through their docket.

- *Sustainability Plan, San Francisco (typical of similar plans in other cities)*

(See http://www.sustainable-city.org/Plan/Air/intro.htm)
The Sustainability Plan became policy of the City and County of San Francisco in July, 1997. It has five goals related to air quality (both indoor and outdoor):
Goal 1. To assure a level of air quality that has no negative impact on the health of humans or the ecosystems of the natural environment.
Goal 2. To maintain a level of air quality that prevents damage to buildings and infrastructure.
Goal 3. To eliminate human causes of climate change and prevent depletion of natural barriers against ultraviolet rays.
Goal 4. To link air quality and energy issues.
Goal 5. To maintain air clarity.

There are long-term objectives, 5-year objectives and actions associated with each goal. The long-term objectives are typically concerned with means of travel, power production and industrial production that do not cause chemical, heat, or particulate pollution of the atmosphere. The 5-year objectives typically are concerned with establishing indoor air quality

standards and reduction of vehicle-miles travelled in private automobiles by 10%. Typical actions are:

(i) Outdoor
- Develop participatory process to identify and plan for auto-free zones.
- Increase the use of clean-fuel vehicles.
- Adopt a program to phase out conventionally fuelled vehicles from the City fleet and investigate possibilities to replace conventionally fuelled heavy equipment and public transit vehicles.

(ii) Indoor
- Design publicly funded buildings with indoor-air-quality design criteria and develop incentives to encourage the private sector to use the criteria.
- Establish a budget for and hire an indoor-air-quality coordinator.
- Endorse and, as appropriate, adopt technical manuals and standards such as those issued by ASHRAE (American Society of Heating, Refrigeration, & Air Conditioning Engineers) and the U.S. Green Building Council.
- Use these guidelines and incorporate new codes to assure good indoor air quality.
- Establish guidelines for purchasing low-emitting products and distribute them widely to city agencies, businesses and consumers.
- Institute stronger health-based occupational standards.

(iii) Education
- Establish a resource centre to provide public access to information on air quality and the health effects of the ingredients of common products.
- Reduce personal impact on the shared indoor environment by limiting the use of scented personal-care products.
- Implement public education campaigns about: (a) the importance of air quality and the need for research; (b) the need to reduce dependence on automobiles; (c) each individual's impact on the shared indoor environment (such as airborne emissions from fragrances and cleaning and maintenance products).
- Create and distribute an education syllabus on indoor and outdoor air quality for use in the schools.
- Implement a city-wide notification program so that the public can be informed in advance of the release of air-borne toxins, such as pesticides and roofing-tar fumes.

- *ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)*

This standard specifies minimum ventilation rates and IAQ that will be acceptable to human occupants and are intended to minimise the potential for adverse health effects. This standard applies to commercial and institutional buildings. To obtain compliance for ventilation design, there are two procedures in the ASHRAE Standard. First is the ventilation rate procedure which requires that acceptable IAQ is achieved by providing ventilation air of the specified quality and quantity to the space. The second is the indoor air quality procedure which requires that acceptable IAQ is achieved within the space by controlling known and specifiable contaminants.

- *Washington State Ventilation and Indoor Air Quality Code (2000)*

(see http://www.sustainable.doe.gov/efficiency/airpollution/codtoc.shtml)

The Washington State Building Code Council adopted the 2000 Washington State Ventilation and Indoor Air Quality Code. This code provides a minimum level of air quality within the structure, but allows flexibility in equipment design, construction, and heating equipment efficiencies. The design of this code allows space heating equipment efficiencies to offset or substitute for building envelope thermal performance.

The chapter on indoor air quality addresses two issues: (a) Pollutant Source Control; and (b) Solid Fuel Burning Appliances and Fireplaces. The Pollutant Source Control is related to **formaldehyde** reduction measures which states that all structural panel components within the conditioned space such as plywood, particle board, wafer board, and oriented strand

board shall be identified as "EXPOSURE 1", "EXTERIOR" or "HUD-APPROVED". (Formaldehyde is used in the adhesives in the production of particleboard and plywood).

The indoor air quality is addressed by several standards and codes of practice (such as ANSI/ASHRAE Standard 62-2001) in terms of ventilation and filtration. However, these two measures require energy consumption. It is estimated that space conditioning represents about 25% of the final energy demand in the EU. It is also important to note that the outdoor air quality plays an important role in the specifications of the indoor air quality and the associated requirements for ventilation and filtration.

B2.6 Japan

Building Standards Law of Japan (MLIT, 2000a)
Mandatory requirements concerning:

- Durability
- Waste water management
- Toxic building materials
- Maintenance

Energy Conservation Law (METI, 1999)
Mandatory requirements together with Guideline and promotion scheme for application including

- Building /Housing Energy Code
- Industry Energy Provisions

Housing Quality Assurance Act (MLIT, 2000b)
Housing Performance Indication Standards are established for the evaluation of housing performance. Performance attributes relevant to sustainability, which required evaluation includes:

- Mitigation of degradation
- Maintenance
- Energy efficiency
- Indoor air environment
- Visual environment
- Acoustic environment

A ranking method is used as indicator of performance. This is a voluntary system. (MLIT, 2000b)

Construction Material Recycling Law (MLIT, 2001)
Mandatory requirements and promotion scheme for:

- Registration of demolition contractors
- Reuse of concrete, timber etc.

Construction waste is about 20% of Japanese industrial waste and uses about 40% of landfill volume. 90% of illegal dumping is construction waste (CIB, 2000).

Government Promotional Measures
Most of industry / building owners actions for improving sustainability are supported by government by the introduction of financial incentives such as subsidiaries, tax reduction, low interest government loans etc.

Environmentally Symbiotic Housing
The Institute for Building Environment and Conservation has proposed this program with 3 objectives: global environment protection, healthy residential environment with amenities and harmony with the surrounding environment. For global environment protection, the proposed measures include:

- Reduce energy consumption for heating and cooling (by reduction of heat loss, proper daylight control, and energy efficient equipments)
- Utilise natural and unused energy resources (passive, active and hybrid systems for solar and other energy sources)
- Design houses for long term use (durability and adaptability)
- Encourage cyclical use and recycling of natural resources ('low emission' of waste, recycling of building materials, effective use of water resources, supporting system for sorting and collection of household waste).

Various guidelines have been issued:

- Guideline for energy saving codes of building/ housing (IBEC, 2001)
- Design Guideline for Environmentally Symbiotic Housing (Association for Symbiotic Housing, 1997)

Architectural Institute of Japan (AIJ)

Has also been active on sustainability and has developed the following:

- *Principal Guide for Service Life Planning of Buildings (AIJ, 1993a)*

This document showed the fundamental concept of durability within each stage of the life-cycle of buildings together with methods for predicting service life.

- *Building Agenda 21 (AIJ, 1993b)*

This is a research agenda that has 7 basic targets:

- Methodology to evaluate life cycle impact of building to the environment
- Code of practice of planning from the aspect of energy consumption
- Prolong life of buildings to reduce resource consumption
- Reduce energy and water use in building operation
- Sustainable land utilisation and prevention of pollution to water air and land
- Measures for a healthy environment
- Technology transfer and information exchange for international co-operation

Comments: Measures concerning waste water, energy and durability are regulated but most of other measures are non mandatory. The Japanese Government is actively promoting sustainability with financial incentives.

B2.7 AUSTRALIA

B2.7.1 National Developments

In 1992, Commonwealth, State and Territory Governments endorsed the National Strategy for Ecologically Sustainable Development (NSESD). The NSESD provides the policy framework for ecologically sustainable development in Australia. It defines 'ecologically sustainable development' as *'development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends'.* Three NSESD core objectives are:

- Enhance individual and community wellbeing and welfare by following a path of economic development that safeguards the welfare of future generations;
- Provide for equity within, and between generations; and
- Protect biological diversity and maintain essential processes and life support systems.
- The NSESD outlines a number of guiding principles. Important among them are:
  - The need for decision making processes to effectively integrate long term and short term economic, environmental and social considerations; and
  - That a lack of full scientific certainty should not be used as a reason for postponing action - known as the precautionary principle.
  - NSESD also acknowledges that governments need to change their institutional arrangements to ensure that ESD principles and objectives are taken into account in the decision making processes.

In his Statement of 20 November 1997, 'Safeguarding the Future: Australia's Response to Climate Change', the Prime Minister announced a package of measures to reduce Australia's greenhouse gas emissions. For the building sector, the PMs statement specified that the Government will work with the States and Territories and industry to develop:

- 'Energy efficiency codes and standards for housing and commercial buildings…'
- 'Minimum energy performance requirements for new houses and major extensions'
- 'Voluntary minimum energy performance standards for new and substantially refurbished commercial buildings'

After 12 months, the Government assessed that the voluntary approach was not achieving acceptable progress towards higher standards of energy efficiency for housing and commercial buildings. It then commenced work with the States/Territories and industry to implement mandatory standards through amendment of the Building Code of Australia (BCA96).

In 1999, the Commonwealth Government initiated a Productivity Commission inquiry into the Implementation of Ecologically Sustainable Development (ESD) by Commonwealth Departments and Agencies. The Government response to this inquiry has not yet been published, however all Commonwealth agencies were encouraged to implement an EMS join the Greenhouse Challenge Program. Nothing specific about building construction is addressed in this report in which key priority areas are natural resources management, transport, dry land salinity and water management. Another recommendation that might be relevant to the implementation of ESD in building construction area is that good practice decision making process should be followed. These include clearly defining ESD objectives, involving stakeholders and developing appropriate institutional frameworks and mechanism.

Environment Australia (The Department of Environment and Heritage) administers environmental laws, including the *Environmental Protection and Biodiversity Conservation Act (EPBC)* of 1999. The portfolio also includes the Australian Greenhouse Office and manages a range of voluntary programs related to building construction.

NABERS: The National Australian Buildings Environmental Rating System was released in December 2001 as a draft structure by Environment Australia as a specification of what an environmental rating system for residential and commercial buildings should cover. The full complement of documents is accessible from www.ea.gov.au. It is meant to perform as a rating system rather than a design (assessment) tool. Its scope covers: land, materials, energy, water, interior, resources, transport and waste. Scores are assigned to buildings in respect of their 'performance' (quantitative and qualitative) under each category, resulting in designation of building as either one through 5 star-rated. NABERS will be finished in July 2003.

The Environmental Protection and Biodiversity Conservation Act considers repairing, maintaining or making alterations to:

- commercial and domestic buildings and properties; and
- utilities for power, water and sewage.

Developments with impacts on special environments are to be referred to the Environment Minister for consideration. This is normally about the land rather than the building.

The Australian Greenhouse Office is the lead Commonwealth agency on greenhouse matters. Its work program includes the following building construction related issues:

- energy efficiency in buildings; and
- supporting the use of solar power on residential and community buildings.

Environment Australia also sponsors State of Environment Reports which contain data related to Australia's State of the Environment. The 2001 Report on Human Settlement (Newton et al., 2001) provides a once-in-five-year snap shot of the key issues of relevance to urban Australia and their environmental impacts. The report is summarised in an article titled

'Urban Australia 2001' (Newton, 2002). The report also contains extensive references to the sources of the data.

Voluntary programs managed by EA include:

- WasteWise Construction Program (with 14 major construction companies and building associations) has now been concluded. The program resulted in several publications for reducing construction waste.
- NABERS project to develop a national building rating system
- PATHE/GreenSmart Program (with HIA)
- Awards (with MBA)
- Recycled Concrete Guide (with CSIRO)

The Institution of Engineers, Australia 'Sustainable Energy Building and Construction Taskforce Report' (I.E Aust., 2001) explores avenues by which the building and construction sector might contribute to more sustainable energy practices. It produces a series of recommendations to Governments, to I.E Aust. and to Individual Engineers.

The Building Code of Australia (BCA96)

The BCA96 is a set of technical rules for the design and construction of buildings. At present, the BCA96 does not address the issue of sustainability. It has no reference, recommendations or restrictions on any issue related to sustainability apart from the following:

- **Durability**: Durability is not directly addressed in the BCA96 but durability requirements are included in referenced documents as means of satisfying the primary goals of the BCA96 namely health, safety and amenity. An ABCB Guideline on Durability in Buildings is also in course of preparation.
- **Energy Efficiency**: Currently there are no national energy efficiency measures in the BCA96. However, three jurisdictions, the Australian Capital Territory, South Australia and Victoria, do have measures in their BCA96 Appendices. A new energy efficiency measure regulatory proposal for housing – 'Energy Efficiency Measures - BCA96 Vol.2 (Housing Provisions)' has been developed and is under consideration (ABCB, 2002). The provisions are targeted to be included in the BCA96 from 1 January 2003.

B2.7.2 State and Territory Developments

(a) New South Wales

- ESD is referred to in legislation including the Local Government Act (1993), Environment Planning and Assessment Act (1979) and Protection for Environment Operations Act (1997).
- The Sustainable Energy Development Authority was set up in 1996 to reduce greenhouse gas emissions and to develop renewable energy and cogeneration (see www.seda.nsw.gov.au)
- Resource NSW is established by the Waste Avoidance and Resource Recovery Act of 2001 to manage Avoidance, Resource Recovery and Disposal of Waste (see www.resource.nsw.gov.au)
- The Sustainability Unit of Planning NSW is currently working on a Sustainability Building Index/ Rating Tool (BASIX) intended to be taken up by Local Governments in 2003.

(b) Victoria

- Activity in Victoria is mostly focused on climate change response per the Victorian Greenhouse Strategy (details on www.greenhouse.vic.gov.au) which addresses building energy efficiency issues in relation to both domestic and commercial buildings.
- The Government has recently announced a new 5 Star energy rating for residential buildings, details of which are available from the Building Commission's own website.

- Solid waste generated by construction and demolition activities is an issue that Victoria is working on with EPA, local councils and EcoRecycle (www.ecorecycle.vic.gov.au)
- Water management is an issue with potential implications for building standards; activity in Victoria has been focused at the policy level lately, through the Victorian Water Strategy (www.watersmart.vic.gov.au) which is producing a series of strategic directions reports.
- The Victorian Government itself has made a high level policy commitment to sustainability, expressed in its 2001 publication "Growing Victoria Together".
- The Metropolitan Strategy (details from www.doi.vic.gov.au) will address sustainability issues relating to urban form when it is released later this year.

(c) South Australia

- The Environment Protection Act 1993 provides environmental policies, guidelines and codes of practice for a wide range of environmental issues some of which concern particular industries. Those that specifically relate to the building and construction industry concern such matters as noise, waste on building sites, storm water pollution prevention and recycling of building and demolition waste.
- An Office of Sustainability has recently been established and its current focus is the long term management of the City's waste including landfill sites.
- The Development Act and the Environment Protection Act are companion acts and both have recourse to the Environment, Resource and Development Court.
- The Development Act 1993, which includes the Building Rules, has in its objectives: 'To encourage the management of the natural and constructed environment in an ecologically sustainable manner' also 'To facilitate sustainable development and the protection of the environment'. Under the Development Act significant development packages to guide consistent development in the State have been developed for Storm Water Management and Wind Farms.
- There is a significant commitment by government to reducing greenhouse gas emissions and improving the energy efficiency of housing in the State. Energy efficiency requirements for housing will be introduced on 1 January 2003.

(d) Queensland

- The Environmental Protection Act 1994 provides environmental protection policies for air, noise, water, and waste management. These policies do affect the building construction sector.
- The Integrated Planning Act 1997 establishes 'a framework to integrate planning and development assessment so that *development* and its effects are managed in a way that is *ecologically sustainable*, and for related purposes'. '*Development'* is defined as, among other things, 'carrying out building work'. *'Ecological sustainability'* is defined as a 'balance that integrates:
  - Protection of ecological processes and natural systems at local, regional, state and wider levels;
  - Economic development;
  - Maintenance of the cultural, economic, physical and social wellbeing of people and communities.'
- The Queensland Department of Public Works has issued a Waste management strategic plan (May 2002) to establish 'an integrated framework to minimise and manage waste in accordance with the principles of ecologically sustainable development promoting efficient resource use'. The strategy is based on Environmental protection (Waste management) Policy 2000.
- The Queensland Department of Housing's Toward Healthy and Sustainable Housing Research Project is an essential part of the Queensland Government's Smart Housing initiative and commitment to reduce greenhouse gas emissions.
- A 'Model Code' for Energy Efficiency in Building has also been proposed.

(e) Western Australia

- A Sustainability Policy Unit has been established within the Policy Office of the Department of the Premier and the Cabinet to develop the State Sustainability Strategy.
- A number of background papers for the State Sustainability Strategy have been developed including one on Sustainable Building and Construction.
- The Western Australian Government has issued a State Sustainability Strategy entitled, Focus on the Future: the Western Australian State Sustainability Strategy - Consultation Draft (Government of Western Australia, 2002). This is a wide ranging strategy involving governance, natural resources, settlements and community. A list of proposed actions includes the following for buildings:
    - Four star energy rating on all new homes;
    - Guide for sustainable planning, building and construction;
    - Incorporate the principles of sustainability into relevant state government documents;
    - Provide incentives for sustainable building and construction including renovation.

(f) Tasmania

- The new Tasmania Building Act (2000) does include sustainability as part of its goal.
- Tasmania has a Resource Management and Planning System, whose objectives are:
    (a) to promote the sustainable development of natural and physical resources and the maintenance of ecological processes and genetic diversity;
    (b) to provide for the fair, orderly and sustainable use and development of air, land and water;
    (c) to encourage public involvement in resource management and planning; and
    (d) to facilitate economic development in accordance with the objectives set out in paragraphs (a), (b) and (c); and
    (e) to promote the sharing of responsibility for resource management and planning between the different spheres of Government, the community and industry in the State.
- The two main pieces of legislation that support the system are: The Land Use Planning and Approvals Act (1993) and the Environmental Management and Pollution Control Act (1994). Pollution prevention, clean production technology, reuse and recycling of materials, waste minimisation as well as the reduction of the discharge of pollutants and hazardous substance are parts of the Objectives of the Acts.
- Of particular interest to this report is the definition of 'sustainable development' - meaning 'managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural well-being and for their health and safety while:
    - sustaining the potential of natural and physical resources to meet the reasonably foreseeable needs of future generations
    - safeguarding the life-supporting capacity of air, water, soil and ecosystems
    - avoiding, remedying or mitigating any adverse effects of activities on the environment

(g) Northern Territory

No specific sustainability provision is being contemplated in the building construction area, although the NT has an Office of Environment & Heritage that has responsibility for several NT and national environment protection strategies.

- NT Waste Management and Pollution Control Strategy. This was endorsed by Government in September 1995, and a progress report was tabled in the Legislative Assembly in August 1998.

- NT Waste Minimisation and Recycling Strategy. This was released in November 1992, and is targeted for review in conjunction with the above strategy (due September 2000).
- A NT Strategy for Management of Contaminated Sites is under development. Contaminated site issues have become an essential consideration in relation to redevelopment of former industrial sites (eg. $2^1/_2$ Mile and Stuart Park fuel tank farm). Many companies are seeking advice on the contaminated status of sites and future cleanup liabilities as part of their due diligence policies before purchasing land in the Territory.
- National Ozone Protection Strategy (DLPE is lead agency).
- National Cleaner Production Strategy (DLPE is lead agency).
- National hazardous waste initiatives and strategies: eg. a scheme for collection and disposal of unwanted farm chemicals and empty containers; plans for management of PCBs and other scheduled wastes; and developing NT strategies for medical and quarantine wastes and ship ballast waters.

The program administers the Environmental Assessment Act, the National Environment Protection Council (NT) Act, the Ozone Protection Act, the Environmental Offences and Penalties Act and the Waste Management and Pollution Control Act. The Office also has a Greenhouse Unit to provide advice to the NT Government on a broad range of greenhouse issues and related policies.

(h) Australian Capital Territory

- Development applications for new dwellings require a four star rating under ACTHERS. The FirstRate software adopted in July 2001 made the rating system more exigent.
- The ACT Greenhouse Strategy is currently under review. It contains energy efficiency proposals for both residential and commercial buildings.
- The ACT Government has introduced new tools and assessment processes for development effective from 1 July 2001 (Designing for High Quality and Sustainability, 2001). These include:
  - Site Analysis
  - Quality design indicators
  - Sustainable Development Index for Residential Development (Energy, Water, Building Materials and other initiatives for improved sustainability)
- In 1996 the ACT Government launched the 'No Waste by 2010' Waste management strategy. Amendments to the Building Act 1972 and the ACT Appendix to the Building Code of Australia require a waste management plan to be part of any application for demolition of a building.

This concludes the review of national and international literature on the current state of play in respect to the representation of sustainability principles within building codes and associated legislation. The next section outlines the state of play with regard to the various sustainability issues that could be included.

3 SPECIFIC ISSUES

This section of the Report provides a review of the specific building-related sustainability issues selected. These are:

- Durability
- Energy
- Waste
- Climate change
- Adaptability
- Indoor air quality
- Noise
- Water
- Urban Salinity
- Assessment tools
- Benchmarking

B3.1 Durability

Durability provisions already exist in building regulation in some form, either directly or indirectly in most countries. It is normally treated as a means for fulfilling the primary requirements of health, safety and amenity and not specifically targeted at sustainability. Although it could be argued that prolonging the life of products does have a positive effect on sustainability in reducing the consumption of materials.

In terms of implementation, some countries use the mandatory route (building code), e.g. in New Zealand, or non-mandatory route (Guideline), e.g. as in Canada. The current Australian position is to follow the non-mandatory route. An ABCB Guideline on 'Durability in Buildings' was published in March 2003.

B3.2 Energy

(a) General

For Australia, the State of Environment Report (SoE 2001) shows that household energy use per capita is relatively stable, having risen only 15% over the past 25 years. However the growth in the energy use in the rest of the economy is quite strong, dominated by industry and transport (see Table 2).

Table 2: Energy use per capita

Type of consumption	**Energy use per capita (GJ)**	
	1975	**2000**
Total	193	258
Final end-use	136	175
Residential end use	18	21

Source: SoE Report, 2001

It is estimated that the buildings are responsible for over 40% of the CO_2 emissions, more than any other sector**.** A study on the CO_2 emissions of variety buildings from cradle to grave with 50 years life has found that the CO_2 emission from use of office buildings (steel and concrete) is about 86% of the total CO_2 emission, with remaining 14% is a result of manufacturing, maintenance and demolition (Anderson, 1996).

Thus, reduction of CO_2 emission can be directly related to energy efficiency. The majority of CO_2 emission is related to building use rather than manufacturing, maintenance and demolition.

(b) Embodied energy
Embodied energy is the energy consumed by all of the processes associated with the production of a building. CO_2 emissions are highly correlated with the energy consumed in manufacturing building materials. There has been little change in material supply and selection in the last 20 years or so, so there has been little change in embodied energy consumption in dwelling per unit area (about 5GJ/m2). However, there is an increase in floor area per dwelling by about 20% with corresponding increase in embodied energy (EA, 2001b). Embodied energy represents 20-50 times the annual operational energy of most Australian buildings (Treloar and Fay, 2000).

Reuse of building materials could save from 20% (glass) to 95% (aluminium) of the embodied energy. Thus in order to save on embodied energy, one can encourage smaller size dwellings (a planning issue) and the reuse of building materials (a building code issue). The BCA96 (and its referenced documents) does not address the issue of reuse of building materials at present.

(c) Operating energy
Reducing operating energy consumption will also have a direct effect on greenhouse gas emissions. Heating and cooling account for about 15% of the total greenhouse emissions from a dwelling (Harrington et al., 1999). Requirements for efficiency of building operating energy have therefore been implemented in most building codes around the world.

Currently there are no national energy efficiency measures in the BCA96. However, three jurisdictions, the ACT, South Australia and Victoria, do have measures in their BCA96 Appendices. A new energy efficiency measure for BCA96 Vol.2 (Housing Provisions) has been developed and is under consideration (ABCB, 2002a). The provisions are targeted to be included in the BCA96 in January 2003. Other areas that the BCA96 might address are the use of alternative energy sources and building design for better energy efficiency.

B3.3 Waste

(a) Waste reduction
Construction and Demolition (C&D) waste represents a large part of the total solid waste in most countries ranging from 20% to 60%. 50%-85% of the solid waste is concrete/masonry with the remainder being timber, metal and plastics. About 1/3 of the waste is reused or recycled. Most countries have regulations concerning waste disposal particularly hazardous waste. They are general regulations under environmental protection or other Acts, but not in building codes.

From regulations and policy-making point of view; the following issues are often discussed:

- Definition of waste
- Preventing the sale of building materials that contain hazardous substance. These measures will protect workers from potential exposure during installation and eliminate the need to remove and reclaim the material in the future.
- Adopt and publicise a policy promoting waste reduction and pollution prevention in all publicly funded construction, renovation, and demolition projects.
- Encourage creative renovation projects with tax and zoning incentives.
- Develop incentives for building contractors to reduce waste. (For example, the city of San Jose, California, requires contractors to pay a construction waste fee as part of the building permit process. The fee is returned to contractors that can demonstrate on-site reuse of materials or provide receipts for materials from recycling facilities)
- Maintain databases of local construction materials recyclers and contractors that practice C&D waste prevention.
- Include waste reduction/building materials pollution prevention elements in storm-water pollution prevention plans.

In Australia, the SoE report (EA, 2001b) provides the following picture: C&D waste averages 37% of total solid waste or 8 million tonnes, with 65% generated during demolition. There has been a good rate of reuse or recycling of building materials with estimates varying from 50% to 80% (Crowther, 2002).

In terms of policy and legislation, the Federal Government has set a target of 50% reduction of waste going into landfill by the year 2000, based on 1990 levels (Australian and New Zealand Environment Conservation Council - Waste management Awareness Program). All State and Territory Governments have some form of legislation related to waste management. Most States impose a levy on land fill. Some States have set target dates for removing C& D waste from landfill altogether (see Table 3).

Table 3: Comparison of C&D waste generation and recovery

Country	**C&D Waste (million tonnes)**	**% of total solid waste**	**% of reuse/ recycle of C&D waste**
US	136	33%	20%-33%
UK	53		45%
Netherlands	14		80%
Germany	45	60%	30%
Europe	180		28%
Australia	8	37%	50%-80%

Source: CIB, 2000

The waste generated in manufacturing phase and demolition phase are considered to be outside the scope of the BCA96. Only the waste generated during the design and construction phase can be considered as being within the scope of the BCA96. An ABCB Guideline on the subject of reducing waste on the building sites would be useful to industry.

(b) Reuse and recycling

The disassembly of buildings at the end of their life for reuse of materials and products has not been a design consideration in current practice. One of the major barriers to reuse is the difficulty of separating without damaging the components that can be reused because they were not initially designed for such a purpose. 'Deconstruction' is being considered by the CIB as an emerging issue by TG39 (CIB, 2000).

The BCA96 does not address the question of reuse of building materials and products. Implicit in some BCA96 reference documents is the assumption that the materials are new. The BCA21 can facilitate sustainability by addressing the issue of reuse of materials and products with respect to product performance and durability requirements.

B3.4 Climate Change

Reports from the Inter-governmental Panel on Climate Change (IPCC, 2001) have established that climate change caused by the enhanced greenhouse effect is already occurring and future change is inevitable. Projections and impacts of climate changes for Australia have been provided by CSIRO and are summarised in Table 4.

Table 4: Climate Change Projections

Event	2030	2070
Temperature (average increase)	+0.4 to +2.0^{o}C	+1.0 to +6.0^{o}C
Rainfall	-20% to +10%	-60% to +35%
CO_2 concentration (from 350 ppm)	430 - 455 ppm	525 - 705 ppm
Sea level rise	3.2 cm to 32 cm	6.4 cm to 64 cm
Cyclones	Wind speeds up 5% to 20% by end of century	
Flooding risk	Double?	Quadruple?

Source: (Whetton, 2001; Ash, 2001)

A level of uncertainty currently surrounds the magnitudes and implications of the changes, but the impacts on building construction are likely in the following areas:

- Flooding - might become more frequent. The BCA might have to give more consideration to the issue of flooding.
- Drought - may cause erosion and vegetation loss that might affect the foundations of buildings.
- Bushfires - the danger might increase with a decrease in relative humidity.
- High winds - Strong tropical cyclones and increased storm intensities may result in higher design wind speeds. However there is no prediction available at present to evaluate whether a change in design wind speeds is warranted.

B3.5 Adaptability of Buildings

Adaptability refers to the capacity of buildings to accommodate substantial change (Russell and Moffatt, 2001). This includes: (a) flexibility (ease of change of spatial organisation or of technology and services), (b) convertibility (ease of change for new use) and (c) expandability (ease of additions).

A building that is more adaptable to change is likely to stay in service longer and in turn, may have an improved environmental performance over the lifecycle. The proof of the above proposition is hard to establish because: (i) the difficulties in predicting future requirements and (ii) few buildings that exist today have been design for adaptability and put to the test of time. Adaptability may benefit environmental performance by providing (a) more efficient use of space, (b) increase longevity and (c) improve operating performance.

Larsson (1999) examined adaptable office buildings and estimated that a 15% reduction in air emission and a 15% reduction in demolition waste are achievable assuming that the environmental benefits are related to only these factors. CIB has formed a Task Group on Open Building in 1996 and attempts have been made to evaluate elements of buildings for adaptability (Russell and Moffat, 2001).

B3.6 Indoor Air Quality

The National Health and Medical Research Council (NHMRC) define indoor air as any non-industrial indoor space where a person spends an hour or more in any day. It is generally recognised that Australians spend 90% or more of their time indoors (similar figures for US and European countries).

There are many complex and interrelated factors which affect indoor air quality. These factors involve the emission of odors, particulates, volatile organic compounds (VOCs), microbial volatile organic compounds (MVOCs), and radon into the air. Examples of such factors include the outdoor air quality; emissions from construction, building materials, indoor occupant activities, building maintenance products, cleaning products, personal care products, and equipment (computers, copy machines, etc.); moulds and mildew; building

ventilation systems; radon emissions from below-grade rock; and environmental tobacco smoke.

Research is increasingly showing links between these factors and human health. Particulates, VOCs, MVOCs and radon can have a negative impact on human health. Some of these impacts have short-term and reversible health effects, while others cause more serious, long-lasting and even life-threatening health effects. Health problems that may result from indoor air quality are classified as follows:

Sick Building Syndrome describes a collection of symptoms experienced by building occupants that are generally short-term and disappear after the individual has left the building. Examples of such symptoms include sore throat, fatigue, lethargy, dizziness, lack of concentration, respiratory tract irritation, headache, eye irritation and other cold- and allergy-like symptoms.

Building-Related Illnesses are more serious than sick building condition ailments and are clinically verifiable diseases that can be attributed to a specific source or pollutant within a building. Examples of such conditions include cancer, Legionnaire's disease, and carbon monoxide poisoning. More recent press reports from US, UK and NZ highlight the health problem associated with toxic mould. The problem is caused by dampness, which allows certain toxic mould to grow in buildings. At least 12 types of fungi are recognised as being harmful including Stachbotrys and Fusarium.

Multiple Chemical Sensitivities: While much more research is needed to understand multiple chemical sensitivities, it appears that for some people, exposure to low levels of a variety of chemicals can produce many diverse symptoms in more than one body-organ system.

Unacceptable indoor air quality also carries an economic impact. Costs due to lost productivity when employees are affected by sick building syndrome are significant to local companies. Furthermore, when building occupants experience sick building syndrome or building-related illness, the building owners and responsible design professionals may be exposed to increased liability. Moreover, when poor air quality has a negative impact on the health of residents, there are increased demands on the health care system, which ultimately translates into increased health care costs for all businesses and residents.

Limited studies in Australia (Brown, 1997) have indicated that high levels of occupant dissatisfaction are common and poor indoor air quality in Australia could incur a potential cost of several billion dollars per year, but a detailed study is needed for a more accurate estimate.

Government Publications related to Indoor Air Quality

Environment Australia has produced a State of Knowledge report: Air Toxics and Indoor Air Quality in Australia 2001 (EA, 2001a). This document drew together a broad range of information e.g., definitions, key items and sources, existing management approaches and case studies, to provide a useful reference point for governments, industry and the public.

The Department of Health and Aged Care has also produced 'Indoor Air Quality: A Report on Health Impacts and Management Options' (2000) and ‘Environmental Health Assessment: Guidelines for assessing human health risks from environmental hazards’ (2002).

Australian Standards related to Indoor Air Quality:

- AS/NZS 3666.1 2002 Air-handling and water systems of buildings – Microbial control – Design, installation and commissioning

- AS/NZS 3666.2 2002 Air-handling and water systems of buildings – Microbial control – Operation and maintenance
- AS/NZS 3666.3 2000 Air-handling and water systems of buildings – Microbial control – Performance based maintenance of cooling water systems
- AS/NZS 1688.1 1998 The use of ventilation and air conditioning in buildings – Fire and smoke control in multi –compartment buildings
- AS/NZS 1688.2 2002 The use of ventilation and air conditioning in buildings – Ventilation design for indoor air containment control
- Handbook HB-32 (1995), companion to AS/NZS 3666 series.

B3.7 Noise

There are many sources and definitions for noise. The most relevant to building occupants is the 'community noise'. This is also referred to as environmental noise, residential noise or domestic noise. Main sources of community noise include road, rail and air traffic, industries, construction and public works, and the neighbourhood. The main indoor sources of noise are ventilation systems, office machines, home appliances and neighbours. Typical neighbourhood noise comes from premises and installations related to the catering trade (restaurant, cafeterias, discotheques, etc.); from live or recorded music; sport events including motor sports; playgrounds; car parks; and domestic animals such as barking dogs.

The World Health Organisation (WHO) produced a report on noise management 'Guidelines for Community Noise (WHO, 1999**)**. According to the WHO, community noise is defined as noise emitted from all sources except noise at the industrial workplace.

Many countries have regulated community noise from road and rail traffic, construction machines and industrial plants by applying emission standards, and by regulating the acoustical properties of buildings. In contrast, few countries have regulations on community noise from the neighbourhood, probably due to the lack of methods to define and measure it, and to the difficulty of controlling it. In large cities throughout the world, the general population is increasingly exposed to community noise due to the sources mentioned above and the health effects of these exposures are considered to be an increasingly important public health problem.

Specific effects to be considered when setting community noise guidelines include: interference with communication; noise-induced hearing loss; sleep disturbance effects; cardiovascular and psycho-physiological effects; performance reduction effects; annoyance responses; and effects on social behaviour. Some guideline limits recommended by WHO are shown in Table 5.

Table 5: Noise limits recommended by the World Health Organisation

Environment	**Critical health effect**	**Sound level dB(A)**	**Time hours**
Outdoor living areas	Annoyance	50 – 55	16
Indoor dwellings	Speech intelligibility	35	16
Bedrooms	Sleep disturbance	30	8
School classrooms	Disturbance of communication	35	During class
Industrial, commercial and traffic areas	Hearing impairment	70	24
Music through earphones	Hearing impairment	85	1
Ceremonies and entertainment	Hearing impairment	100	4

Source: WHO, 1999

In buildings, noise reduction is often addressed by soundproofing and minimising noise from mechanical services. There are three International Standards Organisation (ISO) standards

that are relevant to noise. These standards define the basic measures to be used for the description and measurement of noise in community environments. These standards also lay down guidelines for the specification of limits of noise and describe methods for the acquisition of data that enable specific noise situations to be checked for compliance with specified limits of noise.

- ISO 1996-1:1982 Acoustics -- Description and measurement of environmental noise -- Part 1: Basic quantities and procedures
- ISO 1996-2:1987 Acoustics -- Description and measurement of environmental noise -- Part 2: Acquisition of data pertinent to land use
- ISO 1996-3:1987Acoustics -- Description and measurement of environmental noise -- Part 3: Application to noise limits

Australian Standards on noise AS1055 Parts 1, 2 and 3 (1997) are reproduction of ISO Standards. The BCA96 currently has provisions for controlling the noise within a building (i.e. between sole occupancy units) but not from outside sources.

B3.8 Water

The Australia State of the Environment report 2001 provides the following data on water use by different sectors (see Table 6):

Table 6: Water use by different sectors

Year	Domestic (%)	Industrial (%)	Commercial (%)	Rural (%)	Total (GL)
93/94	9	22	3	66	18575
94/95	9	19	2	70	21142
95/96	9	22	2	67	19875
96/97	8	20	2	70	22186

Source: Environment Australia, 2001b

There are significant variations by state in water use, linked to the underlying population and industry base. There can also be significant local variation by a particular sector within a state. Residential water use accounts for more than half of total water use in urban areas. 70% of water use is for non-potable purposes although all water supply is of potable standard. Average daily per capita household water use in major urban area decreased slightly from 278 L in 93/94 to 253 L in 99/00, a 9% decline over six years (Environment Australia, 2001b). Water is currently not within the scope of the BCA96 as with all other plumbing matters. Potentially, water efficiency could be treated in the same way as has energy efficiency.

B3.9 Urban Salinity

Urban salinity is problem that affects buildings. 68 towns in Australia have been identified as being affected in areas such as: Western Sydney, Wagga Wagga, Yass River Valley, South East region of South Australia, Victorian Mallee and Western Australia's wheat belt. Damage, from water and salt moving through the pores of materials such as concrete, brick and stone, includes efflorescence, deterioration of foundation and concrete slabs on ground and corrosion of underground services.

Acid sulphate soil is another problem affecting coastal areas from southern NSW to northern Queensland. Steel and concrete construction in acid sulphate soils are at risk of accelerated decay due to the salt and the acidity of the soil. There has been a number of developments at Local and State level in NSW, Victoria and WA to deal with the problem. The ABCB has also developed a Discussion Paper on the subject (ABCB, 2002b).

B3.10 Assessment tools

The past several years have seen a significant increase in interest and research activity in the development of building environmental assessment methods. Existing assessment models consist of two types: (a) specific models that are focussed on one aspect e.g., energy performance and (b) general models that try to obtain an overall assessment of the environmental performance of buildings or building components. The review of some general models is presented in Appendix 4 and is summarised here:

GBC (Green Building Challenge): GBCs objective is to develop an internationally accepted generic framework that can be used to compare existing building environmental assessment methods. Its software GBTool allows users to carry out assessment relative to regional benchmarks.

LEED (Leadership in Energy and Environmental Design): The LEED Green Building Rating System™ evaluates environmental performance from a 'whole building' perspective over a building's life cycle, providing a definitive standard for what constitutes a green building.

BREEAM (Building Research Establishment Environmental Assessment Method): The BREEAM assessment is based on 'credits' awarded for a set of performance criteria. The result is a single score, which enables owners or occupants to gain recognition for their building's environmental performance.

BEES (Building for Environmental and Economic Sustainability): BEES is an interactive computer design aid that helps users select building products for use in commercial office and housing projects in a way that balances environmental and economic criteria.

ECO-QUANTUM: Eco-Quantum is simulation-based tool intended to enable a designer to quickly identify environmental consequences of material choices and water and energy consumption of their designs.

ECOPROFILE: Ecoprofile is a top down method for environmental assessment of existing office buildings The method is based on the use of standardised schemes, questionnaires and reports to minimise the work of assessment and this makes it easy and cheap to use.

LCAid: LCAid is aimed at the building designer, and is a user friendly decision making tool using LCA methodology to evaluate the environmental performance of design options and to identify the largest impacts over the entire life cycle of a building.

Appendix 4 provides details of the above tools including:

- Required input data
- End-use
- Assessment criteria
- Scale of assessment
- Scoring/ weighting system

B3.11 Benchmarking

Benchmarking is about measuring and comparing performance. A benchmark or an indicator is a point of reference from which measurement can be made (Oresund Committee, 1999). It is important to set benchmarks to monitor the effectiveness of any environmental measure. There are various ways to apply benchmarks and its science is still in the development stage. Effective benchmarking requires clear objectives to select appropriate indicators. The description of performance is complex and a few indicators may not be adequate to describe the situation.

Although there are a number of works on environmental indicators and benchmarks (Mesureur, 2002), there has been no agreement on the appropriate range of indicators or specific benchmarks. Indicators for various impact categories e.g., resource depletion, indoor air quality etc. have been reviewed by Soo (2002). A typical example is provided below (see Table 7).

Table 7: Indicators for global warming impact for building

Life cycle	**Indicators**
Construction	• Embodied emission of Greenhouse gases of materials, annualised over the life cycle (kg CO2 eq/m2/maph*) • Greenhouse gas emission for construction (kg CO2 eq/m2) • Energy consumption for construction (MJ/CO2/m2) • Embodied energy/CO2 in materials
Operation/ Maintenance	• Greenhouse gases emission from all energy used for building operations over the life cycle (kgCO2 eq/m2/maph) • Annualized greenhouse gas emission (kg/m2/year) • CO2 emission from transport • Greenhouse gas emissions for high performance building (kg/m2/year) • Energy efficiency
Demolition	• Greenhouse gas emission for demolition (kg/m2) • Energy consumption for demolition (MJ/CO2/m2)

Source: Soo, 2002

Other attributes for indicators, apart from being measurable, are (Sigurjonsson et al., 2002):

- Provide a representative picture of an environmental condition of the building sector's status concerning environmental burden
- Be simple, easy to interpret and able to show trends over time
- Be responsive to quick changes in the environment related to human activities
- Provide a basis for international comparisons
- Be well founded in technical and scientific terms
- Be based on international standards and an international consensus concerning its validity
- Adequately documented and of known quality
- Updated at regular intervals in accordance with reliable procedures

B4. DISCUSSION

This survey of the literature has identified various **paths to improvement** with respect to environmental performance within the building and construction sector. These can be categorised as:

- Encouraging eco-efficiency during upgrades
- Design for disassembly
- New procurement policies
- Eco-labelling for building materials
- Effective environmental (and cost) assessment tools for buildings
- Extended supply chain
- Owners and tenants recognising the value added by green building
- Re-engineering of building construction as a manufacturing process/supply chain
- Increase information among consumers and producers
- Codes, standards and contracts

A brief description and discussion of these issues is provided in the following subsections.

B4.1 Encouraging eco-efficiency during upgrades

Buildings are among the most long-lived products within the durable products category, ranging from 30 years in the US to over 60 in UK. Australia averages approximately 50 (OECD, 2002). This low turnover rate represents a major inhibitor to introduction of technical innovation into existing stock, locking obsolete technologies into older buildings. This is particularly the case in relation to energy and water efficiency measures.

Measures to encourage eco-efficiency during upgrades would contribute significantly to overall environmental performance of the building stock, as would encouragement of undertaking life cycle environmental and cost assessments for new and re-developed buildings. Studies have indicated that extra capital cost of making energy improvements can often be recouped over the life of a building (Tucker et al, 1999). The challenges here reside with distribution of return of investments, discount rates for investing in environmental performance, etc.

B4.2 Design for disassembly

There is an absence of cradle to grave concepts in the building and construction sector in general. It is emerging in the manufacturing sector, where manufacturers re-cycle and re-use components from their product range. Issues here relate to:

- Absence of policies, practices, technologies that encourage re-cycle and re-use
- An absence of policies and know-how that relates to design for de-construction

B4.3 New procurement policies

Current procurement policies that elevate cost above all other performance attributes of building design and construction are a significant disincentive for introduction of environmental (and other forms of) innovation. This is likely to continue until there are:

- Changes to procedures which enable consideration of performance attributes additional to that of cost.
- Life cycle costing and environmental assessment tools that can automatically identify opportunities for performance innovation during the design stage of a building project.

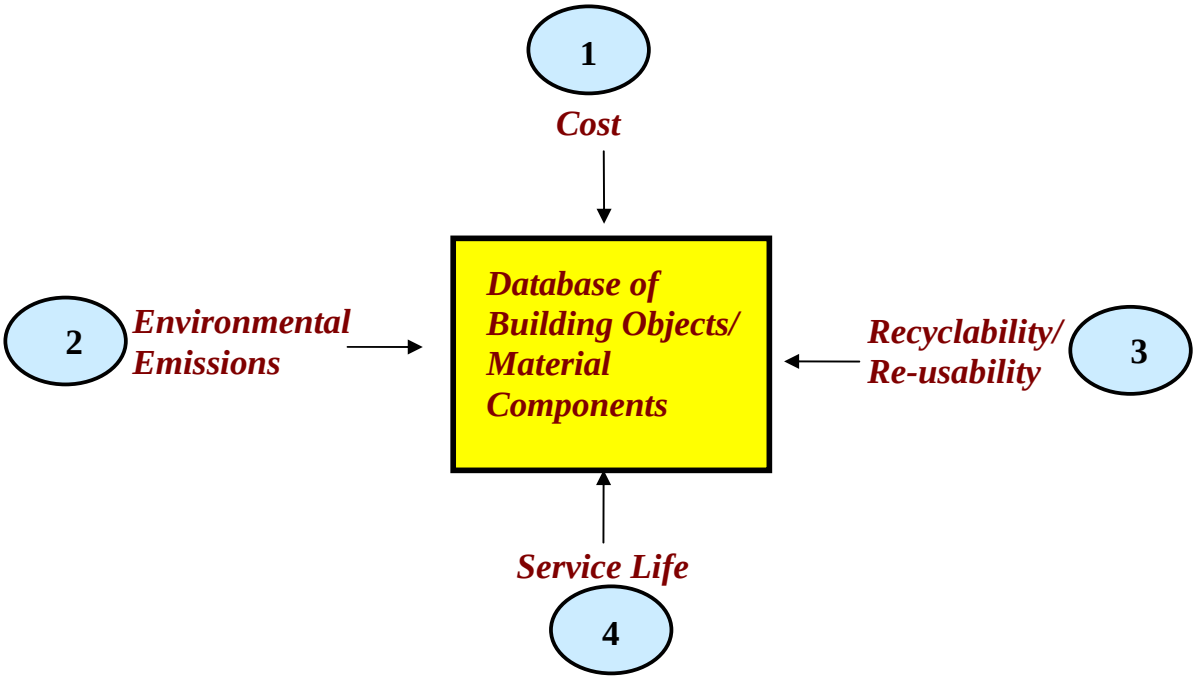
B4.4 Eco-labelling for building materials

Pick-up any can or package from the supermarket and the shopper can expect to be able to find information on three key items:

- Shelf Life (service life)
- Contents (resource inputs, environmental emissions)
- Cost

There is as yet no equivalent for building products. In the absence of such data, our ability to undertake quick and meaningful environmental assessments of buildings is inhibited. The potential of eco-labelling as an enabler of environmental assessment is shown by Figure 6.

Figure 6: Eco-Labelling as an Enabler of Environmental Assessment



Key Assessments Enabled:

- **Life Cycle Costing** 1 + 3
- **Eco-Efficient Design** 1 + 2
- **Design for De-Construction, Disassembly** 1 + 4 + 3

Source: Newton, Pers. Comm., 2002

B4.5 Effective environmental (and cost) assessment tools for buildings

In Section 3 of this report, there is a summary and brief evaluation of existing environmental assessment tools for commercial buildings. A key deficiency in all is the **lack of automation** they offer to the design professional and the building regulator – each requires a measure of data to be re-entered and along with it, time, cost and potential error. Australia's CRC CI is developing LCA Design, an automated environmental and cost assessment tool for commercial buildings to facilitate the transition to **eco-efficient design** (Newton, Pers. Comm., 2002). The latter component is a key feature as a means of overcoming barriers that equate green buildings with costly buildings.

B4.6 Extended supply chain

A recent OECD (OECD, 2002) study highlights the complexity of the supply chain in building and construction (different actors, cultures, drivers of behaviour, etc). With the consequence, that targeting of the most appropriate and effective points for intervention and co-ordination of policy instruments to achieve maximum environmental outcomes, is essential for implementing effective policies related to environmental sustainability. For example, designer's knowledge of environmental performance of materials and their potential for recyclability, buildability and the environmental consequences of different construction and procurement methods.

B4.7 Owners and tenants recognising the value added by green building

The owner-tenant discrepancy highlights issues of who benefits vs. who pays. There is as yet a poorly developed knowledge base on the premium rent or value that green buildings can demand in the marketplace versus conventional buildings. Methodologies for **valuing** buildings (e.g., as developed by the Property Council of Australia, are currently deficient in this regard and is an area which warrants attention) are required as a driver for owners or landlords to make extra investments related to enhancing environmental performance. A current CRC CI research project, which focuses on indoor environment quality, health and productivity, is designed to provide data on this issue (Newton, Pers. Comm., 2002).

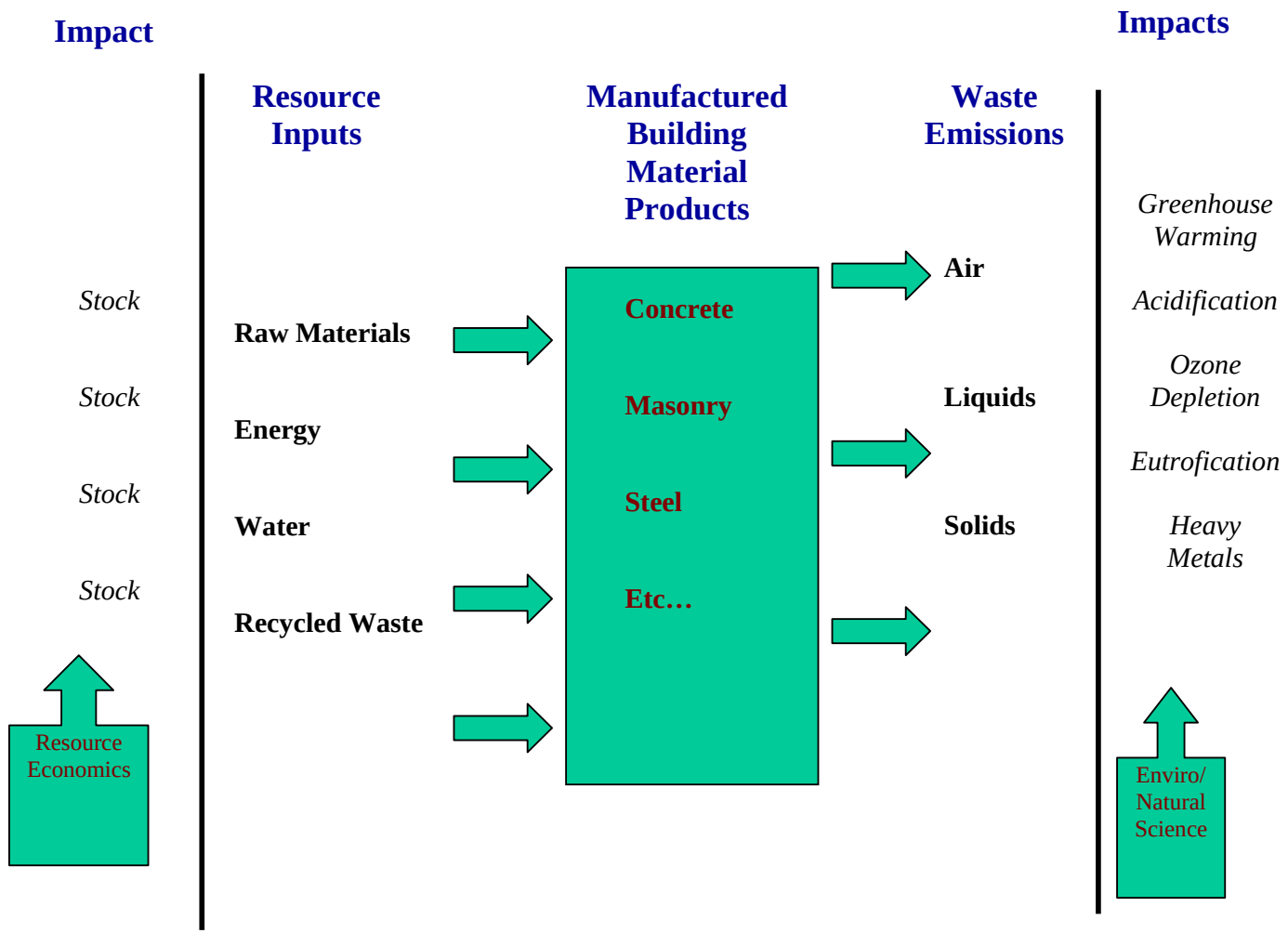
B4.8 Reconnection between environmental threats and community response

National 'State of Environment' reporting has only recently begun to achieve an ability to provide alerts to government and community regarding environmental trends that warrant action (Newton et al, 2001). Recent examples have included:

- ozone layer;
- blue-green algae;
- enhanced greenhouse effect and climate variability and change;
- loss of biodiversity;
- shortage of water.

Yet the quantification of impacts of 'business-as-usual' scenarios on resource stocks and the natural environment (see) is only in its infancy, and at a national level (Foran and Poldy, 2002). This is a deficiency in the nation's **knowledge base**. Of equal concern is lack of effective mechanisms to **communicate** this information to the community with a view to changing attitudes and behaviour.

Figure 7: Environmental Impacts of the Fabric of Built Environments



Source: Tucker, Pers. Comm., 2002

B4.9 Re-engineering of Building Construction as a Manufacturing Process/Supply Chain

The unique nature of most buildings (universally in terms of location and commonly in terms of design) has led to a low level of standardisation in the design and production of buildings and the failure to exploit economies of scale – which deliver economic and environmental benefits – resulting from limited repetition (Finkel, 1997).

Re-engineering construction to more closely align to a manufacturing process (e.g., modular construction, prefabrication, etc) has had limited impact to date in countries such as Australia. Another key factor linked to the non-standard characteristic of buildings is the wide spectrum of building components accessible to the designer and contractor. As the OECD comments:

> *'The low level of standardisation – or, in other words, the high level of flexibility – in the design of buildings can be illustrated by comparing the number of different kinds components used for housing with those used for automobiles. Toyota, one of the largest automobile manufacturers, also supplies prefabricated housing in Japan. Toyota's most popular car model consists of about 1,800 kinds of components that are assembled at their factories (eg side-view mirror) and about 3,700 (twice as many) alternatives for these components (eg standard side-view mirror, wide side-view mirror, etc). The number of alternatives is largely due to the need for automobiles to satisfy different regulations in different countries. On the other hand, the most popular model of prefabricated housing is comprised of 1,900 kinds of components (eg window frames), but around ten times as many (some 19,000) alternatives for these components (e.g., wooden window frame, aluminium window frame etc) are available. This allows for considerable flexibility in design.*
>
> *For prospective buyers who are looking at what is on the market, it is not easy to understand the level of performance of poorly standardised products like buildings, especially when this concerns invisible performance such as energy efficiency. A 'standardised' model of product manufactured under standardised quality control methods can undergo laboratory tests that provide results, but this is not feasible for actual buildings. Consequently, prospective buyers tend to lack information on the quality of buildings unless they conduct costly assessments'.* (OECD, 2002, 38).

B4.10 Increase information among consumers and producers

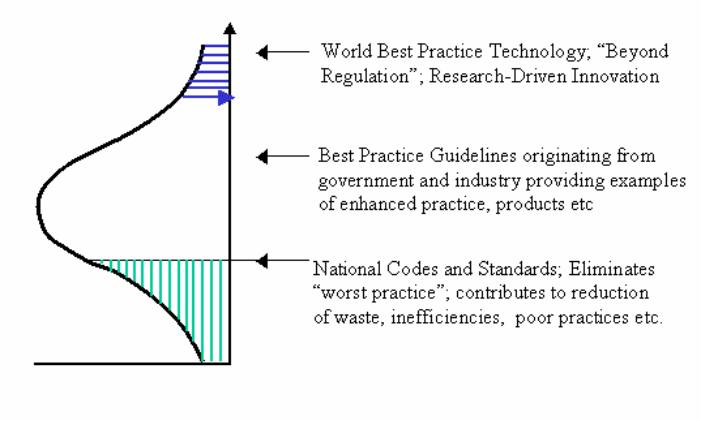
Whether owner-occupant or tenant, the relatively infrequency that individuals change jobs (physical work environments) and housing (physical living environments) contributes to a lack of **experiential** knowledge about good (environmental) design, and good products (from environmental perspective). When coupled with a significant lack of information about building and product performance and ineffective channels for communicating this information, the challenge of improving the environmental performance of buildings from the **demand-side** becomes evident. Compounding the problem is the **supply-side**. The predominance of small firms in this sector has been recognised for some time as a barrier to take-up of new products and processes: this relates primarily to the risk of the unknown, or being reluctant to adopt products or practices that do not have a proven track record.

B4.11 Codes, Standards and Contracts

The role of codes and standards is to eliminate 'worst practice'; it is the role of best practice guidelines, and world best practice technology to raise the bar in terms of sustainability (see

Figure 8).

Figure 8: Innovation through codes and standards



Source: Newton, Pers. Comm., 2002

In certain circumstances, Australia's codes, standards and contracts act as a disincentive for sustainability. For example, many contracts prohibit the use of reused materials through default clauses that state that materials should be new unless otherwise specified (Gelder, 2000): AS 4000 clause 29.1 'Unless otherwise provided the contractor shall use suitable new materials'. As a result, the extent to which innovation is driven by government through instruments such as codes and standards remains an issue of 'creative tension'.

> The typical industry 'anti-regulation' view on environmentally sustainable development is reflected in two recent statements:
>
> 'Government needs to be vigilant in watching market trends in relation to sustainability and make every effort to assist markets to find solutions which meet the expectations of society. This may be by a focus on the promotion of voluntary industry codes. Proactive regulation should only be considered where absolutely necessary, in a light-handed form, and only after the effects on industry are fully understood'.
> *Recommendation in Australian Industry's Sustainable Competitiveness, Paper Presented to Prime Minister's Science, Engineering and Innovation Council, 31 May 2002, p.2.*

And;

> 'With the help of members, HIA's lobbying efforts over the past three months have proven extremely successful in getting a redraft of the initial, unworkable energy efficiency proposals. Now we would like your help again. The ABCB released last week revised proposals which address many of the issues raised by HIA members and appear to present a significant improvement on the original draft measures. The ABCB appears to have lowered the stringency level of a number of requirements and simplified others. This better reflects the primary objective of developing minimum, cost effective energy efficiency measures intended to eliminate worst practice. The ABCB still aims to introduce the energy efficiency measures in the BCA96 on 1 January 2003'.
> *Sourced from Housing Industry Associations' web site: www.buildingonline.com.au, Current Industry Issues, 18 August 2002.*
>
> However, this is not the complete story. There are organisations, i.e., individual companies, local governments etc., that are seeking to 'push the

envelope' beyond standard practice. An example here is local government regulations on noise, whereby certain councils (e.g., City of Sydney) have specified standards higher than the BCA96 in relation to sound insulation through the use of development consent conditions imposed on a specific project. This is a clear pointer to areas where the community believes existing codes and standards are inadequate.

B5. CONCLUSIONS

The previous sections have provided a background of understanding as to the level of sustainable building activity being undertaken internationally and in Australia. They have also investigated key building-related sustainability issues / topics and provided a discussion on the possible paths to improvement. This concluding section of the report brings the research back to the implications of introducing sustainability into the BCA21, and covers the following points:

- Perspectives on sustainability, building construction and the role of the BCA
- Definitions of sustainability
- Sustainability as an additional goal for the BCA21
- Means of implementation
- What can be done within the current scope of the BCA
- Extending the scope of the BCA
- Criteria for sustainability measures in the BCA

The results of this discussion provide a background for the up coming workshop sessions (Stage 2 of the project).

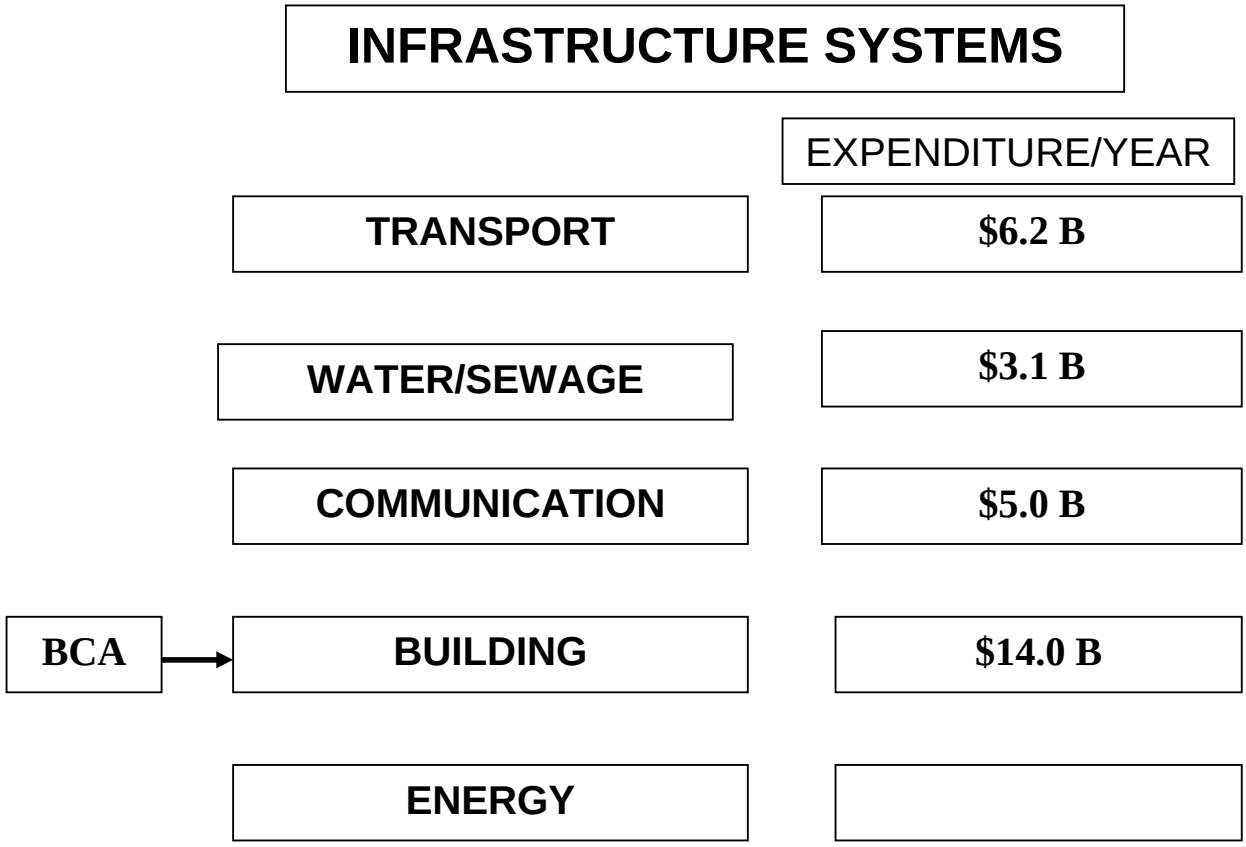
B5.1 Perspectives on sustainability, building construction and the role of the BCA.

It has been claimed that the rates of consumption per capita in Australia of key imput resources such as water, materials and energy are among the highest in the world and the trend is unlikely to be sustainable (Newton, 2002). A key problem however is that there is no consensus on the understanding of what 'sustainability' is. Most of the pro-sustainability literature appears to 'preach to the converted'; while sceptics such as Lomborg (2001) are critical of the way in which scientific evidence has been selectively and misleadingly used. Critics of the sceptics use the same argument against the sceptics.

Within the area of infrastructure systems, there are a number of inter-related systems of which building infrastructure is just one (see Figure 9). Within the field of building construction, the role of the BCA is limited mainly to aspects of design and construction with operation and maintenance gradually assuming greater roles (see Figure 10). Sustainability, on the other hand, needs to be considered in the 'big picture' context. Thus, to be effective, any sustainability oriented measure needs to be clearly defined and well researched before being introduced into the BCA21.

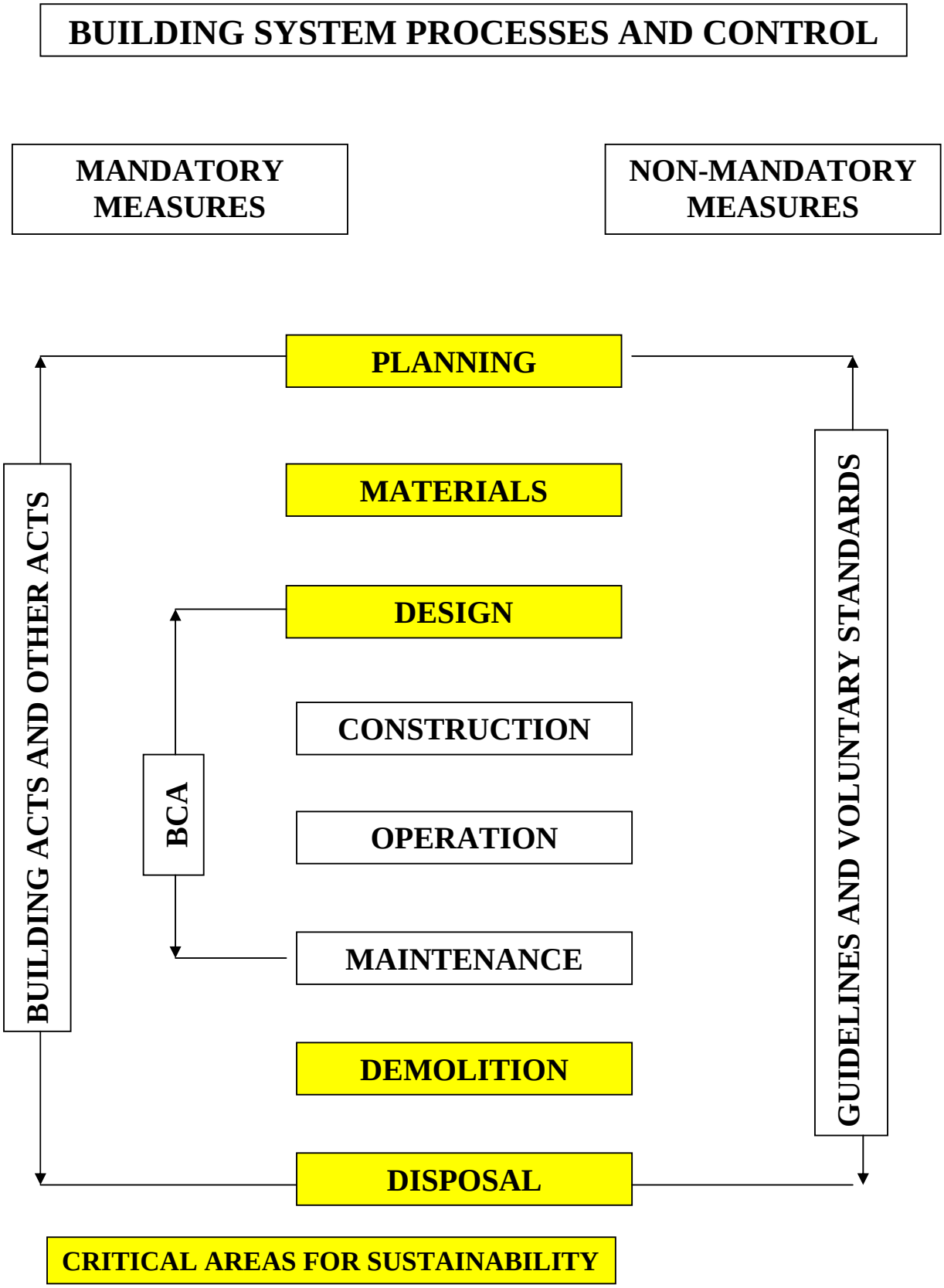
As stated in the NSESD (see Section B2.7.1), ESD is about short term and long term economic, social and environmental impacts. Decision making in this area is relatively complex because it may involve scientific uncertainty, difficult tradeoffs between the short and long term, and between objectives. In this context, it might be worthwhile to review the ABCB Economic Evaluation Model for Building Regulatory Change to see whether it needs any modifications to make it an effective tool for assessing the impact of any ESD measures.

Figure 9: Infrastructure Systems



Source: McDermott, Pers. Comm., 2002

Figure 10: Building system processes and control



Source: Pham, Pers. Comm., 2002

B5.2 Definitions of sustainability

The generally accepted definition of sustainable development is '*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*' (WCED, 1987). This definition appears to indicate that resource issues, environmental degradation, human needs, building economics and community development are all parts of sustainable development that need to be balanced.

The Commonwealth, State and Territory Governments have endorsed the following definition of 'ecologically sustainable development' as *'development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends'.* This definition appears to put ecological balance as the driving force.

Figure 11 illustrates the differences between some of the conceptual ideas of sustainable development. Just as there are differing views of sustainable development, so too are there various definitions of 'sustainable construction':

- "The creation and responsible management of a healthy built environment based on resource efficient and ecological principles" (Kibert, 1994).

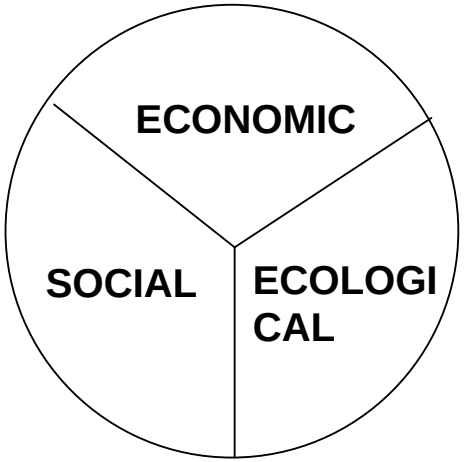
- "A way of building which aims at reducing negative health and environmental impacts caused by the construction process or by buildings or by the built-up environment" (The Netherlands: CIB, 1999).

- "In its own processes and products during their service life, aims at minimising the use of energy and emissions that are harmful for environment and health, and produces relevant information to customers for their decision making" (Finland: CIB, 1999).

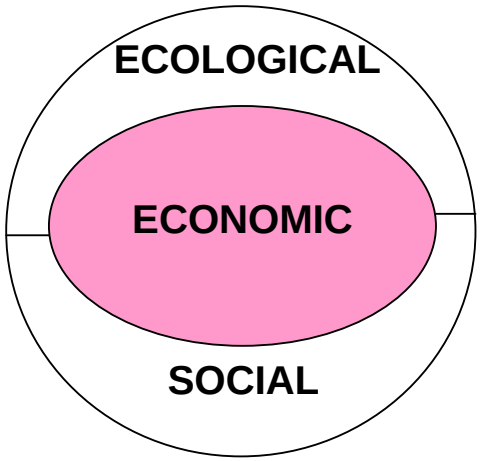
- "Sustainable construction means that the principles of sustainable development are applied to the comprehensive construction cycle from the extraction and beneficiation of raw materials, through the planning, design and construction of buildings and infrastructure, until their final deconstruction and management of the resultant waste. It is a holistic process aiming to restore and maintain harmony between the natural and built environments, while creating settlements that affirm human dignity and encourage economic equity" (du Plessis, 2002).

A suitable definition for 'sustainable construction' in the context of the BCA needs to be found if sustainability is to be declared as an additional goal for the BCA21.

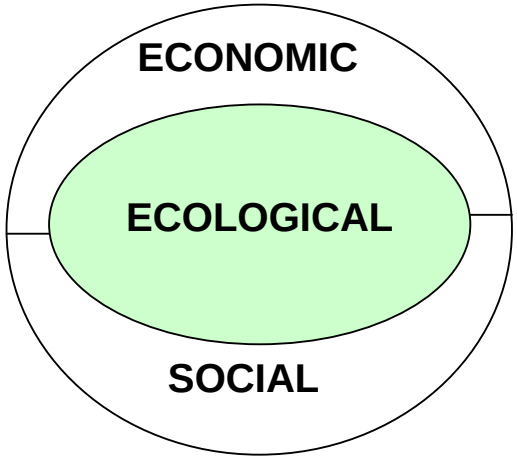
Figure 11: Conceptualisations of sustainable development



Past Development
Separate decision making for each sector



Current Development
Economic consideration drives the development process



Future Development
Ecological consideration drives the development process

Source: adapted from SoE Advisory Council, 1996

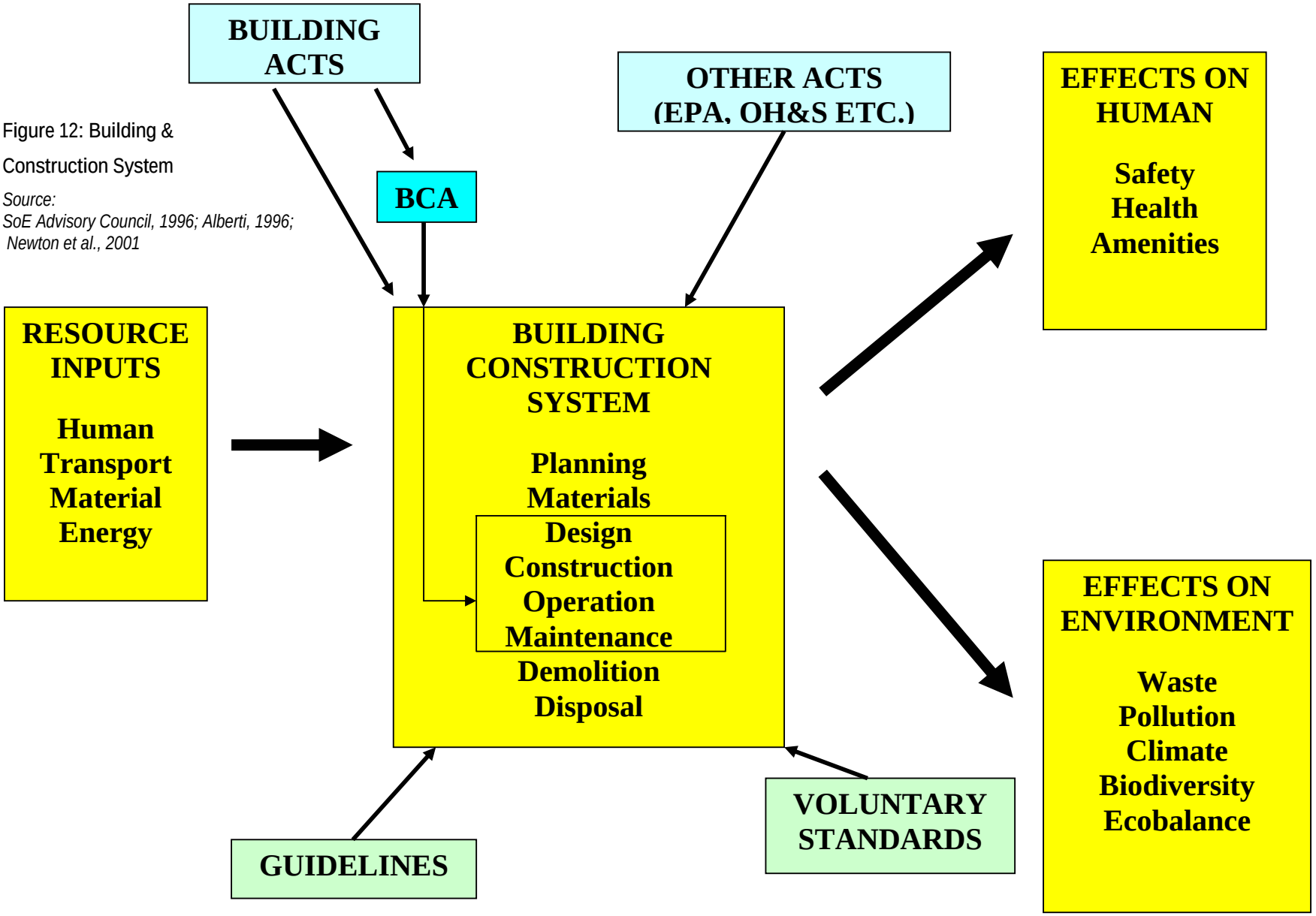


Figure 12: Building & Construction System

Source:
SoE Advisory Council, 1996; Alberti, 1996; Newton et al., 2001

B5.3 Sustainability as an additional goal for the BCA21

Currently 'sustainability' is not a stated goal of the BCA although some of the current developments such as 'Energy Efficiency' provisions are sustainability oriented. Other provisions such as 'Durability', 'Maintenance' or 'Access' can also be considered as sustainability measures although these are debatable depending on how sustainability is defined.

The States and Territories legislation concerning building construction has set the goals as:

- 'Safety, health and amenity' (NT, QLD, SA, VIC)
- 'Environmentally efficient' (NSW, QLD, NT, VIC)

Also many States and Territories have Environmental Protection Acts or similar that will impact on the building construction industry. Thus it is arguable that sustainability should be a goal for the BCA21 not only because 'environmentally efficient' is a goal for some Building Acts but also to facilitate the implementation of the Environmental Protection Acts.

Consideration should also be given to the fact that Australia is a participant in the creation of UN Agenda 21 and the Kyoto protocol.

It can also be argued that there is a ‘market failure’ with respect to sustainable construction. Existing market forces focus on economic costs and benefits only and do not reflect the environmental costs and benefits and have failed to deliver sustainable development. Proof for this proposition is difficult to establish because economic costs and benefits are generally evaluated on a short term basis while the environmental costs and benefits need to be evaluated on a long term basis.

B5.4 Means for implementation

Figure 12 is an adaptation of the 'metabolism model' for State of Environment reporting (SoE Advisory Council, 1996; Alberti, 1996; Newton et al., 2001), where it is seen that the BCA is just one of many instruments that the Federal, State and Local Governments have at their disposal to implement sustainability objectives in building construction. Financial incentive measures (e.g., procurement policy, levies, etc) have been used both in Australia and other countries to great effect.

Non-mandatory measures such as voluntary guidelines from authoritative sources are also an effective means to communicate environmental information to the industry and the public. In this context it is interesting to note that in the COAG 'Principles and Guidelines for National Standard Setting and Regulatory Action', 'regulations' refer to:

> *'the broad range of legally enforceable instruments… as well as to those voluntary codes and advisory instruments for which there is a reasonable expectation of widespread compliance'* (COAG, 1997).

The ABCB Guideline Series, for example, can provide non-mandatory guidance on various sustainability issues that in time may achieve reasonably widespread compliance.

Recent seminars and workshops on sustainability, however, have revealed that industry, because of competitive pressure, prefers the mandatory path in favour of the voluntary path in implementing sustainable practice.

B5.5 What can be done within the current scope of the BCA?

Consideration should be given to what can be done within the current scope of the BCA to facilitate sustainability. These might be:

- Re-examining current provisions to see whether they might unintentionally lead to unsustainable practices.
- Developing new provisions for areas such as deconstruction, adaptability and recycling.

B5.6 Extending the scope of the BCA

Consideration should be given to the issue of extending the scope of the BCA. As noted in many instances in this report, many sustainability issues are outside the current scope of the BCA. Critical areas for sustainability are planning, material and product manufacturing, design, demolition and disposal. A slight extension of the BCA scope may allow some of these issues to be more effectively dealt with. Water, for example, is a major issue for sustainability and could be regulated along the same line as energy. However, the subject is outside the current scope of the BCA.

B5.7 Criteria for sustainability measures in the BCA

In order to remove the subjective elements in discussing implementation measures, formal criteria for accepting sustainability measures in the BCA should be established. Some criteria are outlined here for consideration.

B5.7.1 Generic criteria

- Any action on sustainability should be part of the global participation (Are advanced economies better placed than developing economies to benefit commercially from these global measures?)
- National and industry benefits (Need to consider it in the context of political and economic imperatives: growth, development, social advancement. Community support depends on these).
- Actions should enhance our industry rather than handicapping it (if the actions are out of step with global community).
- Must establish the case that there is a ‘market failure’ according to the COAG agreement.
- Must have a well defined objective.

B5.7.2 Technical criteria

- Must be within the scope of the BCA.
- The requirements must be expressed in performance-based terms.
- Must not be in conflict with other Requirements in the BCA.
- Means of compliance must be provided, including paths for innovative solutions.
- Must establish sustainability indicators to assess the effectiveness of the measures.
- Governance and implementation strategies.
- Technical and educational support systems.

B5.8 Overall Summary

The Australian Building Codes Board (ABCB) is currently developing a Future Building Code (BCA21) that will replace the Building Code of Australia 1996 (BCA96). Contributing to this development is a research project entitled 'Sustainability and the Building Code of Australia', which aims to provide the Board with information that will allow it to determine whether sustainability requirements are necessary in the BCA21. The key points discussed in this paper (put forward for the Building Code Committee and the Board to deliberate on) are a result of the findings from this research. They are summarised as follows:

1. The BCA96 is neutral with regard to sustainability. As a performance-based code, innovative sustainable solutions are always acceptable as alternative solutions. Some proposed provisions such as energy efficiency are oriented toward sustainability. On the other hand, it could also be argued that BCA96 does not facilitate sustainability by not specifically addressing sustainability-related issues such as reuse/recycling, design for disassembly, etc.

2. The case for inclusion of sustainability in the BCA21 can be made on the following grounds:

- To facilitate the implementation of Commonwealth and State Government policy regarding the protection of the environment. This policy has already been enshrined in various regulations. Building construction and associated activities are by far having the most impact on the environment.
- To prevent fragmentation of building regulations as Local and State Governments may introduce their own sustainability regulations on issues for which national consistency is desirable.
- To respond to community expectation on health and productivity of building occupants as well as to increasing community concerns on environmental issues.

3. The Council of Australian Governments (COAG) has set specific criteria for the introduction of regulation. Essentially, it must be proven that there is a case of 'market failure'. Criteria for developing sustainability provisions should be formulated. The impacts of any proposed provision needs to be assessed. Tools need to be developed to prove the case, as well as to facilitate the implementation of the provisions. Less stringent is the introduction of nationally endorsed but non mandatory measures/guidelines. These can also serve as a preliminary step before the introduction of regulation.

4. The BCA is just one of many tools available to Governments of all levels for implementing sustainability. Many major sustainability issues are well outside the scope of the current BCA96. Whether the scope of the BCA21 needs to be extended so that it can manage sustainability more effectively is a question that needs to be considered. A key criterion might be whether national consistency is necessary or desirable for a particular sustainability issue.

This research report has provided the background to the research project and has discussed the main issues for the ABCB and the BCA21 in terms of regulating sustainability. Its provides a starting point for policy makers in determining whether or not sustainability should, or can, be regulated in building regulations in Australia. In evaluating the points raised, it would seem opportune for the ABCB to regulate sustainability in the same capacity as the existing broad objectives as safety, health and amenity in the BCA21. What this capacity will manifest as, and which sustainability issues are to be included in the Code, are further aspects which still have to be decided.

APPENDICES

APPENDIX B.1: ISO DEFINITIONS OF SUSTAINABILITY-RELATED TERMS

Biodiversity: the variability among living organisms from all sources including: terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems (ISO/TC59/SC3 - N4).

Indoor air pollution: the level of air pollution in an enclosed environment (ISO/TC59/SC3 - N4).

Indoor air quality (IAQ): the composition and characteristics of the air in an enclosed space that affect the occupants of that space (ISO/TC59/SC3 - N4).

Life-cycle: Consecutive and inter-linked stages of a product system, from raw material acquisition or generation of natural resources to the final disposal (ISO 14040).

Non-renewable resource: a resource that exists in a fixed amount in various places in the earth's crust and that cannot be replenished on a human time scale (ISO/TC59/SC3 - N4).

Renewable resource: a resource that is grown, naturally replenished, or cleansed, at a rate which exceeds depletion of the useable supply of that resource (ISO/TC59/SC3 - N4).

Sustainability: the maintenance of ecosystem components and functions for future generations (ISO/TC59/SC3 - N4).

Sustainability indicator: a parameter or other sign that indicates the sustainability of a building regarding environment, economic, social and/or cultural aspects (ISO/TC59/SC3 N469)

Environmental indicator: an indicator that expresses the environmental impact of a building in terms of the use of natural resources, environmental pollution and/or biodiversity considering the life cycle or whole life point of view (ISO/TC59/SC3 N469)

APPENDIX B.2: ABBREVIATIONS

ABCB	Australian Building Codes Board
ACT	Australian Capital Territory
AEC	Architecture, Engineering and Construction (Industry)
AGO	Australian Greenhouse Office
AIJ	Architectural Institute of Japan
ANSI	American National Standards Institute
AS	Australian Standard
AS/NZS	Australian/New Zealand Standard
ASHRAE	American Society of Heating, Refrigeration, & Air Conditioning Engineers
ASTM	American Society for Testing of Materials
BCA	Building Codes of Australia
BEES	Building for Environmental and Economic Sustainability):
BEQUEST	Building Environmental Quality Evaluation for Sustainability through Time
BIA	Building Industry Authority (New Zealand)
BRANZ	Building Research Association of New Zealand
BREEAM	Building Research Establishment Environmental Assessment Method
C&D	Construction and Demolition (Waste)
CIB	International Council for Research and Innovation in Building and Construction
CIRIA	Construction Industry Research and Information Association
COAG	Council of Australian Governments
CRC	Cooperative Research Centre (for Construction Innovation)
CSD	Commission on Sustainable Development (UN)
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
EA	Environment Australia (Australian Government - Department of the Environment and Heritage)
EPA	Environment Protection Authority
EPBC	Environmental Protection and Biodiversity Conservation Act (Australia)
ESD	Ecologically Sustainable Development
EU	European Union
BCA	Building Code of Australia
BCA96	Building Code of Australia (1996)
BCA21	Future Building Code of Australia
FCCC	Framework Convention on Climate Change
FIEC	European Construction Industry Federation
GBC	Green Building Challenge
HIA	Housing Industry Association (Australia)
I.E Aust	Institution of Engineers, Australia
IAQ	Indoor Air Quality
IBC	International Building Code (United States)
IBEC	Institute for Building Environment and Conservation (Japan)
IPCC	Intergovernmental Panel on Climate Change (Australia)
ISO	International Standard Organisation
LCA	Life Cycle Assessment
LEED	Leadership in Energy and Environmental Design
MBA	Master Builder Association (Australia)
METI	Ministry of Economy, Trade and Industry (Japan)
MLIT	Ministry of Land, Infrastructure and Transport (Japan)
MVOC	microbial volatile organic compounds
NABERS	National Australian Buildings Environmental Rating System
NHMRC	National Health and Medical Research Council (Australia)
NSESD	National Strategy for Ecologically Sustainable Development (Australia)
NSW	New South Wales
NT	Northern Territory

NZBC	New Zealand Building Code
OECD	The Organisation for Economic Co-operation and Development
OGC	Office of Government Commerce (United Kingdom)
OH & S	Occupation health and Safety
QLD	Queensland
SA	South Australia
SoE	State of Environment (Report)
TAS	Tasmania
UN	United Nations
UNCED	United Nations Conference on Environment and Development
VIC	Victoria
VOC	Volatile Organic Compounds
WA	Western Australia
WCED	World Commission on Environment and Development
WHO	World Health Organisation

APPENDIX B.3: BUILDING SUSTAINABILITY IN AUSTRALIA

The following is a list of Australian Government bodies involved with ecologically sustainable development with relevance to building and construction.

- **Federal**

Environment Australia
http://www.ea.gov.au
Sustainable Industries Branch:
http://www.environment.gov.au/epg/env_sust.html
Sustainable Construction Branch:
http://www.ea.gov.au/industry/waste/construction/index.html
Environmental Economics Unit:
http://www.environment.gov.au/epgc/eeu/eeu_home.html

Australian Greenhouse Office
http://www.greenhouse.gov.au
Click on the 'buildings' program under:
http://www.greenhouse.gov.au/energy_transport.html

Australian Building Codes Board
http://www.abcb.gov.au
Looking at sustainability and sustainable construction in conjunction with the CRC CI:
http://www.crc.gov.au/centres/man/construct.htm

Department of Industry, Tourism and Resources
http://www.industry.gov.au
Click on the 'Energy Efficiency Best Practice Program'

- **New South Wales Government**

http://www.nsw.gov.au/

For specific programs see:
Resource NSW
http://www.resource.nsw.gov.au
Planning NSW
Sustainability Unit:
http://www.planning.nsw.gov.au
Sustainable Energy Development Authority
http://www.seda.nsw.gov.au
Sustainability Advisory Council
http://www.sustainability.nsw.gov.au
Click on 'BASIX' – The Building Sustainability Index

- **Victoria Government**

http://www.vic.gov.au/

Melbourne City Council
http://www.melbourne.vic.gov.au

For specific programs see:
http://www.melbourne.vic.gov.au/index.cfm?CategoryID=1&TopicID=3&ContentFile=infopage.cfm&CFID=156637&CFTOKEN=21095252 the Environment and Sustainability section

Department of Sustainability & Environment (formerly the Department of Natural Resources and Environment)
http://www.nre.vic.gov.au

For specific programs see:
Strategic Planning
http://www.environment.vic.gov.au/
Greenhouse Policy Unit
http://www.greenhouse.vic.gov.au/index.htm
Sustainable Energy Authority
http://www.seav.gov.au Click on the 'Buildings' Program
Building Commission
http://www.buildingcommission.com.au
http://www.buildingcommission.com.au/BuildingSustainability/SustainabilityPolicy.asp

EPA Victoria

- **South Australia Government**

http://www.sa.gov.au/

For specific programs see:
Department for Environment and Heritage
http://www.environment.sa.gov.au/
http://www.environment.sa.gov.au/sustainability/index.html

- **Queensland Government**

http://www.qld.gov.au/

For specific programs see:
Department of Public Works
http://www.publicworks.qld.gov.au
http://www.build.qld.gov.au/research/research02.htm click on 'Building Research'
Department of Housing
http://www.housing.qld.gov.au/researchhouse
EPA Queensland
http://www.epa.qld.gov.au/cgi-bin/w3-msql/environment/business/development/msqlwelcome.html?page=main.html

- **Western Australia Government**

Department of the Premier and the Cabinet
Sustainability Policy Unit:
http://www.sustainability.dpc.wa.gov.au

- **Tasmania Government**

http://www.tas.gov.au/

Department of Primary Industries, Water and Environment
http://www.dpiwe.tas.gov.au/inter.nsf/ThemeNodes/DREN-4VH8CZ?open

- **Northern Territory Government**

http://www.nt.gov.au

Department of Infrastructure, Planning and Environment (DIPE)
http://www.ipe.nt.gov.au/
http://www.lpe.nt.gov.au/enviro/default.htm

- **Australian Capital Territory Government**

http://www.act.gov.au/

Department of Urban Services
http://www.urbanservices.act.gov.au/general/

- **Local Government**

Environs http://www.environs.org.au/councils/
Profiles the sustainability achievements and objectives of its member councils.

- **Other Key Organisations**

The Green Building Council
http://www.gbcaus.org
Launching a Green Building Rating Tool.

The Barton Group
An alliance of senior environment industry leaders who are taking a leadership role in the implementation of the actions assigned to industry in the Environment Industry Action Agenda (EIAA).

Property Council of Australia

APPENDIX B.4: Environmental Assessment Tools for Buildings

The past several years have seen a significant increase in interest and research activity in the development of building environmental assessment methods. Existing assessment models, which are used widely in the world, are reviewed to grasp their characteristics. Of the existing models, some models such as ASEM (A Simplified Energy Analysis Method), are only focused on energy performance, and are not considered in the reviewing because of their narrow focus.

GBC (Green Building Challenge, GBTool)

Description

The Green Building Challenge (GBC) is a consortium of over twenty countries that has developed and is testing a new method of assessing the environmental performance of buildings. The assessment framework has been produced in the form of software (GBTool) that facilitates a full description of the building and its performance, and also allows users to carry out the assessments relative to regional benchmarks. GBTool can handle both new building and renovation projects. The GBTool has been implemented on a Microsoft Excel spreadsheet and can be downloaded for evaluation and education purposes (Larsson and Cole, 2001).

Participating national teams test the assessment system on case study buildings in each country. GBC has consisted of two stages. An initial two-year process, including 14 countries, culminated in the GBC ’98 conference in Vancouver in October 1998, where 34 projects were evaluated in depth. Work resulting from a second two-year round of development was displayed and reviewed at the Sustainable Building (SB) 2000 conference in Maastrict, the Netherlands, in October 2000, which is a continuation of the GBC '98 process and an 18-month period of review, modification and testing of the GBC Assessment Framework and GBTool (Cole and Larsson, 2000).

The three general goals for the Green Building Challenge process are to:

- Advance the state-of-the-art in building environmental performance assessment methodologies.
- 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.
- Sponsor conferences that promote exchange between the building environmental research community and building practitioners and showcase the performance assessments of environmentally progressive buildings.

These goals reflect the acknowledged success of the GBC process in having significantly increased the understanding of building environmental assessment through international collaboration. In addition to the above general goals, two specific objectives of GBC 2000 process are to:

- Develop an internationally accepted generic framework that can be used to compare existing building environmental assessment methods and used by others to produce regionally based industry systems
- Expand the scope of the GBC Assessment Framework from ‘green’ building to include environmental sustainability issues and to facilitate international comparisons of the environmental performance of buildings

The first goal above is particularly important. It accepts that the primary emphasis of the Green Building Challenge effort primarily lies in the development of a comprehensive, generic assessment framework and not necessarily in the development of a commercially

viable version of GBTool. The GBC process can thus constitute a forum for discussion and possible convergence of existing methods. Irrespective of this emphasis, many of the IFC member countries are, of course, interested in the eventual commercial implementation of the GBC assessment framework and GBTool, or some variant of it (Larsson and Cole, 2001).

Required data

The required data is in two forms:
Quantitative: detailed statistics values on the predicted consumption of energy, water, land use, materials, environmental emissions as well as the measurable aspects of indoor environmental conditions.
Qualitative: most aspects of indoor environment, health issues, design issues related to longevity, design and building operations planning and management provisions, and environmental loading on immediate surroundings, mainly in terms of the effects on neighbouring or adjacent properties.

End-use

The end use is as a building design and assessment tool.

Assessment criteria

The assessment criteria for GBC are presented in Table 8. The first four criteria (Resource consumption, Environmental loadings, Indoor environmental quality and Service quality) are considered core requirements in the GBC assessment. Criteria and sub-criteria in these performance issues are scored using the –2 to +5 assessment scale. The remaining criteria are important but are not scored in a GBC 2000 assessment. These characteristics of the case-study buildings are simply reported as text descriptions.

Table 8: Assessment criteria for Green Building Challenge

Criteria	Sub-criteria	Note
Resource consumption	life cycle energy use, land use, net use of water, and net consumption of materials	Core requirement in GBC 2000 assessment
Environmental loadings	emission of greenhouse gases (1), emission of ozone-depleting substances (2), emission of gases leading to acidification (3), emission leading to formation of photo-oxidants (4), emissions with eutrophication potential (5), solid wastes (6), liquid effluent (7), hazardous wastes (8), and environmental impacts on site and adjacent properties (9)	Core requirement but not included (4), (5) and (8) in sub criteria at GBC 2000 assessment
Indoor environmental quality	air quality and ventilation, thermal comport, day lighting illumination and visual access, noise and acoustics, electro-magnetic pollution	Core requirement but electro-magnetic pollution was not included in GBC 2000 assessment.
Service quality	flexibility and adaptability (1), controllability of systems (2), maintenance of performance (3), privacy and access to sunlight and views (4), quality of amenities and site development (5), impact on quality of service of site and adjacent properties (6)	Core requirement but not included (4), (6) in GBC 2000 assessment.
Economics	life cycle cost, capital cost, operating and maintenance cost	Not be scored in GBC 2000 assessment
Pre-operation management	construction process planning, performance tuning, building operations planning	Not be scored in GBC 2000 assessment
Commuting transport	greenhouse gas emission, acidification gas emission, photo-oxidant formation gas emission	Not be scored in GBC 2000 assessment

Source: GBC, 2000

Scale of assessment

The spatial boundary is the building level (for office building, school, and multi-unit residential building). Some criteria refer to the public transport system and other services of the surrounding community, such as waste minimisation, which have implications for the city and district scales. However these are taken into account from the viewpoint of the individual building. In addition the whole methodology is based around reduction of impacts, which implies a longer-term (more than 20 years) interest in protecting and preserving the environmental systems.

Scoring/weighting system

All performance criteria and sub-criteria assessed are scored (from -2 to +5), then summed using two types of weighting: default by GBC or modified weighting by each of national team participated in the GBC. Performance scores are presented in a consistent manner all relative to an explicitly declared benchmark - the zero (0) on the performance scale. When scoring for criteria, the score is assigned according to the rule that is shown in Table 9.

Table 9: Scoring criteria for GBC

Scoring	Description
-2* and –1	levels of performance below the acceptable level in the region that building is located, for occupancies specified
0	the minimum level of acceptable performance in the region that building is located for occupancies specified
3	best practice
5	the best technically achievable, without consideration of cost

*This is assigned when performance is clearly inferior to accepted industry norms.
Source: GBC, 2000

Intermediate scores (1, 2, and 4) represent varying degrees of performance between the primary benchmarks (i.e., score 1 represent a moderate improvement over the industry benchmark performance, e.g., 'good practice' within the region). The result is made, via scores and weights. There are two types of results shown: Environmental Sustainability Indicators (ESI), which are absolute numbers; and bar charts that show weighted scores (-2 to +5) relative to the benchmarks (0).

In defining appropriate benchmarks:

- Quantifiable issues (energy use, water use etc.) are assumed to be either minimum code requirements or typical practice, depending on access to reliable data. In either case there must be a clear description and rationale of the choice.
- For many of the qualitative criteria considerable judgement will be required. The default benchmarks for these are simply a declaration of what would be considered to be a typical condition or typical practice for the building type in the region.

Present Status

GBC has been tested on a total of 34 buildings in 14 different countries. The results of these assessments were reported at the Green Building Challenge '98 Conference held in Vancouver, Canada and reviewed in SB 2000 conference in Maastrict, the Netherlands, in October 2000. The current round of the GBC process will culminate in the presentation of the assessed buildings at the SB 2002 conference held in Oslo, Norway in September 2002. This conference was another major opportunity for each country to display the state-of-the-art of its industry.

LEED (Leadership in Energy and Environmental Design)

Description

The LEED (Leadership in Energy and Environmental Design) Green Building Rating System™ is a priority program of the US Green Building Council (USGBC, 2002). It is a voluntary, consensus-based, market-driven building rating system based on existing proven technology. It evaluates environmental performance from a "whole building" perspective over a building's life cycle, providing a definitive standard for what constitutes a green building.

LEED™ is based on accepted energy and environmental principles and strikes a balance between known effective practices and emerging concepts. Unlike other rating systems currently in existence, the development of LEED Green Building Rating System™ was instigated by the US Green Council Membership, representing all segments of the building industry, and has been open to public scrutiny (USGBC, 2002).

LEED™ is a self-assessing system designed for rating new and existing commercial, institutional, and high-rise residential buildings. It is a feature-oriented system where credits are earned for satisfying each criterion. Different levels of green building certification are awarded based on the total credits earned. The system is designed to be comprehensive in scope, yet simple in operation.

LEED™ rating system uses a simplified checklist format that facilitates its use in the design process – design teams often use the checklist as the basis for a charrette and discussions of which strategies and credits they will try to achieve in the building.

LEED™ awards ratings of certified, silver, gold, and platinum. To obtain a rating, a building must meet seven prerequisites and then obtain points for credits related to sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality.

Data requirement

Quantitative: detailed statistics values on the predicted consumption of energy, water, materials, as well as measurable aspects of indoor environmental conditions and site.

End-use

Building design tool.

Assessment criteria

All of criteria and sub-criteria in LEED rating system are described in Table 10. Based on the criteria/sub-criteria, points are assigned. Then, a building is certified as “Silver”, “Gold” or “Platinum” according to the obtained points (26-32 points - Silver 33-38 points - Gold 39-51 points - Platinum 52-69 points).

Table 10: Assessment criteria in LEED rating system

Criteria	**Sub-criteria**	**Points***
Sustainable Sites	site selection, urban redevelopment, brownfield redevelopment, alternative transportation, reduced site disturbance, storm water management, landscape & exterior design to reduce heat Islands, light pollution reduction	14
Water Efficiency	water efficient landscaping, innovative wastewater technologies, water use reduction	5
Energy & Atmosphere	optimize energy performance, renewable energy, additional commissioning, ozone depletion, measurement & verification, green power	17
Materials & Resources	building reuse, construction waste management, resource reuse, recycled content, local/regional materials, rapidly renewable materials, certified wood	13
Indoor Environmental Quality	carbon dioxide (CO_2) monitoring increase ventilation effectiveness, construction IAQ management plan, low-emitting materials, indoor chemical & pollutant source control, controllability of systems, thermal comfort, daylight & views	15
Innovation & Design Process	innovation in design, LEED™ accredited professional	5

*Building is certified as Silver, Gold and Platinum according to the obtained points (26-32 points, Silver 33-38 points, Gold 39-51 points, Platinum 52-69 points). *Source: USGBC, 2002*

Scale of assessment

Spatial boundary is building level.

Scoring/weighting system

Each criterion is specified as credits and the user selects criteria for scoring. Then rates, based on total number of points scored by user. All criteria are weighted equally, except for number of points assigned. Unlike other rating systems, the development of LEED Green Building Rating System™ was instigated by the US Green Council Membership, representing all segments of the building industry and has been open to public scrutiny. Different levels of green building certification are awarded based on the total credits earned. In evaluating a building using the LEED criteria, for example, there are minimum, mandatory requirements in areas such as building commissioning, energy efficiency, indoor air quality, ozone depletion/CFCs, smoking ban, comfort, and water (Table 11). Once the mandatory requirements are met, a building can earn 'credits' in 14 areas. Depending on the total credits, a building receives a rating level of 'Silver', 'Gold', or 'Platinum'.

Table 11: Seven prerequisites to obtain a rating in LEED green building rating system

Criteria	Prerequisite	Objective
Sustainable Sites	Erosion & Sedimentation Control	to control erosion to reduce negative impacts on water and air quality
Energy & Atmosphere	Fundamental Building Systems Commissioning	to verify and ensure that fundamental building elements and systems are designed, installed and calibrated to operate as intended
	Minimum Energy Performance	to establish the minimum level of energy efficiency for the base building and systems
	CFC Reduction in HVAC&R Equipment	to reduce ozone depletion
Materials & Resources	Storage & Collection of Recyclables	to facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills
Indoor Environmental Quality	Minimum IAQ Performance	to establish minimum indoor air quality (IAQ) performance to prevent the development of indoor air quality problems in buildings, maintaining the health and well being of the occupants
	Environmental Tobacco Smoke (ETS) Control	to prevent exposure of building occupants and systems to environmental tobacco smoke

Source: USGBC, 2002

Present status

After development of the LEED green building rating system by US GBC, 14 buildings were certified using LEED 1.0, and 9 buildings were certified using LEED 2.0 rating system. More than 470 buildings are registered to be certified using LEED green building rating system by 2002. Presently, LEED 2.1 rating system is available, and LEED 3.0 rating system is scheduled for release in 2005 following balloting by USGBC members and pilot testing of the new criteria.

BREEAM (Building Research Establishment Environmental Assessment Method)

Description

The Building Research Establishment (BRE) in the UK developed Building Research Establishment Environmental Assessment Method (BREEAM), which was found to be the most widely recognized international method, implemented in 1990, provides authoritative guidance on ways of minimising the adverse effects of buildings on the local and global environments (Curwell and Spencer, 1999). The assessment is based on 'credits' awarded for a set of performance criteria. When a building has been evaluated using BREEAM, the result is a single score, which enables owners or occupants to gain recognition for their building's environmental performance.

Environmental performance is assessed under nine main categories: 1) Management (of the building and the occupant organisation), 2) Health and Comfort, 3) Energy, 4) Transport, 5) Water Consumption, 6) Materials, 7) Land Use, 8) Site Ecology, and 9) Pollution. Assessment credits are awarded for the environmental performance in range of criteria in each of these categories leading to a category score. Finally an environmental weighting system is applied across the nine category scores in order to determine the final BREEAM rating. The weighting system applied is the result of a consultation process across a wide range of professional actors and other stakeholders in the UK, which is updated from time to time.

The system is modularised to facilitate assessment of new and refurbished buildings, existing and occupied buildings. The core module provides for the assessment of the buildings potential environmental performance and allows cross comparison between existing buildings and between new designs and existing buildings. The design and procurement module is for the assessment of new build and refurbishment at the design stage and covers additional issue over the core module relevant to design such as land use and selection of materials and components. The management and operation module is for assessment of buildings that are in use and adds additional issues such as the health and well-being of users. Specialist assessors licensed by BRE undertake assessments.

Data requirement

The required data is in two forms:
Quantitative: energy and water consumption, materials data, environmental profiling system based on LCA data (used to determine the credits attributed for materials)
Qualitative: the use of high frequency ballasts in fluorescent lighting, (a health and comfort factor) or whether efforts have been made to plant new trees (a site ecology factor).

End-use

Building Design and environmental assessment tool.

Assessment criteria

The criteria in BREEAM are shown in Table 12.

Table 12: Assessment criteria in BREEAM

Criteria	Description
Management	Overall policy, commissioning and procedural issues
Energy use	Operational energy and CO_2 issues
Health and well being	Indoor and external issues affecting health and well being (lighting, air quality, hazardous materials, radon, indoor noise, hot water system)
Pollution	Air (CO_2, NOx, CFCx, HCFCs, Halons) and water pollution
Transport	Transport related CO_2 and location related factors
Land use	Greenfield and brownfield sites
Ecology	Ecological value of the site
Materials	Environmental implication of building materials
Water	Consumption and water efficiency

Source: Grace, 2000

Scale of Assessment

Buildings (office, home, superstore, and industrial unit) and their operation form the primary focus of assessment. Estate issues are address though consideration of the environmental implications of location, transport to the building and its site ecology.

Scoring/ Weighting System

For each of the criteria set out, the building is assessed against performance criteria set by BRE and awarded credits based on the level of performance against each criterion. The percentage of credits achieved under each category is then calculated and environmental weightings are applied to produce an overall score for the building. The overall score then translated into a BREEAM rating of “Pass”, “Good”, “Very good”, or “Excellent”. The weighting system is predetermined through the national consultative process and so users cannot apply their own individual weighting priorities.

Present status

It was first implemented in 1990 and subsequently revised and extended in scope. Currently BRE estimates that 20-30% of new office accommodation constructed since 1990 has received a rating using the method in the UK and adapted for and marketed in other jurisdictions. Presently, more than 500 buildings have been certified by BREEAM. The latest version of BREEAM has been launched in 1998 (EcoHomes, the version of BREEAM for home in 2000), and BREEAM versions have been developed for Canada, Hong Kong, New Zealand, and BREEAM derivative scheme in Norway (Grace, 2000).

BEES (Building for Environmental and Economic Sustainability)

Description

Building for Environmental and Economic Sustainability (BEES) is an interactive computer design aid that helps users select building products for use in commercial office and housing projects in a way that balances environmental and economic criteria. A range of material options can be compared for different elements of the building, using graphical outputs of a range of environmental and economic criteria, considered individually or in combination (Lippiatt, 1999; 2000).

At present the tool contains 65 building products. Future versions of BEES are planned that to cover building components, or collections of elements (Lippiatt and Rushing, 2002). BEES measures the environmental performance of building products by using the environmental life-cycle assessment approach. Economic performance is measured using the ASTM (American Society for Testing and Materials) standard life-cycle cost method, which covers the costs of initial investment, replacement, operation, maintenance and repair, and disposal. Environmental and economic performances are combined into an overall performance measure using the ASTM standard for Multi-Attribute Decision Analysis. For the entire BEES analysis, building products are defined and classified according to the ASTM standard classification for building elements.

Data requirement

The required data is in two forms:

1. Quantitative data, based on US building technology, is included in the system tool and so is not required of users. The environmental performance measure is derived using the LCA approach and covers six impacts (resource depletion, global warming, acidification, eutrophication, indoor air quality and solid waste).

2. Qualitative data required of users involves setting or adjusting the weightings between parameters, such as the balance between environmental issues and cost. Economic performance is derived using the ASTM standard LCC approach (ASTM, 1994) and includes the cost of purchase, installation, operation, maintenance, repair, replacement, and disposal over a 50-year use stage. Environmental and economic performances are combined using the ASTM standard for multi-attribute decision analysis.

End-use

Primarily building materials design

Assessment criteria

The assessment criteria in BEES are shown in Table 13.

Table 13: Assessment criteria for BEES

Criteria (Performance)		Items considered in BEES
Environmental Criteria	Global warming	CO_2, CH_4, NOx
	Acid rain	SOx, NOx, NH_3, HF, HCl
	Eutrofication	P, NOx, NH_3, nitrogenous matter, nitrates, phosphorous, COD
	Resource depletion	Oil (in ground), natural gas (in ground), coal (in ground), bauxite (ore), Cd (ore), Cu (ore), Au (ore), Fe (ore), Pb (ore), Mn (ore), Hg (ore), Ni (ore), phosphate rock (in ground), Ag (ore), Sn (ore), U (ore), Zn (ore)
	Indoor air quality	VOC from floor coverings, interior wall finishes, wall and roof sheathing, wall and ceiling insulation
	Solid waste	
	Smog	NOx, VOC
	Ozone depletion	Methyl bromide, carbon tetrachloride, CFC11, CFC113, CFC114, CFC115, CFC12, Halon 1201, Halon 1202, Halon 1211, Halon 1301, Halon 2311, Halon 2401, Halon 2402, HCFC 123, HCFC124, HCFC141b, HCFC142b, HCFC22, HCFC225ca, HCFC225cb, methyl chloroform HC 140a
	Ecological toxicity	Hydrocarbons, NOx, CO, dioxines, HCl
	Human toxicity	NH_3, benzene, formaldehyde, Pb, phenolics
Economic criteria*	First cost	-
	Future cost	-

*economic performance is measured over a 50 year period

Source: Lippiatt, 2000

Scale of assessment

Components and Materials form the subject of assessment.

Scoring/weighting system

Environmental and economic values obtained are transformed by relative value. For environmental performance, BEES uses the LCA approach, following guidance in the ISO 14040s of standards for LCA. For economic performance, it is measured using the American Society for Testing and Materials (ASTM) standard life cycle cost approach. Both performances are aggregated into a single score using the weighting factors (EPA Science Advisory Board study (1990), Harvard University Study (Norberg-Bohrn, 1992), or Equal weightings).

Users may set relative importance weights for;

1. synthesizing environmental impact scores into an environmental performance score;
2. discounting future costs to their equivalent present value; and
3. combining environmental and economic performance scores into an overall performance score. Default values provided for all of this windows-based input.

Present Status

It has been used for a number of projects in the USA. 570 copies distributed at 11/99.

ECO-QUANTUM

Description

Eco-Quantum is a simulation based tool intended to enable a designer to quickly identify environmental consequences of material choices, water and energy consumption of their designs (Mak et al. 1997; Kortman et al., 1998). This tool calculates the environmental effects during the entire life cycle of the building from the moment the raw materials are extracted, via production, building and use, to the final demolition or reuse. This includes the impact of energy, the maintenance during the use phase and the differences in the durability of parts of the construction related to the life span of the building.

Two kinds of versions of Eco-Quantum are available (Eco-Quantum Research and Eco-Quantum Domestic). Both are provided with information from a stand-alone version of the Dutch LCA program SimaPro 4. Eco-Quantum Research is a tool for analysing and developing innovative and complex designs for sustainable buildings and offices and Eco-Quantum Domestic is a tool which architects can apply to quickly reveal environmental consequences of material and energy use of their designs of domestic buildings.

Data requirement

Quantitative: Energy and water consumption, materials data, environmental profiling system based on LCA data (used to determine the credits attributed for materials).

End Use

Building and building material design.

Assessment criteria

The assessment criteria in ECO-QUANTUM are shown in Table 14.

Table 14: Assessment criteria for Eco-Quantum

Criteria	**Items**
Natural resource	Consumptions of energy, water, material
Environmental loading	Air emission, water emission, and waste
Land use	-
Biodiversity	-

Source: Seo, 2001

Scale of assessment

Primarily the assessment is focus on buildings and their operation. Also, building materials and components are included in the assessment.

Scoring/weighting system

Eco-Quantum relates the environmental profiles to the corresponding material and energy flows. By doing so the environmental interventions related to the total life cycle of the building are accumulated in the form of raw materials, energy, land-use (input), waste and emissions (output). And then, the environmental interventions are converted on the basis of characterisation factors of the LCA methodology (Heijungs et al., 1992) into the various

environmental effect scores such as exhaustion of resources, ecotoxicity and greenhouse effect. In the following step these environmental effect scores are automatically converted into four environmental indicators: depletion of resources, emissions, energy consumption and waste according to the Dutch Environmental Rating methodology.

Present status

It is extensively tested by architects, building industry, municipalities and other organisations. Various case studies have been undertaken using Eco-Quantum:

- a new test with version 3.0 in 10 municipalities: around 50 residential projects (1999)
- a new test with version 3.0 in 12 branches of the building product industry (1999)
- calculation of two design for one office building in Amsterdam (1998)
- a research project in which various levels of the Energy Performance Standards with related equipment are calculated
- research projects with steel, concrete and wood frame industry

ECOPROFILE

Description

Ecoprofile, which is a method for simplistic environmental assessment of buildings, is a top down method for environmental assessment of existing office buildings. It includes three principal components that are given the designations “External Environment”, “Resources” and “Indoor Climate” (Pettersen, 2000). Each of the principal components has 4-6 sub-areas with a total of approximately 90 parameters assessed within these areas. Each sub-area is weighted. The method is based on the use of standardized schemes, questionnaires and reports to minimize the work of assessment and this makes it easy and cheap to use. The method has been under development since 1995, but has been operative since autumn 1998.

Data requirement

Quantitative and qualitative data is used (not included economics, such as LCC). As a quantitative data are needed such as energy consumption and water consumption, and materials inputted. The method does not go into details concerning impact categories like GWP, ozone layer depletion, etc.

End-use

Building design and assessment tool.

Assessment criteria

The assessment criteria in ECOPROFILE are shown in Table 15.

Table 15: Assessment criteria in Ecoprofile and their weighting value

Principal components	Sub-components	Weight
External environment	Release to air	3
	Release to ground	3
	Release to water	3
	Waste management, toxic substances	2
	Outside areas	1
	Transport	2

Resources	Energy	10
	Water	1
	Materials	-
	Land	-
Indoor climate	Thermal climate	3
	Atmospheric climate	2
	Acoustic climate	1
	Aclinic climate	1
	Mechanical climate	1
	Cross factors	3

Source: Pettersen, 2000

Scale of assessment

Buildings and their operation form the primary focus of assessment.

Scoring/weighting system

Each criterion is scored and sub-criterion is weighted from 1 to 3 (except for energy as 10). Then, the results which are added scores for criteria are presented as bar charts for the major categories or target plot for detail within the major categories (resource depletion, environmental emission, energy consumption, and waste).

Present status

At present the method covers only existing office buildings, but work is going on to adapt the method for dwellings. Approximately 50 existing office buildings had been assessed by 1999 (Pettersen, 1999).

LCAid

Description

LCAid is a computer software developed by NSW Department of Public Works and Services (DPWS). LCAid takes Life Cycle Assessment (LCA) information, which until now has been limited to LCA specialists, and makes it more accessible to other practitioners (e.g., architects, engineers, and portfolio managers) to make more complete environmental assessments. It is aimed at the building designer, and is a user friendly decision making tool using LCA methodology to evaluate the environmental performance of design options and to identify the largest impacts over the entire life cycle of a building (Eldridge, 2002).

Data Requirement

Quantitative: operational energy, waste, building material quantities
Qualitative: areas of project type, climate zone, operational, waste management, water management and water use as project and operational input

End-use

Building Design and environmental assessment tool.

Assessment Criteria

The assessment criteria in LCAid are shown in Table 16.

Table 16: Assessment criteria in LCAid

Criteria (Performance)		Items considered in LCAid
Resource	Energy consumption	Energy
	Water consumption	Water
Environmental Loading	Greenhouse effect	CO_2, CFCs, HCFCs, HFCs, Halons, methane, N_2O, other chlorinated hydrocarbons
	Ozone depletion	CFCs, HCFCs, HFCs, Halons, other chlorinated hydrocarbons
	Heavy metals	Cadmium, mercury, lead, arsenic, copper, nickel, manganese, chrome
	Nutriphication	Ammonia/ammonium, nitrates, NOx, phosphates, COD
	Acidification	Ammonia, HCl, HF, NO, NO_2, NOx, SO_2, SOx
	Carcinogenesis	Aromatic hydrocarbons, and derivatives
	Summer smog	Chlorinated hydrocarbons., alcohols, aldehydes, saturated & unsaturated hydrocarbons, mercaptans, aromatic hydrocarbons, volatile organic compounds, ketones, phenols
	Winter smog	Dust, SO_2
Economics		Life cycle cost

Source: Seo, 2001

Scale of Assessment

Buildings (office, home, superstore, and industrial unit) and their Operation form the primary focus of assessment.

Scoring/Weighting System

Given known quantities of components that make up a building, LCAid calculates the environmental impacts of the building over its whole life. Building materials quantities can be entered in LCAid by manually entering quantities and assigning materials from the LCAid library or importing quantities generated by a 3-D architectural drawing and assigning materials to each building element (3-D model is not essential). Life Cycle Inventories (LCI) of building materials are stored in a library in LCAid and are based on the DPWS LCI database. LCAid can read Boustead Model files and has a template for data to be entered for other LCA packages such as Sima-Pro. Based on the entered data, environmental impacts are calculated using Eco Indicator 95 with the additional reporting of water consumption and solid waste produced.

Present Status

LCAid is currently the subject of an Expression of Interest for further development.

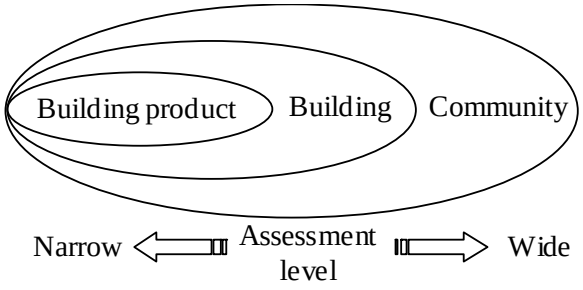
Comparison of the models

All models described above are compared with each other according to the selected comparison criteria: assessment level, criteria covered and weighting. A brief description for each model is summarized in Table 18.

Assessment level

Building assessment level can be divided in three levels: assessment of building product, building, or community as shown in Figure 13. Presently, many of models address the building product and/or building assessment level based on some form of LCA database Table 17. Most of models considered here are mainly focused on the assessment of "building level" except for BEES, which is focused on the "building products".

Figure 13: Building Assessment Level



Source: Seo, 2001

Table 17: Assessment level of each model

Model	GBC	LEED	BREEAM	BEES	ECO-QUANTUM	Ecoprofile	LCAid
Level	Building	Building	Building	Building product	Building/ building product	Building	Building

Source: Seo, 2001

Table 18: Scope of Assessment Models

Model	GBC	LEED	BREEAM	BEES	ECO-QUANTUM	Ecoprofile	LCAid
Nation	Canada	U.S.A	U.K	U.S.A	Netherlands	Norway	Australia
Main Developer	National Resource Canada (NRC) in 1995	US Green Building Council in 2000	Building Research Establishment in UK in 1990	National Institute of Standards and Technology (NIST) in 1994	IVAM Environ.l Research & W/E consultants in 1999	Norwegian Building Research Institute (NBI) in 1999	NSW DPWS
Purpose	Research/contribute to the state-of-the-art of building performance assessment during design or after completion	Voluntary, market-based assessment	Voluntary, consensus-based, market-focused assessment	Consensus-based decision support tool	-	-	LCA for environmental assessment and design improvement
End-use	Building	Building	Building	Building product	Building product	Building	Building
Stakeholder	Researcher, organisation	Building project team member - architect, designer, owner, builder	Building owner, Operator	Designer, builder, Product manufacturer	Architect, Building researcher	Building owner, Assurance Company, Contractor, Building user	building designer
Type Assessed	·office building ·multiunit residential building ·school building	Commercial office, Institutional building, ·High-rise residential building	·Commercial office ·Residential building	·Building products	·Building products Office building	·Commercial office	Office, residential building, school, and hospital

Continued

Present Status	GBC `98: tested on 34 buildings (14 different countries) GBC 2000: 40 buildings (16 countries) by national team from 20 countries[+]	20 certified and more than 437 registered projects	·Used for 30% of new office construction in the UK	Used for a number of projects in the USA. 570 copies distributed at 11/99. Over 3500 copies requested in first 8 months of BEES 2.0 availability	·50 residential projects by 1999	·Assessed 50 existing office buildings by 1999	
Regional Scope	Participated countries (member[+])	U.S.A and Canada	UK	U.S.A	Netherlands	Norway	Australia

+ Members: Austria, Australia, Brazil, Canada, Chile, Finland, France, Germany, Hong Kong, Italy, Japan, Korea, Netherlands, Norway, Poland, South Africa, Spain, Sweden, U.S.A., Wales

Source: Seo, 2001

Criteria covered

When assessing a building, it is necessary to consider a number of factors such as energy and raw materials consumption, environmental loadings, etc. In relation to this, Cole et al (2000) suggested that economic and social concerns as well as environmental aspects of sustainability should be considered in building assessment as sustainable criteria.

Criteria covered in each model are described in Table 19. All models reviewed in here include environmental loadings and resource consumption while none of them include any social concerns. In addition, economics is only included in BEES and LCAid though GBC includes economics but not be scored in GBC 2000.

Table 19: Criteria in each model considered

Model / Criteria			GBC	LEED	BREEAM	BEES	ECO-QUANTUM	Eco Profile	LCAid
Resource consumption	Energy	Embodied	V	-	V	V	-	-	-
		Operation	V	V	V	-	V	V	V
	Land		V	V	V	-	V	V	-
	Water		V	V	V	V	V	V	V
	Materials		V	V	V	V	V	V	V
Environmental loading	Air		V	-	V	V	V	V	V
	Solid		V	V	V	V	V	V	V
	Water		V	-	V	V	V	V	V
	Others		V	-	-	V	V	V	V
Indoor environmental Quality	Air		V	V	V	V	V	V	-
	Thermal		V	V	V	-	-	V	-
	Visual		V	-	-	-	-	V	-
	Noise		V	-	-	-	-	-	-
Economics	Life Cycle		V*	-	-	V	-	-	V
	Operation		-	-	-	-	-	-	-
Social concerns			-	-	-	-	-	-	-

*GBC includes economics (life cycle cost, capital cost, operating and maintenance cost) in the criteria, but it's not scored to aggregate into a single value in evaluation in GBC 2000.
Source: Seo, 2001

Weighting

Weighting is needed to most assessment models, which have various criteria/sub-criteria, to present various criteria as a single value. But there is no homogeneous weighting system to apply all of models. Under the absence of scientifically based weights, some organisations use consensus-based weighting system. In this approach, users or groups to give a weight rank various elements, such as environmental issues, in terms of their relative importance or assign points to these elements. This ranking or scoring is then used to establish weights (Dickie and Howard, 2000). Various weighting system employed in each model are presented in Table 20.

Table 20: Weighting systems and their transparency

Weighting / Model	Weighting system	Transparency**
GBC	Using default or modified weights by national team to reflect each country's or regional condition	++
LEED	Using all criteria weighted equally	
BREEAM	Using fixed weight through the national consultative process	--
BEES	Using by relative importance value*	++
ECO-QUANTUM	Using LCA-based impact assessment	+
Ecoprofile	Using fixed weight ranged from1 to 3 (except for energy as 10)	--
LCAid	Using LCA-based impact assessment	+

* In BEES, relative importance value can be used by EPA science advisory board study (US EPA, 1990), or Harvard University study (Vicki et al., 1992), or specified by user

** Very transparent ++, relative transparent +, less transparent -, not transparent –

Source: Seo, 2001

Discussion

Six models used in the world widely in relation to building assessment, have been compared on the basis of their assessment level, criteria covered and weighting method.

Considering the comparison of the results, there is no model that satisfied all the criteria. Even though GBC can be better model of the considered models, it has limitations that it may give rise the time consuming than others and bring out the users difficulty to use the model. Because it is a framework, not a simulation model, thus users are expected to use other tools to simulate energy performance, estimate embodied energy and emissions, predict thermal comfort and air quality, etc. Also, the model is used to assess predicted or potential performance of a building before occupancy. It is not intended to assess performance during operational conditions (NRC, 2001).

In relation to LEED and BREAM models, Cole and Larsson (1997) pointed out the limitation that these models are not structured to handle different levels of assessment due to difficulty to simplify. And these models were not explicitly designed to handle regional-specific issues. That is, the systems were not originally designed to accommodate national or regional variations. Especially in LEED model, Todd et al (2001) described the specific limitation that the criteria in LEED are not applicable to certain types of locations and LEED does not include explicit weighting because of a lack of consensus on appropriate weights (Todd et al., 2001).

These limitations described above are matched with the comparison results here as following.

In assessment level, even though some models included some criteria such as commuting transport in GBC and sustainable cities in LEED, which might be included in community level, all of models considered in here are remained in building assessment level except for BEES, focused on building products. Thus it is needed to extend the assessment level of each model into the broader one, community level.

In criteria covered at each model, all of models did not include the social concerns, which is one of sustainable criteria suggested by Cole et al (2000) for sustainable building assessment. All real-world design/assessment decisions should operate within an economic aspect that must be considered in conjunction with the other objective criteria, but most models compared in here excluded except for BEES and LCAid. Seeing the models compared in here, most models emphasize environmental loadings such as global warming, indoor air quality as well as energy and resource consumptions.

Whilst LEED includes the criteria with simple checklists, which contain site selection, water efficiency, building reuse, or indoor environmental quality control energy that are easily accessible by architects or constructors, and thus it may be considered as more familiar model to building designer, architect or constructor. The checklist in LEED is fixed, however, thus it can't be reflected by regional differences or users' concerns.

For weighting method in each model compared in here, most models give all criteria equal weight partially due to difficulty of weight assigning to criteria (LEED) or fixed weight which can't reflect relative importance between criteria due to regional differences or conditions (BREEAM, Ecoprofile). Whilst, GBC and BEES employ the flexible weighting method, which can give a weight by each user adequately to their regions or conditions.

APPENDIX B.5: DOCUMENTS REFERENCED IN THIS REPORT

ABCB. 1997, *Economic Evaluation Model: Building Regulatory Change,* Australian Building Codes Board: Canberra, Australia.

ABCB. 1996a, *Building Code of Australia. Vol. 1. Class 2-9 Buildings*, Australian Building Codes Board: Canberra, Australia.

ABCB. 1996b, *Building Code of Australia. Vol. 2. Class 1&10 Buildings,* Australian Building Codes Board: Canberra, Australia.

ABCB. 2002a, *Energy Efficiency Measures: Regulatory Proposal and Regulatory Assessment, RD/RIS 2002–1,* Australian Building Codes Board and Australian Greenhouse Office: Canberra, Australia.

ABCB. 2002b, *Salt Attack. Technical Amendment proposal. Discussion Paper*, Australian Building Codes Board: Canberra, Australia.

AIJ. 1993a, *Principal Guide for Service Life Planning of Buildings,* Architectural Institute of Japan: Tokyo, Japan.

AIJ. 1993b, *Building Agenda 21,* Architectural Institute of Japan: Tokyo, Japan.

Alberti, M. 1996, Measuring Urban Sustainability*, EIA Review* Special Issue 16, July-Nov, 1996, 4-6.

Anderson, J. 1996, *LCA of Building Frame Structures*, SBI Report, Swedish Institute of Steel Construction, Available from world wide web: http://www.sbi.se/miljo/rap1873.htm

AS/NZS 1688.1. 1998, *The use of ventilation and air-conditioning in buildings. Fire and smoke control in multi–compartment buildings*. Standards Australia: Sydney.

AS/NZS 1688.2. 2002, *The use of ventilation and air-conditioning in buildings. Ventilation design for indoor air containment control*. Standards Australia: Sydney.

AS/NZS 3666.1. 2002, *Air-handling and water systems of buildings. Microbial control: Design, installation and commissioning.* Standards Australia: Sydney.

AS/NZS 3666.2. 2002, *Air-handling and water systems of buildings. Microbial control: Operation and maintenance.* Standards Australia: Sydney.

AS/NZS 3666.3. 2000, *Air-handling and water systems of buildings. Microbial control: Performance based maintenance of cooling water systems.* Standards Australia: Sydney.

Ash, A. 2001, *Climate Change: Impacts for Australia,* CSIRO Atmospheric Research, available from world wide web: www.marine.csiro.au/iawg/impacts2001.pdf

Association for Symbiotic Housing. 1997, *Design Guideline for Environmentally Symbiotic Housing,* Institute for Building Environment and Conservation: Japan.

ASTM. 1994, *Standard practice for measuring Life Cycle Costs of Buildings and Building Systems*, ASTM International: West Conshohoken, PA.

ASTM E2114. *Standard Terminology for Sustainability Relative to the Performance of Buildings.* ASTM International: West Conshohocken, PA.

ASTM E2129. *Standard Practice for Data Collection for Sustainability Assessment of Building Products.* ASTM International: West Conshohocken, PA.

Benge, D.C. 2002, *The NZ Building Regulatory System: Does it facilitate sustainable building?* Thesis for Master of Architecture in Sustainable Architecture, University of Auckland: Auckland, New Zealand.

BIA. 1991, *The New Zealand Building Act,* Building Industry Authority: Wellington, New Zealand.

BIA. 1992, *The New Zealand Building Code: 1st Schedule of the Building Regulation,* Building Industry Authority: Wellington, New Zealand.

BRANZ. 1997, *The Green Home Scheme*, BRANZ: Wellington, New Zealand.

BRANZ, Auckland Regional Council, Hamilton City Council. 2001, *Easy Guide to Eco-Building,* BRANZ: Wellington, New Zealand.

Brooks et al. 1994, Germany's *Construction and Demolition Debris Recycling Infrastructure: What Lessons Does It Have For The U.S?* In *Sustainable Construction: proceedings of the First International Conference of CIB TG16*, *November 6-9, 1994, Tampa, Florida*, CIB TG16 and the Centre for Construction: Gainesville, Florida.

Brown S. K. 1997, *Indoor Air Quality: Australia, State of the Environment -Technical Paper Series*, Environment Australia: Canberra, Australia.

CIB. 1998, *Sustainable Development and the Future of Construction*, CIB Report Publication 225, CIB: Rotterdam, The Netherlands.

CIB. 1999, *Agenda 21 on Sustainable Construction, CIB Report Publication 237*, July 1999, CIB: Rotterdam, The Netherlands.

CIB. 2000, *Overview of deconstruction in selected countries,* CIB Report Publication 252, 2000, CIB: Rotterdam, The Netherlands.

CIB. 2001a, *Sustainable Construction: A Framework and International Agenda for Change,* CIB: Rotterdam, The Netherlands.

CIB. 2001b, *ScooBE Proposal: Expert Domains to Sustainable Construction of Built Environment: Elaboration of the Scope, State of the Art and Main Objectives for the defined 13 ScooBE Expert Domains.* CIB: Rotterdam, The Netherlands.

CIRIA. 1997, *Waste minimisation and recycling in Construction. Site handbook, Report/CP/4,* CIRIA: London.

CIRIA. 1998, *Waste minimisation in construction: site guide (SP133).* CIRIA: London.

CIRIA. 1999, *Waste minimisation and recycling in construction: design manual (SP134).* CIRIA: London.

COAG. 1997, *Principles and Guidelines for National Standard Setting and Regulatory Action by Ministerial Councils and Standard-Setting Bodies,* Council of Australian Governments: Barton, ACT, Australia.

Cole R.J. 1999, Chapter 16 Environmental Performance of Buildings: Setting Goals, Offering Guidance and Assessing Progress *In:* C.J Kibert (ed.) *Reshaping the Built Environment: ecology, ethics and economics,* Island Press: Washington DC, USA.

Cole and Larsson. 1997, *Greenbuilding challenge '98*, Proc.CIB 2nd Int. Conf. on Buildings and the Environment, Paris France June 9-12 Vol.1 19-29.

Cole and Larsson. 2000, *Greenbuilding challenge: lesson learned from GBC'98 and GBC 2000. Proceedings,* International Conference Sustainable Building 2000, 22-25 Oct. Maastricht, The Netherlands, 213-215.

Cole et al. 2000, *Assessing Life Cycle: Shifting from Green to Sustainable Design*, Proc. Sustainable Building 2000 22-25 Oct. Maastricht, The Netherlands.

Crowther, P. 2002, *Design for Disassembly: An Architectural Paradigm for Sustainability* - Thesis submitted for Doctor of Philosophy, Queensland University of Technology: Brisbane, Australia.

Curwell, S. and Spencer, L. (1999), *Environmental Assessment of Building*s, Centre for the Built Environment, University of Salford, Salford, Greater Manchester, UK

Department of Health and Aging. 2000, *Indoor Air Quality: A Report on Health Impacts and Management Options,* Commonwealth Department of Health and Aged Care: Canberra, Australia.

Department of Health and Aging. 2002, *Environmental Health Assessment: Guidelines for assessing human health risks from environmental hazards*, Department of Health and Ageing and enHealth Council: Canberra, Australia.

Dickie, I, and Howard, N. (2000) Assessing environmental impacts of construction-industry consensus, BREEAM and UK Ecopoints, BRE Digest #446, Garston, Watford, Building Research Establishment

du Plessis, C. 2002. *Agenda 21 for Sustainable Construction in Developing Countries*, available on the world wide web: www.sustainablesettlement.co.za

Eldridge, C. (2002) "LCAID Software: Measuring Environmental Performance of Buildings," 9th International Conference on Durability of Building Materials and Components, 17-20 March, Brisbane, Australia. CSIRO, Australia

Energy Efficiency and Conservation Authority (EECA). 2001, National Energy Efficiency and Conservation Strategy, available from the world wide web: www.eeca.govt.nz

Environment Australia. 2001a. *Air Toxics and Indoor Air Quality in Australia 2001,* Department of the Environment and Heritage, Air Toxics Section: Canberra, Australia.

Environment Australia. 2001b. *Australia State of the Environment 2001,* Independent Report to the Commonwealth Minister for the Environment and Heritage, CSIRO publishing on behalf of the Department of Environment and Heritage: Canberra, Australia.

European Union. 2000, *European Charter on Sustainable Design & Construction.* Sustainable Design International: Dublin.

FIEC. 2000, *FIEC Environmental Charter: A Europe building efficiently for the environment and jobs,* European Construction Industry Federation: Brussels.

Finkel, G. 1997, *The Economics of the Construction Industry*, Sharpe: London.

Government of Western Australia. 2002, *Focus on the Future: The Western Australian State Sustainability Strategy - Consultation Draft,* Department of the Premier and Cabinet: Perth.

Harrington et al. 1999, *Australian residential greenhouse gas emission 1990-2010,* Australian Greenhouse Office: Canberra, Australia.

Heijungs, R. et al. (1992) Environmental life cycle assessment method of products, Centre of Environmental Science, Leiden, The Netherlands.

HMSO. 1991, *Environmental Protection Act 1990, Waste Management, the Duty of Care - a Code of Practice*, HMSO: London.

I.E.Aust. 2001, *Sustainable Energy Innovation in the Commercial Buildings Sector: the challenge of a new energy culture.* Sustainable Energy Building and Construction Taskforce Report*,* Institute of Engineers: Barton, ACT, Australia.

IBEC. 2001, *Environmentally Symbiotic Housing.* Institute for Building Environment and Conservation: Japan.

Institution of Civil Engineers. 1995, *Managing and Minimising Construction Waste. A Practical Guide*, Institute of Civil Engineers: UK.

IPCC. 2001, *Climate Change 2001: impact, adaptations and vulnerability - summary for policy makers*, Available from world wide web: http://www.ipcc.ch/

ISO 14001:1996. *Environmental Management Systems: Specification with Guidance for Use,* International Organisation for Standardisation: Switzerland.

ISO 14004:1996. *Environmental Management Systems: Guideline on principles, Systems and Supporting Techniques,* International Organisation for Standardisation: Switzerland.

ISO 14020:2000. *Environmental labels and declarations: General Principles*, International Organisation for Standardisation, Switzerland.

ISO 14031:1999. *Environmental management: Environmental performance evaluation,* International Organisation for Standardisation: Switzerland.

ISO 14040:1997. *Environmental Management: Life-Cycle Assessment, Principles and Guidelines,* International Organisation for Standardisation: Switzerland.

ISO 1996-1:1982. *Acoustics: Description and measurement of environmental noise, Part 1: Basic quantities and procedures,* International Organisation for Standardisation: Switzerland.

ISO 1996-2:1987. *Acoustics: Description and measurement of environmental noise, Part 2: Acquisition of data pertinent to land use,* International Organisation for Standardisation: Switzerland.

ISO 1996-3:*1987. Acoustics - Description and measurement of environmental noise - Part 3: Application to noise limits,* International Organisation for Standardisation: Switzerland.

ISO GUIDE 64:1997. *Guide for the inclusion of environmental aspects in product standards,* International Organisation for Standardisation: Switzerland.

ISO 15686-1:2000. *Buildings and constructed assets: Service life planning, Part 1: General principles,* International Organisation for Standardisation: Switzerland.

ISO 15686-5:2001. *Buildings and constructed assets: Service life planning, Part 5: Service life prediction methods,* International Organisation for Standardisation: Switzerland.

ISO 15686-3:2002. *Buildings and constructed assets: Service life planning, Part 3: Performance audits and reviews,* International Organisation for Standardisation: Switzerland.

ISO/TC 59/SC 3 N 4. *Sustainability in building construction: Terminology,* International Organisation for Standardisation: Switzerland.

ISO/TC 59/SC 3 N 449. *Sustainability in building construction: General principles,* International Organisation for Standardisation: Switzerland.

ISO/TC 59/SC 3 N 467. *Sustainability in building construction: Assessment of environmental impacts from buildings,* International Organisation for Standardisation: Switzerland.

ISO/TC 59/SC 3 N 468. *Sustainability in building construction: Environmental declaration of building products,* International Organisation for Standardisation: Switzerland.

Kibert, C.J 1994, *Sustainable construction: Proceedings of the First International Conference on Sustainable Construction*, CIB TG 16, November 6-9, 1994 Tampa, USA. Center for Construction and Environment, College of Architecture, University of Florida: Florida, US.

Kibert C.J. 1999, *Reshaping the Built Environment*, Island Press, Washington, USA.

Kibert et al. 2000, *Implementing Deconstruction in the US,* In Overview of Deconstruction in selected countries, CIB Report No 252, CIB: Rotterdam, The Netherlands.

Kortman J., H. van Ewijk, J. Mak, D. Anink, and M. Knapen. (1998) "Eco-Quantum the LCA-based Computer Tool for the Quantitative Determination of the Environmental Impact of Buildings", Proc. of Buildings and Environmental in Asia Conference, Singapore, 1998. National University of Singapore

Kristinsson et al. 2001, *Reuse of Secondary Elements: Utopia or Reality,* CIB World Building Congress: Performance in Product and Practice, 2-6 April, Wellington, New Zealand.

Larsson. 1999, *Sustainable Development and Open Building,* Presentation to CIB TG26: Brighton, UK.

Larsson and Cole. 2001, Green Building Challenge: the development of an idea, *Building Research and Information* 29(5), 336-345.

Lippiatt, B.C., and Rushing, A.S. (2002) Integrating LCA and LCC to Select Cost-Effective Green Building Materials- the BEES Approach, *9th International Conference on Durability of Building Materials and Components*, 17-20th March, Brisbane, Australia, 1-5, Melbourne, VIC, CSIRO, p 194-198.

Lippiatt, Barbara C. (2002) Building for Environmental and Economic Sustainability (BEES) Technical Manual & User Guide, NIST, Gaithersburg, MD. (NISTIR no. 6520)

Lippiatt B. C. (1999) Selecting Cost-Effective Green Building Products: BEES Approach, *Journal of Construction Engineering and Management, ASC*E, 125(6), 448-455.

Lomborg, B. 2001, *The Sceptical Environmentalist,* Cambridge University Press: UK.

McGrath et al. 2000, *UK Deconstruction Report: CIB Report No 252,* CIB: Rotterdam, The Netherlands.

Mak, J. D. and Knapen A. M. (1997) Eco-Quantum, Development of LCA Based Tools for Buildings, *Proceedings of CIB Conference Task Group* 8, Buildings and the Environment, 9-

12 June Paris, France. CIB, International Centre for Research and Innovation in Building & Construction, Rotterdam, The Netherlands

Mesureur, Bruno (2002) High Environmental Quality and Technological Innovative Solutions, *Building Science*, 18, 15-20

METI. 1999, *Energy Conservation Law*, Ministry of Economy, Trade and Industry: Tokyo, Japan.

Ministry for the Environment. 2002, *People, Places, Spaces*, MfE: Wellington, New Zealand.

Ministry of Economic Development. 2003, Sustainable Development for New Zealand: Program of Action, MED: Wellington, New Zealand.

MLIT. 2000a, *Building Standards Law of Japan,* Ministry of Land, Infrastructure and Transport: Tokyo, Japan.

MLIT. 2000b, *Housing Quality Assurance Act,* Ministry of Land, Infrastructure and Transport: Tokyo, Japan.

MLIT. 2001, *Construction Material Recycling Law,* Ministry of Land, Infrastructure and Transport: Tokyo, Japan.

NAHB. 1993, *The Regulation of Solid and Hazardous Waste: A Builder's Guide,* National Association of Home Builders: Washington USA.

National Research Council (2001) Limitation of GBTool, NRC Buildings Group Canada (http://buildingsgroup.nrcan.gc.ca/Projects_e/GBTool.html).

Nesmith. 1993, Ready or Not, Construction Recycling is on the way*, Architectural Record,v.181, no. 12, p 18(6),* December 1993.

Newton. 2002, Urban Australia 2001: Review and prospect, *Australian Planner* Vol.39 No1 2002.

Newton et al. 2001, *Human Settlements, Australia State of the Environment Report,* CSIRO Publishing on behalf of the Department of the Environment and Heritage: Collingwood, VIC, Australia.

Norberg-Bohrn et al. (1992) International Comparisons of Environmental Hazards: Development and Evaluation of a Method for Linking Environmental Data with the Strategic Debate Management Priorities for Risk Management, Center for Science & International Affairs, John F. Kennedy School of Government, Harvard University, Cambridge, MA

OECD. 2001a, *Policy Instruments for Environmentally Sustainable Buildings Working Party on National Environmental Policy,* Environment Policy Committee: Paris.

OECD. 2001b, OECD/IEA Joint Workshop on the Design of Sustainable Building Policies Working Party on National Environmental Policy, Environment Policy Committee: Paris.

OECD. 2002, *Policies Instruments for Environmentally Sustainable Buildings- Working Party on National Environmental Policy,* Environment Policy Committee: Paris.

Office of Regulation Review. 1998, *A Guide to Regulation,* Productivity Commission: Canberra, Australia.

OGC. 2000, *Achieving sustainability in construction procurement: Sustainability Action Group of the Government Construction Clients' Panel (GCCP),* Office of Government Commerce: UK.

Oresund Committee, (1999) The Methodological Environmental benchmarking Seminar, Copenhagen August 26, 1999 - Documentation report. Copenhagen V, Denmark, Oresund Committee Benchmarking Secretariat

Peng et al*.* 1994, *Construction Waste management and Recycling Strategies in the US,* In Sustainable construction: Proceedings of the First International Conference of CIB TG 16, CIB TG16: Gainesville, Florida.

Pettersen T. D. (1999) *Ecoprofile for Office Building*s, Norwegian Building Research Institute. Oslo, Norway

Pettersen, T.D. (2000) Ecoprofile for Commercial Buildings-Simplistic Environmental Assessment Method, Reference Document, GRIP Centre, Oslo, Norway.

Queensland Government. 2002, *'Research House',* Department of Housing Web Site, Available from world wide web: http://www.housing.qld.gov.au/org/researchhouse/index.htm

Queensland Government. 2002, *Waste Management Strategic Plan,* Department of Public Works: Brisbane, Australia.

Ruch et al. 1994, *A Case Study of Integrated Dismantling and Recycling Planning for residential Buildings*, CIB Task Group 8: Watford, UK.

Russell and Moffatt. 2001, *Adaptability of Buildings: IEA Annex 31 Energy-Related Environmental Impact of Buildings,* International Energy Agency: Paris.

Sigurjonsson, Jon, Dinesen, Jorn and Glaumann, Mauritz (2002) "Environmental indicators for the construction and property", Sustainable Building 2002: Third International Conference on Sustainable Building, September 23-25, Oslo, Norway, EcoBuild, p.78.

Standards Australia. 1995, *Handbook HB-32: Control of Microbial Growth in Air-handling and water systems of buildings. C*ompanion to AS/NZS 3666 series codes, Standards Australia: Sydney.

Scholten et al*.* 2001, *Developing An Environmental Performance Standard For The Materials In Buildings For The Dutch Building Decree,* In *CIB World Building Congress: Performance in Product and Practice, 2-6 April:* Wellington, New Zealand.

Schultman and Rentz. 2000, *The State of Deconstruction in Germany,* CIB Report No 252, CIB: Rotterdam, The Netherlands.

Seo, S. 2001, *International review of environmental assessment tools and databases,* Report 2001-006-B-02, CRC CI: Brisbane, Australia.

Soo, (2002) Environmental Impact Indicators and Benchmarking for Commercial Buildings - Report 2001-006-B-03 CRC for Construction Innovation, Brisbane

Soo,(2001) International review of environmental assessment tools and databases Report 2001-006-B-02 CRC-CI Brisbane

Standards New Zealand. 2001. *Subdivision for People and the Environment. SNZ HB 44:2001*, SNZ: Wellington, New Zealand.

State of the Environment Advisory Council. 1996, *State of the Environment, Australia, 1996,* CSIRO Publishing: Melbourne.

The International Building Code (IBC). 2000, International Code Council: Chicago, IL.

The International Energy Conservation Code, 2000, International Conference of Building Officials: Whittier, CA.

Todd J. A., Crawley D., Geissler S. and Lindsey G. (2001), "Comparison assessment of environmental performance tools and the role of the Green Building Challenge," *Building Research & Informatio*n, 29(5), 324-335.

Treloar and Fay. 2000, *Building materials Selection: Greenhouse Strategies: BDP Environment Design Guide DES 35*, Royal Australian Institute of Architects: Melbourne, VIC, Australia.

Tucker, S.N et al. 1999, *Towards more energy efficient Australian Housing – life cycle aspects,* BCE Doc.99/149 CSIRO Building Construction and Engineering: Melbourne Australia.

UK Dept. of Trade & Industry. 1999, *A better quality of life: a strategy for sustainable development in UK,* DTI: London.

UK Dept. of Trade & Industry. 2000, *Building a better quality of life: a strategy for more sustainable construction*, DTI: London.

UK Dept. of Trade & Industry. 2001, *Building a better quality of life: a strategy for more sustainable construction: progress report 2001*, DTI: London.

United Nations World Commission on Environment and Development (WCED). 1987, *Our Common Future,* Oxford University Press: London, UK.

United Nations. 1992, *Agenda 21: Program of Action for Sustainable Development, United Nations Conference on Environment and Development,* 3-14 June 1992, UN: Rio de Janeiro, Brazil.

United Nations. 1996, *Conference on Human Settlements: Habitat II,* UN Conference: Istanbul, Turkey.

United Nations. 1997, *Kyoto protocol to the United Nations Framework Convention on Climate Change*, December 1997, UN: Kyoto.

United Nations. 2000, *Indicators of Sustainable Development: Guidelines and Methodologies*, UN, Division for Sustainable Development: New York.

Waitakere City Council. 1997, *Sustainable Home Guidelines*, Waitakere City Council: Auckland, New Zealand.

Waitakere City Council. 2000, *The Better Building Code*, Waitakere City Council: Auckland, New Zealand.

Whetton, P. 2001, *Climate Change Projections for Australia,* CSIRO Atmospheric Research, Available from world wide web: www.dar.csiro.au/publications/projections2001.pdf

World Health Organisation (WHO). 1999, Guidelines for Community Noise, WHO, Available from world wide web: www.who.int/peh/noise/guidelines2.html

Yost. 2000, Deconstruction: Back to the Future for Buildings? *Environmental Building News, 9* (5).

Appendix C: Stage 2 Report (Workshops)

CONTENTS

C.1 BACKGROUND

The 'Sustainability and the Building Code of Australia' project is a scoping study aimed at providing the Australian Building Codes Board with:

- Current information on sustainable construction.
- An identification of the issues and implications of sustainability.
- A preliminary exploration concerning if and how it should be regulated in the building and construction sector.

The overall project consists of two stages. Stage 1 is a report based on a review of national and international literature on "what is" the current state of play in respect to the representation of sustainability principles and objectives within current national, state or local building codes. Stage 2 is a series of workshops in all States and Territories to solicit opinions of major stakeholders on the issues and implications of sustainability and if and how it should be regulated. It offers a perspective on "what could be". This Report summarises the findings of Stage 2.

It is recommended that this Report be read in conjunction with the Stage 1 Report.

C.2 WORKSHOP STRUCTURE

Workshops were held in eight locations to obtain the views of key stakeholders across all States and Territories. The workshops were managed by the ABCB and by external representatives within each jurisdiction. The participating cities and the respective dates of the workshops were as follows:

- Perth (25/11/02)
- Darwin (27/11/02)
- Hobart (2/12/02)
- Adelaide (4/12/02)
- Melbourne (11/2/03)
- Canberra (17/2/03)
- Brisbane (18/2/03)
- Sydney (27/2/03)

To obtain a broad cross section of views within each State and Territory, people from the following types of organisations were invited to attend:

- State Government Department/Agencies with an interest in sustainability and its applicability to the BCA
- Local Government
- Building Designers (Architects, Draftspersons)
- Builders
- Engineers
- Planners
- Researchers
- Building Surveyors
- Property Owners
- Industry Organisations
- Non Governmental Organisations (NGO)

Prospective attendees were provided with a copy of the Stage 1 Report, and a combined discussion paper and pre-workshop questionnaire (see Appendix 2) prior to each workshop session. The workshop structure itself consisted of brief introductory speeches on the ABCB and the CRC CI, followed by an introduction of the Stage 1 Report and its contents. After this first session, the workshop attendees divided themselves into groups for discussion of three themes. These were:

1. Key factors for successful implementation of sustainability in building construction.
For example, what are the roles of key players, what are the constraints on the key players, and what means are available to co-ordinate the key players. It also included questions related to the means available for implementation, the major impediments to successful implementation and the research questions that need to be answered before implementation.

2. General issues and implications associated with regulating sustainability in the BCA.
This involved discussion around whether sustainability should be introduced as a theme or a goal, or both, into the BCA21, and to what extent. This lead to whether or not the scope of the Building Code should be extended, and whether or not the current guidelines for regulation are adequate for formulating sustainability requirements. Methods for dealing with sustainability issues other than the BCA21 were also discussed.

3. What should be done for each specific issue?
Issues included for discussion were: durability, operating energy, embodied energy, C&D waste, adaptability, climate change, indoor air quality, noise, water, urban salinity, eco-labelling and benchmarking. What should be done for each issue was discussed, including the level at which it should be done (National, State or Local) and the option preferred (e.g., regulation, guideline, or left to industry).

C.3 DISCUSSION

The workshops presented a diversity of views in regard to the issue of regulating sustainability (see the workshop summaries, Appendix 1). A number of recurring themes/statements/ideas emerged and are discussed as follows.

Theme 1: Key factors for successful implementation
The majority of views indicate that any sustainability requirements introduced into the Building Code must be easy, simple, practical and affordable in their application. Clearly, there is a need to define what these sustainability requirements are, and what their scope is, i.e., from a triple bottom line perspective, or from an ESD viewpoint. There was a preference for the triple bottom line perspective. An incremental approach to the introduction of any measures seemed to be favoured, and likened to a process of continuous improvement.

The need for better information and the provision of education and training were strongly advocated – as was the need for a means of monitoring, enforcing, and the measuring of success of any introduced measure. In relation to this, the need for a consistent approach was favoured, with some kind of overarching co-ordination body instigated. There was a strong message that Government has a role in leading by example.

In terms of constraints, cost continues to be a dominant concern. To overcome this, there needs to be a range of incentives to promote change, and support for systems or methodologies that encompass the full range of costs and benefits of sustainability requirements. Government, industry, academia and the public all have a role to play.

Theme 2: Issues and implications associated with the regulation of sustainability
Opinion was evenly divided over whether sustainability should be a goal, or a theme, or both, for the BCA21. In other words, some thought it should be just a goal, others just a theme, others advocating both (either at the same time, or staged). There was minimal support for the exclusion of sustainability, i.e., that none of these options be instigated. A problem encountered by most groups was the regulatory distinction between the terms goal and theme.

The majority of participants thought the scope of the BCA21 should be extended; however there was debate as to how to implement any changes in scope, and to what extent the scope extended. There was concern that the sustainability issues that currently lie outside the scope of the BCA21 are caught up in the other regulatory processes, and to increase the

scope of the BCA21 to include them would create political tension, especially between the planning and building system interface.

Opinion was also divided in regard to whether or not the current guidelines for regulation are adequate for formulating sustainability regulatory requirements. However, the general consensus was that the current process is inadequate, as environmental benefits are not captured, and that market failure is an insufficient measure (especially in regard to incremental change).

Other options for introducing sustainability into the built environment included eco-labelling schemes, education, building rating schemes, and market incentives.

Theme 3: Specific issues

A problem encountered by most groups was what each issue meant (how defined) in the context of the workshop. As a result, there was a divergence of views across each issue with regard to what should be done, by whom and how. There was debate concerning the respective roles and boundaries of planning legislation and building regulation. Where an issue was perceived to need more research, a guideline tended to be advocated as a first choice, followed by regulation later. A mix of governance level tended to be suggested for most issues.

General trends from the issue analysis

Durability: Already in Standards, overlap with adaptability. Guideline recently released. National approach and production of Guideline preferred.

Operating Energy: Already in the BCA96. A problem was perceived with the multitude of proprietary rating systems available. National approach preferred; vote split between Guidelines and Regulation.

Embodied Energy: General feeling that it is too complex for the BCA. Better addressed through product manufacturing? A future issue best tackled at National, State and Local levels; Guideline preferred.

Renewable Energy: views split over whether it is an issue for the BCA. Views also split over level (N and S) and option (R and G).

Waste Reduction: should be encouraged and promoted through smart design. Views split as to whether it is an issue for the BCA. Preferred choice of Level (N, S, L) and Option (G, R) also unclear.

Reuse/Recycling: Mixed opinions about whether or not it should be included in the BCA. Advocated at all levels (N, S, L), and both Regulation and as a Guideline.

Material Selection: Needs more information; links with embodied energy and reuse/recycling. Advocated for National control, with all options employed (R, G, and I).

Deconstruction: Mixed views as to its inclusion in the BCA. Also linked to Reuse/Recycling, with National control. A guideline is the most favoured option.

Adaptability: Difficulty was had with what this meant – more a design issue? Both views for and against inclusion in the BCA were stated. Preference for National approach and for a guideline.

Indoor Air Quality: Complex issue as many contributing factors. Despite this, the majority of participants thought it should be in the BCA, controlled at the National level. Mix of views as to the preferred option: both Regulation and Guideline supported.

Noise: Perceived to already be in the BCA, unclear whether the views expressed that this should be more stringent. Both regulation and Guidelines were advocated, at both National and State levels.

Water: Contentious issue; interface of the BCA with the PCA. Those in favour supported National Regulation.

Urban Salinity: Divided views over its inclusion in the BCA; more of a regional, local planning issue? If yes, then National and State Regulation and Guidelines needed.

Eco-labelling: Majority stated that they were unclear if this was an appropriate issue for the BCA. Main problem is that there are many different tools available. If it were to be included, a National Guideline is preferred.

Climate Change: Yes, but what? Climate change is a complex, future oriented issue. Nationally lead (R, and G), but incorporated with local planning solutions.

C&D Waste: Mix of views, all levels of Government and options suggested.

Benchmarking: Perceived as a key issue, performance indicators and measures needed to ensure implementation a 'success'. National and State governments have a role to play as do the full range of options (R, G and I).

C.4 RECOMMENDATIONS

These are reported on page 2 under Conclusions.

Appendix C.1: WORKSHOP SUMMARIES

A. Perth

Location:
Department of Local Government and Regional Affairs
32 St. George Terrace
Perth WA

Time:
13:00 - 17:00
Monday 25th November 2002

Chair:
Antony Mee (AM) - DLGRA

Presenter/Facilitator:
Lam Pham (LP) - CSIRO/ABCB

Participants:
John Hodgins – BDA
Trevor Walker – AIEH
Colin Stretton – BRB
Elizabeth Karoi - Curtin Uni.
Peter Bullen - Curtin Uni.
Daniel Smee – HIA
Tony Hatton – IEA
Mark Thornber – WALGA
Nathan Martin – WALGA
Darryll Rentallack – MBA
Matt Wallwork – RAIA
Peter Jones – RAIA
Andrew Fairs – SEDO
Tony Stewart – SEDO
Michael Roe – DPC
Beyer - DPC

Summary of proceedings:
Antony Mee opened the meeting by thanking everybody for coming then gave a brief introduction about the ABCB.

Lam Pham provided a brief description of the Collaborative Research Centre on Construction Innovation (CRC-CI) then presented a summary of the Report on the Stage 1 of a CRC-CI research project titled 'Sustainability and the BCA'.

General comments relating to the presentation:
- Scepticism of the high level of reuse/recycle reported for Australia in Stage 1 Report.
- Governments are NOT leading by example.
- Concern that governments only pay lip service to ESD.
- Younger generation is more demanding but also more aware and concerned about the environment.
- Concern that key institutions (e.g., ABCB, CSIRO etc.) are more concerned with their own self interest when working on ESD issues.
- Too much discussion (e.g., this workshop) and not enough action.

The participants divided themselves into three groups for discussion of two themes:

1. Key factors for successful implementation of ecologically sustainable construction.
2. Issues associated with the introduction of sustainability in the BCA.

The following comments are noted:

Theme 1: Key factors for the successful implementation of sustainable construction

Successful implementation of ecologically sustainable construction needs:

- To be driven by community.
- People to be informed of the benefits of sustainable construction.
- Develop educational program for sustainable construction.
- Marketing of the concept using current community interest in certain issues (e.g., the drought).
- The BCA21 to be proactive.
- Need an integrated national framework for industry to work within it.
- Need consistent approach and coordination with planning.
- Introduction of incentive for change.
- To establish benchmarks to monitor progress.
- ABCB role to be enlarged.

Some barriers to successful implementation:

- Concern on implementation at local level particularly if Alternative Solution path is used.
- BCA is concerned with minimum acceptable level while ESD requires 'best practice'. Means must be found to enable implementation of both.
- The fact that BCA is not a static document and is under continuous improvement must be made known to all practitioners.
- Insurance and financial institutions are key drivers in building construction but they are not engaged in this effort.

Theme 2: General issues concerning sustainable construction and the BCA

- Need specific, workable definition for sustainable construction within the context of the BCA.
- Develop objectives for sustainable construction within the BCA.
- Issues included in the BCA21 must be National; State and Local Governments can act as distributors of knowledge.
- Should be a goal/theme for the BCA21.
- Need to develop a consistent approach.
- BCA needs to define performance.
- Disagreement on whether BCA21 scope should be extended.
    - Argument against: local building surveyors cannot cope
    - Argument for:
        - to facilitate implementation of ESD
        - all building issues should be contained in the BCA21
- RIS will be a major hurdle.
- How to implement changes - the process must be managed.
- Design for Deconstruction has already happened in some area (e.g., tilt-up construction - for safety not sustainability?).
- Need for flexible assessment method.
- Need to set up construction benchmarks.
- Need to reward for good performance.
- Need to encourage voluntary scheme.

- Some measures may not be effective if placed in the BCA; may be better off lobbying directly with product manufacturers.

Specific issues

Key: -
Level = National (N), States and Territories (S), Local (L)
Option = Regulation (R), Guideline (G), Industry (I)

Issue	What to do	Level	Option
Operating Energy	Yes? Monitor performance of current proposals No, energy efficiency should be built-in in new buildings	N	G
Embodied Energy	Not in BCA May be a Guideline		G
Renewable Energy	Not in BCA Encourage EPA		
Waste reduction	Encourage EPA Yes, provide objectives	L N	 G
Reuse/ Recycling	Not in BCA Yes - Provide objectives	N	G
Material Selection	Need to introduce more choice Provide objectives for selection Emphasis on reuseable/recyclable	N	G
Deconstruct.	Not in BCA Yes	 N	 G
Adaptability	Not in BCA Yes	 N	 G
Indoor Air	Yes, provide minimum requirements	N	G
Noise	Yes, provide minimum requirement	N	G
Water	No - involving many other regulators Yes - provide minimum requirements	L	R
Urban Salinity	Not in BCA Yes but leave it to States & Territories	N S	G
Eco labelling	Yes in concert with other activities Provide goals	N	G
Climate Change	Yes but what? Increase wind speed, design for flood	N	

Note: It appears that there is a distinct difference between designers and surveyors. Designers would like to see most issues in the BCA (meaning that there will be rules to design to) while surveyors do not like to see too many new issues in the BCA (because of difficulties in ensure compliance).

B. Darwin

Location:
Northern University
Room 23.01
Darwin NT

Time:
13:00 - 18:00
Wednesday 27th November 2002

Chair:
Fabio Finocchiaro - DIPE

Presenter/Facilitator:
Lam Pham - CSIRO/ABCB

Participants:

NAME	ORGANISATION	CONTACT DETAILS
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Patrick Flynn	Building Designers Association, NT	Spiros.f@optusnet.com.au
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Serry Alberty	Building Branch, DIPE	Serry.alberty@nt.gov.au

Summary of proceedings:

Fabio Finocchiaro opened the meeting by thanking everybody for coming, outlined the purpose of the Workshop and gave an introduction about the ABCB.

Lam Pham provided a brief description of the Collaborative Research Centre on Construction Innovation (CRC-CI).

Ken Hawkins and Jo Kieboom gave a presentation on the Desert Knowledge Project in which the NT Government seeks to lead by example by commissioning a study on energy efficient building for the Alice Spring area.

Lam Pham then presented a summary of the report on the Stage 1 of a CRC-CI research project titled 'Sustainability and the BCA'.

General comments relating to the presentation:

- Disagree with National Strategy for ESD on the definition of ESD - more comfortable with the Brundtland definition.

The participants divided themselves into three groups for discussion of three themes:

1. Key factors for successful implementation of ecologically sustainable construction.
2. Issues associated with the introduction of sustainability in the BCA.
3. What needs to be done on specific issues?

The following comments were noted:

Theme 1: Key factors for the successful implementation of sustainable construction

Roles of key players:

- Developers/owners are not doing much and need to do a lot more. Their constraints are the fear of increase cost. The market demand is not there.
- Designers are trying but are constrained by design fee and construction cost. They need to have a way for selling ESD to clients.
- Building users/occupiers are asking for more space. They are not aware of the benefits of ESD. Need to create a demand for ESD from the consumers.
- Federal, State and Territory governments need to
    - use government buildings as examples
    - provide guidance - monitor progress
    - identify innovation / solutions
- Research: product evaluation, background research, capacity building.

Key factors for success:

- Need to identify causes for un-sustainability.
- Sustainability must include affordability.
- Reduction in standard of living will lead to reduction in cost hence demands on the environment.
- Need national debate on the 'standard of living'.
- Less is more in regulation.
- Need to change approach to design - give consideration to ESD at the beginning.
- Governments need to lead by example, i.e., the way they handle their buildings.
- Effective rating systems that are easy for consumers to understand.
- Educational campaign for professionals - guidelines to be issued - leaving room for creativity.
- Create financial incentive - link it to ESD outcomes.
- Include in the BCA reference to aesthetics and user emotions.
- Stream lining processes across professions and jurisdictions.
- Assessment tools for use throughout building life.
- Planning and development approval processes could be staged.

- Current policy of giving tax advantages for high running cost but not to high up front costs needs to be reviewed.
- Set up mandatory minimum ESD requirements.
- Education in schools - Scholarships and research awards in higher education.
- Inform the public to encourage knowledge and demand for ESD.
- Current guideline for regulation does not account for true environmental and social 'externalities'.

Barriers to success:

- Ability of people to pay.
- Consumer acceptance.
- People lack of understanding of objective, lack of education on ESD.
- Resistance to change.
- What's in it for me?

Theme 2: General issues concerning sustainable construction and the BCA

- As a goal for BCA:
    - 'No' case:
        - BCA already has a core function
        - Cut across other legislations
        - 'Catch-up' - too little, too late
    - 'Yes' case:
        - ESD ought to be a long term goal
        - Some ESD aspects can be handled by the BCA
- Need specific, workable definition for sustainable construction within the context of the BCA involving:
    - Meeting the needs of today and the future
    - Minimise negative effects on environment caused by construction and operations of buildings
    - Affordable
- BCA must allow trade-off e.g., point system.
- Need additional guidelines to accommodate advances in ESD.
- Raise the bar gradually - do not set minimum levels too high - a step behind education.
- Connection with planning.
- Need to investigate all options:
    - Regulation
    - Eco-Labelling
    - Educational Guidelines
    - Tax incentives
    - Rating schemes
    - Actual well publicised examples
- Need to regulate the use of building materials.
- Need to investigate issues associated with reuse/recycling of materials in the BCA.
- Planning needs to take account of ESD at macro level.
- Need specific goals not vague theme e.g.,
    - Minimise greenhouse gases and other pollutants
    - Minimise operational energy and embodied energy
    - Reduce impacts of noise
    - Reduce use of natural resources - adaptability
    - Minimise impact on human health of indoor air quality
- BCA has not sufficiently addressed the energy efficiency situation. A separate manual should be provided to address the energy efficiency provisions.

Theme 3: Specific issues

Key: -
Level = National (N), States and Territories (S), Local (L)
Option = Regulation (R), Guideline (G), Industry (I)

Issue	What to do	Level	Option
Operating Energy	Need to assess efficiency. Investigate ways to conserve.	N	G
Embodied Energy	Not in BCA - too complex. Address product manufacturer - look at life cycle cost, environmental cost.		G
Renewable Energy	Not in BCA. Economic viability? Try to maximise its use.		
Waste reduction	Not in BCA. Smart design.		
Reuse/ Recycling	Yes - current standards too high. Look for ways to facilitate reuse.	N	R
Material Selection	Not in BCA. Provide more information on choice of materials.		
Deconstruct.	Not in BCA - except for short term buildings. Issues in relocation of existing whole buildings: non compliance with current regulation, risk to neighbour.		
Adaptability	Modularisation of dwellings – e.g., from 1 to 4 bedrooms as need arises. Do not understand the concept. Designer problem.		
Indoor Air	Already in - too high as is.		
Noise	Already in. Must be appropriate for the use.		
Water	User pays principle. Not in building regulation. Need to consider for all buildings.		
Urban Salinity	Planning issue.		
Eco labelling	Already done. Not in BCA.		
Climate Change	Not in BCA - relationship between climate change and building?		

NB: several participants had to leave before the discussion of theme 3, and therefore this summary is not necessarily representative of the views of all attendees.

C. Hobart

Location:
Workplace Standards Tasmania
Dept of Infrastructure, Energy and Resources
Conference Room
30 Gordon Hills Road, Rosny Park

Time:
13:30 - 17:00
Monday 2 December 2002

Chair:
Graeme Hunt - DIER

Presenters/Facilitators:
Lam Pham - CSIRO/ABCB
Mark Davis - ABCB

Participants:

NAME	ORGANISATION	CONTACT DETAILS
Alan Sims	Housing Industry Association	
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Liz Gillam	Local Government Association	
Margaret Steadman	Tasmanian Environment Centre Inc	
Michael Kerschbaum	Master Builders Association of Tasmania	
Phil Clark	Dept of Industry, Energy and Resources	
Stephen Ashton	Hobart City Council, DIPE	
Tony Rowell	Dept of Industry, Energy and Resources	Ph (03) 6233 2010 Tony.Rowell@dier.tas.gov.au
Zbiniew Bromberek	University of Tasmania	Ph (03) 6324 3502 Z.Bromberek@utas.edu.au

Summary of proceedings:

Graeme Hunt opened the meeting by thanking everybody for coming and introducing Lam Pham and Mark Davis.

Mark Davis gave two brief presentations on the Australian Building Codes Board (ABCB) and the Collaborative Research Centre on Construction Innovation (CRC-CI).

Lam Pham then presented a summary of the Stage 1 Report for the CRC-CI research project titled 'Sustainability and the BCA'.

General comments relating to the presentation:

- It was suggested that the term sustainable construction is too limiting. The Tasmanian Building Act (2000) was referred to as providing a more comprehensive scope for sustainability.

- It was also pointed out that ecological sustainability is also too limiting because the economic and social aspects of sustainability should also be considered.
- There was general support for the Brundtland's (Dutch) definition of sustainable construction.
- It was pointed out that if sustainability is incorporated into the BCA, and it is found to be detrimental to health, safety and amenity, then the code-writers may be liable.
- Participants questioned the accuracy of the construction and demolition waste figures published by CSIRO.
- It was pointed out that the BCA discourages the use of recycled materials, e.g., AS 1684 requires materials to be machine graded, which is difficult to carry out on recycled timber.
- It was pointed out that there is a need for applicants, developers, builders and building surveyors to be more educated on the use of Alternative Solutions.
- It was pointed out that decisions of a long term nature need to be made now if they are to be effective, e.g., decisions needs to be made now as to whether houses likely to be subject to flooding, as a result of global warming, need to be built higher.
- It was pointed out that it is quite feasible to include requirements covering topics such as flooding in the BCA.
- Participants indicated that they were encouraged that the issue of sustainability is being tackled by the ABCB and CRC-CI.

The participants divided themselves into two groups for discussion on the following three themes:

1. Key factors for the successful implementation of ecologically sustainable construction.
2. General issues and implications associated with regulating sustainability in the BCA.
3. What should be done for each specific issue?

The following comments were noted:

Theme 1: Key factors for the successful implementation of sustainable construction

- Be part of basic education i.e., ESD should be a mandatory subject in all construction industry courses.
- The benefits of sustainable construction need to be promoted. Governments, industry and academia have a role to play in this area.
- Requires political will.
- Governments to remove impediments e.g., taxes should be removed from recycled materials.
- Needs to be regulated.
- Needs to be part of Government procurement policies e.g., governments should only procure and lease buildings which embrace sustainability principles.

Theme 2: General issues and implications associated with regulating sustainability in the BCA

- A workable definition for sustainability is required.
- Regulations should be based on current standards / best practice.
- Sustainability should be one of the goals of the BCA.
- Sustainability should also be a theme of the BCA.
- Market failure is insufficient – must be policy driven (market failure can be used to justify implementation).
- RIS – made on sustainability grounds.
- Application of sustainability requirements to existing buildings may be via guidelines.
- Sustainable construction issues should remain in the BCA.
- Research must be done to determine appropriate methods of construction and use of materials.

- Rating scheme on sustainable materials i.e., need to get to 100 points.
- Life cycle rating.
- Holistic approach.
- Longer timeframe i.e., over building lifetime (say 50 years).
- AAA shower heads.
- Rain water retention.
- Grey water – treatment and reuse.

Theme 3: What should be done for each specific issue?

Key: -
Level = National (N), States and Territories (S), Local (L)
Option = Regulation (R), Guideline (G), Industry (I)

Issue	What to do	Level	Option
Operating Energy	BCA. BCA should promote passive design.	N N	R R, G
Embodied Energy	Research. Complex, how is it measured?	N L	 G
Renewable Energy	BCA. Incentives (for hot water). Complex.	N S N	R incent's
Waste reduction	Regulations and incentives. Modular designs, good practice.	S N	R, incent's I, G
Reuse/ Recycling	Research and facilitation. Should do nothing that prohibits.	N, S, L N	G G
Material Selection	Incorporated into holistic approach. Toxic gases – emission from fire.	N N	R, G R, G
Deconstruction	Research. Linked to reuse / recycling.	N	G, future R
Adaptability	Research. Nothing.	N	G, future R G
Indoor Air	BCA.	N	R
Noise	Research, BCA.	N	R
Water	BCA and PCA (incl wastewater).	N	R
Urban Salinity	BCA.	N	R
Eco labelling	Research.	N	G
Climate Change			

- It was also suggested that "radiation" should be included in this table as another specific issue.

D. Adelaide

Location:
Planning SA
Level 4, rooms 4/5
136 North Terrace, Adelaide

Time:
13:00 - 17:00
Wednesday 4 December 2002
Chair:
Don Freeman – Planning SA

Presenters/Facilitators:
Lam Pham - CSIRO/ABCB
Mark Davis - ABCB

Participants:

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Trevor Cooke	PCA	tcooke@sa.propertyoz.com.au

Summary of proceedings:

Don Freeman opened the meeting by thanking everybody for coming and introducing Lam Pham and Mark Davis.

Mark Davis gave two brief presentations on the Australian Building Codes Board (ABCB) and the Collaborative Research Centre on Construction Innovation (CRC-CI).
Lam Pham then presented a summary of the Stage 1 Report for the CRC-CI research project titled 'Sustainability and the BCA'.

General comments relating to the presentation:

- It was pointed out that protection of the environment is only one aspect of sustainability. The economic and social aspects must also be considered.
- Several arguments were raised as to why sustainability should not be regulated in the BCA:
  - It was questioned whether there has been a market failure to justify regulating sustainability in the BCA.
  - Given that we cannot predict the future, code-writers cannot make a valued judgement about what should be regulated for in the future.
  - It was pointed out that it has become more economic to send waste material to a recycling centre rather than the tip. Hence market forces are encouraging more sustainable practices in this instance.
  - It has not been demonstrated that regulating sustainability will achieve the desired objectives i.e., it is not yet known whether the new energy efficiency provisions will actually reduce greenhouse gas emissions.
- With clever regulations, economic savings to industry can be achieved.
- It is important to consider the source of the energy because this can affect the amount of carbon dioxide produced.
- We should be charged for carbon dioxide production rather than energy consumption.
- Regulatory changes should be made incrementally. With small steps we can get somewhere in the long term.
- There is a stronger case for regulating some areas of sustainability in the BCA than others e.g., water usage.
- The new energy efficiency provisions concentrate on heating and cooling energy. However, there are more significant gains to be made by regulating water heating and lighting.
- Research indicates that there is a relationship between indoor air quality and the efficiency / output of occupants. In addition this is an area that the BCA could regulate.
- It was suggested that there is a relationship between the cost of materials and their embodied energy (although it was also acknowledged that this is not always the case). On this basis it was suggested that there is no need to regulate for embodied energy because normal market forces will indirectly do so.
- It was pointed out that the taxation system needs to be changed because it currently provides concessions for maintenance, thereby encouraging the construction of cheaper, less durable buildings which require more maintenance. The taxation system needs to be changed to provide monetary incentives to produce sustainable buildings.

The participants divided themselves into two groups for discussion on the following three themes:

1. Key factors for the successful implementation of ecologically sustainable construction.
2. General issues and implications associated with regulating sustainability in the BCA.
3. What should be done for each specific issue?

The following comments were noted:

Theme 1: Key factors for the successful implementation of sustainable construction

Roles of key players:

- Government – leadership, legislators, funders, facilitators, coordinators.

- Industry – professionalism, best practice, commercial reality check, should be representative.
- Research / academia – innovation, developments.
- Occupants – feedback, community values.

Constraints:
- Governments – balancing interest groups, obtaining correct advice, financial constraints, time in government.
- Industry – financial, short term horizons, conservatism, lack of skills base.
- Research / academia – resources, lack of support.
- Occupants – rarely consulted / lack of being informed, lack of organisation, may not be able to operate.

Coordination:
- ABCB – maybe better representation.
- Better integration with Australian Standards.
- Up skilling with new knowledge.

Impediments:
- Communication.
- Understanding the question.
- Factional interests.
- Lack of awareness of ESD.
- Over-simplistic view of ESD.

Theme 2: General issues and implications associated with regulating sustainability in the BCA

- The BCA should have sustainability as a theme using life cycle costing as a basis.
- The underlying principle should be part of health and safety.
- Should be throughout the BCA.
- Specific areas should be made into goals.
- No limit to final extent, given sufficient knowledge.
- The scope of the BCA should be extended to be more effective in handling sustainability issues.
- The current guidelines are adequate for formulating sustainability regulatory requirements, but they need to be applied holistically.
- Labelling schemes and star schemes should also be used for dealing with sustainable construction issues.

Theme 3: What should be done for each specific issue?

Key: -
Level = National (N), States and Territories (S), Local (L)
Option = Regulation (R), Guideline (G), Industry (I)

Issue	What to do	Level	Option
Operating Energy	Minimum standards. Should be climate change related. New BCA should be developed to include emissions.	N, S	R
Embodied Energy	Guidelines, not mandatory. Government to request information on content and energy in products – create information and database.	N, S	G
Renewable Energy	Best practice guidelines. Target carbon dioxide intensities as benchmarks – maximum.	N, S	G

Waste reduction	Guidelines, other standards.	N (EPA)	G
Reuse/ Recycling	Minimum standard, safety required.	N	R, G
Material Selection	ESD indices.	I	I
Deconstruction	Guideline.	I	G
Adaptability	Guideline.	I	G
Indoor Air	New regulations, new standard.	N	R
Noise	Regulations required for land use.	S	R
Water	Minimum standard, guideline, best practice.	N, S	R
Urban Salinity			
Eco labelling			
Climate Change			

E. Melbourne

Location:
Building Commission
Level 27, Casselden Pl
2 Lonsdale St, Melbourne

Time:
13:00-17:30
Tuesday 11 February 2003

Chair:
Robert Enker – Building Commission

Presenters/Facilitators:
Lam Pham - CSIRO/ABCB
Rachel Hargreaves – BRANZ/ABCB

Participants:

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Victoria Hart	SKM	

Summary of proceedings:

Rob Enker opened the meeting by welcoming everyone and introduced Lam Pham and Rachel Hargreaves. Lam Pham gave two brief presentations on the ABCB and the CRC-CI. He then presented a summary of the Project, and introduced the format of the workshop group sessions.

General comments relating to the presentation:

- The plumbing industry perspective advocated exclusion of standards relating to water conservation from the BCA.

The participants divided themselves into three groups for discussion on the following three themes:

1. Key factors for successful implementation of sustainability in building construction.
2. General issues and implications associated with regulating sustainability in the BCA.
3. What should be done for each specific issue?

The following comments were noted:

Theme 1: Key factors for successful implementation of sustainability in building construction

Key factors:

- Be proactive rather than reactive.
- Performance based, with positive VALID outcomes.
- Certainty in the process (with recognised boundaries).
- Adequate resourcing.
- Skills/competency for all participants including consumers.
- Industry support / market provision.
- Cost effective solutions.
- Clear goals within other regulations that create synergies (and are consistent).
- Community education to enhance industry understanding.

Key issues:

- Sustainability must hurdle existing traditional planning building approval process.
- More training for industry and professions.
- Better assessment tools at the approval process.
- Lack of broadly accepted tools and performance measures.

Successful implementation:

- Aware of commercial reality (a full comprehensive understanding, not just in $$ terms).
- Operational aspects must compliment regulations – any measures put in must be operative.
- Sustainability product/service supply availability to meet demand.
- Enforceability and inspections.
- Education of design professionals to be able to use the tools proscribed.
- In terms of progress toward sustainable outcomes, there is a role for guidelines to prepare industry. Some outcomes can happen today.

General points:

- Multi-regulatory model advocated, taking into account the many regulatory players. The ABCB is a lynch pin in delivering this.
- Must take into account multiple ‘efficiency measures’, e.g. water, energy, gas. Co-ordination of all issues is necessary, but not in such a way as to intrude on other regulatory ‘turf’.
- May be a role for an overarching ‘ESD Commission’.

Theme 2: General issues and implications associated with regulating sustainability in the BCA

- One group thought that sustainability should be both a theme and a goal; the other 2 groups preferred sustainability just as a goal.
- The scope the BCA should be extended, with a sustainability aim in all measures. However, need to be aware of boundaries of other systems.
- Guidelines for regulation should include a 'sustainability filter' and a means of achieving innovation (e.g., targets and scores). One example of an ESD scorecard in practice is Port Phillip.
- Other methods could include financial incentives (e.g., rebates and subsidies), contracts, servicing authorities, and performance bonds.
- Need for a tool, one that is comprehensive and government and industry supported/lead.
- Staged introduction of elements.
- BCA should take on sustainability issues. Therefore, its role should be extended but not to the point of constricting the market.
- Current level of inspection not sufficient to support sustainability regulation. The builder should be liable (requiring change in legislation).
- Education and market incentives required.
- There are sustainability issues that can be regulated now, e.g., energy efficiency and water efficiency, and there are other issues which would be better suited to guidelines now (regulations later) such as stormwater, rainwater and site waste. Those issues that are measurable with established benchmarks fall into the 'regulation camp', those that are non-measurable, or measurable but with no established benchmark, fall into the 'guidelines camp'.
- In general, the framework for deciding is OK; the problem lies in how to measure environmental benefits and how to weigh these against other issues.
- Need more information on the environmental impacts of products (and third party certified).
- BCA to cover appliances.

Theme 3: What should be done for each specific issue?

Key: -
Level = National (N), States and Territories (S), Local (L)
Option = Regulation (R), Guideline (G), Industry (I)

Issue	What to do	Level	Option
Durability	R&D; difficult to measure.	All, S	G
Operating Energy	Further R&D; difference in building use and occupant densities.	N	R, G
Embodied Energy		N	G
C&D Waste	Infrastructure is needed to support this – local and state levels.	S	R
Adaptability		N	G
Climate change	R&D; not enough info to be able to recommend anything?		??
Indoor Air Quality	R&D; needs reconciliation between energy and other air quality issues.	N	R
Noise	R&D.	N	R
Water	Greater specification.	All	R, G
Urban Salinity	R&D.	N, S	G
Eco labelling		N	G
Benchmarking	Key issue.	N	G, R

General points

- All governance levels should be considered for every issue. All issues should be handled nationally.
- Where issues/measures are specific to certain regions in Australia, list in a schedule.
- Regulations have the biggest impact. Start with Guidelines, monitor industry progress, and if the market fails, regulate.
- Benchmarking is key – establishes what is poor/good practice. Also what is the contribution of each issue to sustainability as a whole? If a lot is known about an issue but it has a small impact, maybe a Guideline is sufficient.
- Indoor air quality needs a smarter approach – integrate with other issues.
- See eco-labelling and benchmarking as mechanisms to support above issues.
- Need better product information which links to the community, in turn to drive consumer demand.
- One idea is LCA performance sheets – like MSDS sheets.
- Another idea is centralised recycling facilities for builders.

F. Canberra

Location:
Dame Patties Menzies Building
16 Challis St, Dickson
Canberra, ACT

Time:
13:00-17:30
Monday 17 February 2003

Chair:
Stephen Johnson – Planning and Land Management
Presenters/Facilitators:
Peter Scuderi – CRC CI
Steve Hudson – ABCB
Lam Pham - CSIRO/ABCB
Rachel Hargreaves – BRANZ/ABCB

Participants:

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Stephen Johnson	PALM	stephen.johnson@act.gov.au
Steve Hudson	ABCB	Steve.Hudson@abcb.gov.au

Summary of proceedings:

Stephen Johnson opened the meeting by welcoming everyone and introduced Lam Pham and Rachel Hargreaves. He also introduced the two introductory speakers, Peter Scuderi and Steve Hudson. Peter gave a brief outline of the CRC CI; Steve for the ABCB. Lam Pham

presented a summary of the Project, and introduced the format of the workshop group sessions.

General comments relating to the presentation:

- None.

The participants divided themselves into three groups for discussion on the following three themes:

1. Key factors for successful implementation of sustainability in building construction.
2. General issues and implications associated with regulating sustainability in the BCA.
3. What should be done for each specific issue?

The following comments were noted:

Theme 1: Key factors for successful implementation of sustainability in building construction

General

- Requirements for sustainability should be in the BCA. For class 1 this could include energy use (operational and embodied), water use, salinity, soil fertility, and site issues.

Key factors

- Sustainability is an enormous issue; so need to keep it simple.
- Need a definition.
- Industry incentives are needed. These could be prioritised according to environmental impact, e.g., an industry wide system for recycling aluminium.
- Requires staged implementation. Those implementing the regulations need to have discretionary power to approve something which is not already conceived.
- Guidelines.
- Measurement indicators:
    - Min. acceptance to public
    - Training
    - Communication
    - Regulating implementation
- Must be cost effective.
- Ability to monitor is important.
- Rating systems – need to be able to measure the value of sustainability over time.
- Need mechanisms in place to deal with the spin offs, e.g., recycling.
- Any regulation must be easy to use – to compensate for inspector difficulties it must be easy to sign off at the end of the day.

Whose problem is it?

- Government.
- Industry.

(One view is that the sustainability is outside the scope of the BCA as it's too far-reaching, with many definitions. The other view is that the BCA should be the one to interpret sustainability for industry – in consultation with industry).

How?

- Incentives.
- Coercion:
    - regulations
    - education
    - marketing
    - true costings of resource inputs
    - pricing of public goods

- integration of government/local/national/global in relation to policy implementation

- Pursuing 'best practice' as a marketable commodity.

Constraints

- Costs (to industry, government, consumers).
- Recognising value (star ratings).
- Holistic integration (politics is a constraint in itself).

Means of implementation

- Staged (mix of measures that are complementary).

Theme 2: General issues and implications associated with regulating sustainability in the BCA

- Should be a theme first, and then move to a goal. Others thought it should be both at the same time. Whatever the introduction, it should be a flexible system to enable the introduction of further regs when the science allows.
- BCA should only extend to handle building construction related issues. Others thought the scope should be extended.
- Sustainability issues highlight a 'planning vs. building' conflict. Sustainability is perhaps better addressed at the planning stage.
- Current guidelines for regulation are considered adequate. Others considered the guidelines as inadequate (process issues office of regulatory review, and not effective in linking into BCA).

Other methods for dealing with sustainability

- Planning laws, education, incentives, disincentives.
- Eco-labelling.
- Industry best practice / marketing.
- Industry education and consumer training.
- Planning.
- Incentives (rebates, tax cuts).

Theme 3: What should be done for each specific issue?

Key: -
Level = National (N), States and Territories (S), Local (L)
Option = Regulation (R), Guideline (G), Industry (I)

Issue	What to do	Level	Option
Durability	Already in standards	N	G
Operating Energy	Already a national system	N	R, I
Embodied Energy		N	G
C&D Waste		N, S	R, I
Adaptability		N, S	G, I
Climate change	Complex	N, S	G
Indoor Air Quality	Large scope/contributing factors	N, S	G
Noise		N, S	G
Water		N, S	R, G
Urban Salinity		N, S	G, R
Eco labelling	Not BCA	N	R
Benchmarking		N	R

G. Brisbane

Location:
Level 18 Conference Room Mineral House
41 George St, Brisbane

Time:
12:00-16:45 - Tuesday 18 February 2003

Chair:
Ain Kuru – Building Codes Queensland

Presenters/Facilitators:
Lam Pham - CSIRO/ABCB
Rachel Hargreaves – BRANZ/ABCB

Participants:

NAME	ORGANISATION	CONTACT DETAILS
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Summary of proceedings:

Ain Kuru opened the meeting by welcoming everyone and introduced Lam Pham and Rachel Hargreaves. Introductions were made by the attendees around the table.

Lam Pham gave two brief presentations on the ABCB and the CRC-CI. He then presented a summary of the Project, and introduced the format of the workshop group sessions.

General comments relating to the presentation:

- Question relating to the name 'BCA21'. It was explained this name incorporates what we can do now, what we can do over the next few years, and long-term.
- The project includes the full range of buildings.

The participants divided themselves into three groups for discussion on the following three themes:

1. Key factors for successful implementation of sustainability in building construction.
2. General issues and implications associated with regulating sustainability in the BCA.
3. What should be done for each specific issue?

The following comments were noted:

Theme 1: Key factors for successful implementation of sustainability in building construction

Key factors

- Sufficient information/data (for public and politicians).
- Established benchmarks.
- An incremental approach.
- A balancing of economic issues with environmental issues.
- Meaningful data/guidelines for the masses.
- Information.
- A clear definition – with agreement by players (unlikely to get agreement though).
- Consumer education. The public are asking for alternatives / 'green' houses.
- Regulation to set minimum standards, e.g. water efficient devices.
- Consistency. States are allowed variations, but don't want too many of them.
- Cost is still a significant market force.
- Sustainability in the BCA needs to be on practical things.

Key players

- Realistic leadership from Govt.
- Industry (provide checks and balances, direction in common sense, and direction in terms of implementation).
- Academic (to establish benchmarks, technical support, and to identify innovation).
- Public.
- Media.

Constraints

- Financial.
- Political.
- Acceptance by all.
- Truth (don't need to convert – just provide the facts).
- Change in priorities (sustainability may fall out of favour – then what?).
- BCA becoming a very complex document.
- Reluctance by industry to change.
- Community demanding accessibility to the code and standards.

- ABCB under funded to properly inform.

What is sustainability?
- What are the facts.
- Agreed definitions.
- Agreed terms of reference (the perspective one is coming from).

Other points of interest
- Disclose sustainability rating at sale of home.
- Need the building industry to 'sell' green building product.
- Need minimum national standards for products (not necessarily a BCA issue). There are a range of regulatory mechanisms to change people's behaviour. Need to work with plumbers, designers etc.

Theme 2: General issues and implications associated with regulating sustainability in the BCA

Goal and/or theme
- Two groups thought that sustainability should be a goal of the BCA; one group thought it possibly could. Prefer goal over theme, to avoid dilution of intent.
- As a goal:
  - Need a specific statement for sustainability.
  - Needs to be informed by NSESD.
  - Need life cycle costing (continuos improvement process).
  - Expanded social considerations (lifestyle issues).
  - Performance measures.
  - Success factors (what does success 'look' like in this context).
  - RIS to include other issues (environmental impacts).
  - Consider other infrastructure linkages, e.g., transport.
  - Accreditation for performance claims.
  - Standards for accreditation of performance relativity (in competition with other products in the marketplace, and with in 'real life' situations).

Scope
- Scope could be expanded, but regulation should be last resort.
- BCA will influence land development, but will not directly influence land 'carve up'.

Current guidelines for regulation
- Current RIS process doesn't adequately canvass alternatives. Should be undertaken earlier in the process.
- RIS is most difficult (only done when change is significant; incremental change not likely to be picked up).

Other methods other than the BCA
- Financial incentives.
- Star ratings.
- Industry taking responsibility.
- Disclosure at sale.
- Labels/certificates.
- Community demands/market forces and education.
- Threat of regulation.

Theme 3: What should be done for each specific issue?

Key: -
Level = National (N), States and Territories (S), Local (L)
Option = Regulation (R), Guideline (G), Industry (I)

Issue	What to do	Level	Option
Durability	Incorporate into decision making re: life cycle costing. Establish performance measures. Define durability. Possible overlap with adaptability/flexibility. Lifecycle analysis.	N, S	G, I
Operating Energy	Commercial: air conditioning standards. Housing: energy codes (need 'good' data). What's included? Lighting, hot water, appliances.	N, S	R
Embodied Energy	LCA. Greater understanding of issues needed, plus means of measurement. Future issue.	N, S	G, I
C&D Waste	R & D issue. Industry participation. Not sure if BCA issue.	S, L	G, I
Adaptability	Philosophy. Design. Attitude. What is meant by adaptability? Guidelines already exist.	N, S, L	R, G
Climate Change	Acts. Planning. Future issue. Local planning solutions.	N, S, L	R
Indoor Air Quality	Acts/specifications. R&D in practical aspects. WPHS. Appropriate performance measures.	N, S	R, G, I
Noise	Performance measures. Standards.	N, S	R, G
Water	Performance measures. Standards. Tax. Re-use.	N, S, L	R, G
Urban Salinity	Performance measures. Standards.	N, S, L	R, G
Eco-Labelling	Clear measurable standards. Not a BCA issue.	N, S	R, G, I
Benchmarking	Performance Indicators. Performance measures.	N, S	R, G, I

Other

- Health (public). Performance measures. Performance indicators. Glare. Ventilation. N, S. R, G.

General points

- N, S, L means a partnerships, not either/or. Same with R, G or R, I (multifaceted approach).
- Many issues interface with planning schemes, and/or are already in BCA in some shape or form.
- Problem with the definition / scope of the issues identified.
- What about outdoor air quality – caused by the built environment, and other health issues.

H. Sydney

Location:
McKell Building
Level 7, Conference Room 1
2-24 Rawson Pl, Sydney

Time:
13:00-17:30 pm
Thursday 27 February 2003

Chair:
Stephen Durnford – Planning NSW

Presenters/Facilitators:
Tasman Twyman – ABCB
Dennis Lenard – CRC CI
David Eckstein – Planning NSW
Lam Pham - CSIRO/ABCB
Rachel Hargreaves – BRANZ/ABCB

Participants:

NAME	ORGANISATION	CONTACT DETAILS
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Sue Robinson	NSW Urban Taskforce	suerobinson@urbantaskforce.com.au
Trudy Green	Sydney Water	

Summary of proceedings:

Stephen Durnford opened the meeting by welcoming everyone by introducing the guest speakers (Tasman Twyman, Dennis Lenard, and David Eckstein). He also outlined the program for the afternoon and introduced Lam Pham, Rachel Hargreaves and Brian Ashe, representing the ABCB.

Tasman then gave an outline of the roles and functions of the ABCB, followed by Dennis with an outline of the Cooperative Research Centre for Construction Innovation. David presented an introduction to 'BASIX' – the Building Sustainability Index; a new web based building rating tool produced by Planning NSW.

Lam presented a summary of Stage 1 of the Project, and introduced the format of the workshop group sessions.

General comments relating to the presentation:

- None.

The participants divided themselves into three groups for discussion on the following three themes:

1. Key factors for successful implementation of sustainability in building construction.
2. General issues and implications associated with regulating sustainability in the BCA.
3. What should be done for each specific issue?

The following comments were noted:

Theme 1: Key factors for successful implementation of sustainability in building construction

Key factors

- National leadership is required. Baseline standards need to be established.
- Co-ordination of government agencies by national government (not necessarily the role of the BCA, but not necessarily precluded either).
- Education: needs to complement regulation; for the users of the built environment.
- Research: a lot of lack of understanding.
- National standards for products need to be developed (inc. imports).
- Standards: key component and allow investigation and development of manageable issues.
- PATIENCE & ENDURANCE

Key players

- National: role in providing consistent regulation, however, not all areas can be regulated easily, e.g., embodied energy and materials. Also have a role in setting benchmarks.
- Industry: role to play in training and innovation. Point made about support for the supply chain (industry need to time to catch up).
- Public sector to set benchmarks for procurement procedures.

General

- Audacious of the BCA to take on broader task of sustainability when less complex issue of energy was poorly implemented and followed through.
- Management is State; Implementation is Local.
- Absence of good nationally developed policy has led to councils attempting sustainability policies.
- Greater gains can be made upstream with planning and design, rather than downstream at the BCA level (still worthwhile to tackle sustainability at this level, but limited in scope). BCA is just one component or mechanism for implementing the wider sustainability agenda.
- Sustainability can't be 'band aided' – needs education and 'product champions' (who are unlikely to be from industry).

Theme 2: General issues and implications associated with regulating sustainability in the BCA

Goal or theme?

- Goal, yes – but BCA not the correct vehicle. Theme, yes – but only on practical/measurable criteria.
- Should be both a goal and a theme. Goal most important, theme more general. Theme can be implemented quickly, flows over all areas.
- Goal, yes in terms of materials, construction/installation, maintenance, air quality, water, property protection. No, in terms of planning. As a theme, cannot address sustainability.
- Planning and building complementarity (problems start when construction process begins – sustainability ideals get 'lost' along the way, gets 'too hard', or 'too expensive').

Scope

- BCA scope – questionable
- Yes, increase scope, but work also needs to be done on existing operations and maintenance, materials and waste.
- Scope increased, but only to the extent of the goals identified.
- Lifecycle analysis ties many of the issues together (e.g., reuse/adaptability, dismantable, longevity).

Current guidelines for regulation adequate?

- No: concern with RIS, and wrong criteria/questions.
- Market failure: building industry not taken up sustainability, market doesn't look far enough, pollution not costed. Need to assess using triple bottom line.
- RIS should be extended to include triple bottom line analysis.

Other methods

- Yes. All have their role: labelling (complex), guidelines (yes, but limited), sustainability ratings (use prestige).

Theme 3: What should be done for each specific issue?

Key: -
Level = National (N), States and Territories (S), Local (L)
Option = Regulation (R), Guideline (G), Industry (I)

Issue	What to do	Level	Option
Durability	BCA / AS Different levels. NZ model 5/15/45 yrs. Planning stage.	N N	R G R
Operating Energy	BCA / AS Energy Fittings. New buildings – LEED prescriptive. SEDA?	N	R
Embodied Energy	Building size: planning. Materials: AS Research and understanding. Ranking of importance; differences in measurement.	S N	R G
C&D Waste	Planning To inform. Outcome of others.	N/L	R R/G, I
Adaptability	Planning / BCA Planning.	N N/L	R G/R
Climate change	Planning. N/A. Community/state policy.	N	R, G
Indoor Air Quality	BCA / AS	N	R
Noise	BCA / AS	N	R
Water	BCA / Plumbing Consumption, source management. Also embodied water.	N	R
Urban Salinity	National Policy	N, L	R, G
Eco labelling	AS To support.	N	R
Benchmarking	AS Background to enable development, raise bar.	N	R

General points

- There is no one simple answer!
- Work on getting sustainability into existing scope. BCA should be reviewed in terms of how current clauses could be amended to advocate sustainability (and which ones currently hinder progress).
- Lifecycle analysis/approach means that many of the issues are interchangeable – need to know what each issue means.
- Problems with the definition/difference between a theme and a goal and the implications of each.

Appendix C.2: Pre-workshop Discussion Paper and Questionnaire

Sustainability and the Building Code of Australia
Workshop Discussion Paper & Questionnaire

Introduction

The Australian Building Codes Board (ABCB) and the CSIRO are participants in a project on sustainability through the Cooperative Research Centre for Construction Innovation (CRC-CI). The project, titled 'Sustainability and the Building Code of Australia (BCA)', is aimed at assisting the Board of the ABCB in determining the role of the BCA in ecologically sustainable development (ESD), particularly in the development of the Future Building Code (BCA21).

The project consists of two stages. Stage 1 is to produce a Report, based on a review of national and international literature on the current state of development of ESD principles and objectives within national, state or local building regulations. The draft of the Stage 1 report has been made available to all Workshop participants. Stage 2 is to hold a series of Workshops in all States and Territories to solicit opinions of major stakeholders on the issues and implications of sustainability, and if and how it should be regulated. The final recommendations are, of course, to be determined by the ABCB in consultation with the States and Territories.

This discussion paper is to assist with Stage 2 proceedings, by providing a summary of the relevant issues and tentative recommendations that will be discussed at the Workshop. The outcomes of the workshop discussion will be collated into another report for the ABCB.

Summary of Stage 1 Report

A survey of international and national activities on ecologically sustainable development has been carried out. The survey is a 'scoping' study and is neither comprehensive or in depth due to limitations on time and resources. The survey is limited to the building and construction area with specific reference to regulatory policy and implementation. The following observations have arisen from the results of the survey:

1. The current Building Code of Australia (BCA96) is neutral with regard to ecologically sustainable development (ESD). As a performance-based code, innovative sustainable solutions are always acceptable as alternative solutions. Some proposed provisions, such as energy efficiency are oriented toward ESD. On the other hand, it could also be argued that BCA96 does not facilitate ESD by not specifically addressing ESD issues such as reuse/recycling, design for disassembly, etc.

2. The case for inclusion of ESD in the BCA as a theme or goal, can be made on the following grounds:

- To facilitate the implementation of Commonwealth and State/Territory Government policy regarding the protection of the environment. This policy is enshrined in various regulations. Buildings and associated activities are by far having the most impact on the environment.
- To prevent fragmentation of building regulations, as Local and State/Territory Governments may introduce their own ESD regulations on issues where national consistency is desirable.
- To respond to community expectations on health and productivity of building occupants as well as to increasing community concerns on environmental issues.

3. The Council of Australian Governments (COAG) has set specific criteria for the introduction of regulation that must be observed. Essentially, it must be proven that there is a case of 'market failure'. Criteria for developing ESD provisions should be formulated. The impacts of any proposed provisions need to be assessed. Tools need to be developed to prove the case as well as facilitate the implementation of the provisions.

   Less stringent is the introduction of nationally endorsed but non-mandatory Guidelines. These can also serve as a preliminary step before the introduction of regulation.

4. Successful implementation of ESD requires actions from all three levels of government: national, state and local. Appropriate activities for each level of government need to be established to create a coherent national framework.

5. The BCA is just one of many tools available to all Governments for implementing ESD. Many major issues in ESD are well outside the scope of the current BCA. Whether the scope of the BCA needs to be extended so that it can manage ESD more effectively, is a question that needs to be considered. A key criterion might be whether national consistency is necessary or desirable for a particular ESD issue.

6. The attached summary of the current status and tentative recommendations is to be used as the starting point for the Workshop deliberations.

SUMMARY OF CURRENT STATUS AND TENTATIVE RECOMMENDATIONS

ISSUE/CURRENT STATUS	TENTATIVE RECOMMENDATIONS
National Policy Framework The National Strategy for Ecologically Sustainable Development (NSESD) that provides the policy framework has been agreed to by all Australian Governments.	• Adopt ESD as both a goal and a principle for developing the BCA. • Develop criteria for the adoption of sustainability measures in the BCA in accordance with COAG agreement. • Review ABCB Economic Evaluation Model to ensure the tool is effective in dealing with ESD issues in the Regulatory Impact Statement (RIS).
Definitions of ESD/Sustainable construction Many definitions of ESD from UN, Australian Governments, other national governments, ISO, CIB etc. Many definitions of 'Sustainable construction' but none officially from Australian Governments.	• Adopt an ESD definition. One option would be to adopt ESD definition from NSESD i.e. *'development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends'.* Another option could be '*development that maintains the ecological processes on which life depends, without deteriorating the total quality of life, both now and in the future.* • Develop a suitable workable definition of sustainable construction for the BCA.
Scope of the BCA The current scope of the BCA is limited to mainly the design and construction of buildings. Many issues in ESD are currently considered as outside the scope of the BCA.	• Develop selected ESD measures within current scope. • Develop argument for possible extension of BCA scope on selected areas, for more effective ESD implementation.
International Activities International collaboration on ESD is happening in a number of areas such as ISO, CIB and the development of rating tools.	• Participate in ISO activities to keep abreast with international development.

ISSUE/CURRENT STATUS	TENTATIVE RECOMMENDATIONS
Durability Durability is not dealt with directly in the BCA but indirectly through its referenced standards. It is treated as a means for fulfilling the primary requirements of health, safety and amenity and not specifically targeted at sustainability.	• A Guideline on Durability.
Embodied energy The BCA (and its referenced documents) does not address the issue of embodied energy at present. However, the selection of materials is considered to be within the scope of the current BCA.	• Some form of non-mandatory guidance for the selection of materials/components from ESD point of view could be developed.
Operating energy Currently two jurisdictions, the ACT and Victoria have energy efficiency measures in their BCA Appendices. New energy efficiency measures for Vol.2 (Housing Provisions) of the BCA have been developed and will be adopted in Tasmania, South Australia and Northern Territory on 1 January 2003. Western Australia, New South Wales and Queensland are further considering the adoption of the provisions. Measures for other buildings are being developed by the ABCB.	

ISSUE/CURRENT STATUS	TENTATIVE RECOMMENDATIONS
Renewable energy The BCA (and its referenced documents) does not address the issue of renewable energy at present.	
Waste reduction All State and Territory Governments have some form of legislation related to waste management. Most States impose a levy on landfill. Some States/Territories have set target dates for removing C & D waste from landfill altogether. The waste generated in the manufacturing phase and demolition phase is considered to be outside the scope of the BCA. Only the waste generated during the design and construction phase can be considered as being within the scope of the current BCA.	• A Guideline on the subject of reducing waste on construction sites would be useful to industry and is within the scope of the current BCA.
Reuse and recycling The BCA at present does not address the question of reuse of building materials and products. Implicit in some BCA referenced documents is the assumption that materials are new. The disassembly of buildings at the end of their life, for reuse of materials and products has not been a design consideration in current practice.	• The BCA can facilitate sustainability by addressing the issue of reuse of materials and products with respect to product performance and durability requirements. • Design for disassembly could be introduced as a Guideline.

ISSUE/CURRENT STATUS	TENTATIVE RECOMMENDATIONS
Adaptability The BCA (and its referenced documents) does not address the issue of adaptability at present.	• The issue is new and difficult to regulate. A Guideline on Adaptability is recommended.
Climate Change The BCA (and its referenced documents) does not address the issue of the effect climate change will have on buildings, at present.	• Although there is a lack of data, the NSESD precautionary principle requires some action to be taken. A more detailed investigation on the likely impacts is needed.
Indoor Air Quality (IAQ) IAQ is within the scope of the BCA. It's currently addressed through the ventilation requirements. There are no controls on volatile emissions from building materials.	• The case for increasing ventilation requirements or controlling volatile emissions of building materials, needs to be established.
Noise The BCA currently has provisions for controlling the noise within a building, (i.e. between apartments) but not from outside sources. A proposal to change the BCA sound insulation provisions was released in February 2002. The ABCB are continuing the development of the proposal.	• The case for regulation needs to be established.

ISSUE/CURRENT STATUS	TENTATIVE RECOMMENDATIONS
Water The BCA (and its referenced documents) does not address the issue of water. All plumbing issues are considered outside the scope of the current BCA.	• A case for inclusion of water efficiency in the BCA needs to be established.
Urban Salinity There have been a number of developments at Local and State/Territory levels to deal with the problem. The ABCB has developed a Discussion Paper on the subject. The Discussion Paper is due to be released shortly.	

QUESTIONNAIRE

PRE-WORKSHOP QUESTIONAIRRE

Purpose

Prior to attending the workshop, you are requested to complete the following questionnaire (use additional sheets if necessary). The questionnaire requires the workshop participants to provide information on whether sustainability should be an objective of the BCA.

All information contained in the questionnaire will be treated in confidence.

Name: ……
Position: ……
Organisation: ……
Telephone No.: ……..
E-mail: ……..

Question 1 - Does your organisation/sector use the BCA?

If yes, how important is it to your business?

Question 2 – What role do you believe the BCA should or can play in controlling and regulating sustainability in relation to the design and construction of buildings and the impact of those buildings on the built environment?

Question 3 - Should the BCA scope be extended to cover the following aspects of sustainability. If so, please indicate on the attached table.

Item	BCA should cover (Yes/No)	Comment
Operating Energy		
Embodied Energy		
Renewable Energy		
Waste Reduction		
Reuse/Recycling		
Material Use		
Deconstruction		
Adaptability		
Indoor Air Quality		
Noise		
Water		
Urban Salinity		
Rating Tools		
Standards		

Question 4 - For items not selected in Question 3, should consideration be given to dealing with sustainability through the method/s below, rather than the BCA? If so, please indicate on the attached table.

Item	Implementation level			Implementation options		
	National	State/ Territory	Local	Regulation	Guideline	Industry
Operating Energy						
Embodied Energy						
Renewable Energy						
Waste Reduction						
Reuse/Recycling						
Material Use						
Deconstruction						
Adaptability						
Indoor Air Quality						
Noise						
Water						
Urban Salinity						
Rating Tools						
Standards						

Question 5 - Do you agree with recommendations made in the Discussion Paper? Please indicate on the attached table.

Item	Yes/No	Comment
National Policy Framework		
Definitions of ESD/Sustainable Construction		
Scope of the BCA		
International Activities		
Durability		
Embodied Energy		
Operating Energy		
Renewable Energy		
Waste Reduction		
Reuse and Recycling		
Adaptability		
Climate Change		
Indoor Air Quality		
Noise		

Question 6 - Are you aware of any sustainability developments related to buildings (i.e. regulations, local laws, guidelines etc.) that have not been picked up in section 6 of the Stage 1 report? If so, please specify.

Appendix D: Database

Background

The database is not part of the original proposal for the project. It is offered here only as a means for facilitating the access to the documents referenced in this report. The database is on a CD-ROM and is self explanatory. The database has the potential to become a source of reference for sustainability literature, however considerable further work is required and is obviously not within the scope of this project. The database can be accessed by industry partners for searching at http://www.highett.cmit.csiro.au/biex/crc_envi/search.cfm.

Scope of Database

The database is intended to cover all three categories of documents outlined in Section 2 of the Stage 1 Report. Since the subject is vast and is still growing, it will be necessary to identify selected dimensions of sustainability and selected aspects of building construction for the literature search with due consideration for the limited life and available funding for the project.

The scope of the search is literature on sustainable construction published since 1992 (the year of the Rio Declaration – and Australian government's publication of its National Strategy for Ecologically Sustainable Development).

The types of document are classified as follows:
- Policy statement
- Existing regulation
- Proposed regulation
- Guideline/Code of Practice
- Best practice/Case study
- Research report
- Impact report
- Benchmark statistics
- Other report

(The focus is on Existing Regulation, Guideline/Code of Practice and Policy Statement)

The types of sustainability issues are classified as follows:
- Environmental
- Social
- Economic
- Triple bottom line
- General

(The focus is of course on Environmental)

The stages of the building life-cycle are classified as follows:
- Material
- Design
- Construction
- Operation
- Maintenance
- Demolition
- Disposal

The environmental issues in building construction are classified as follows:

- Waste: Generation, Reuse, Solid, Liquid, Hazardous, Minimisation, Recycling
- Water: Consumption, Quality, General
- Climate Change
- Air Quality: Indoor, Pollution, General
- Energy: Embodied, Operating, Life-cycle, General
- Noise
- Thermal Performance
- Biodiversity
- General

The regional origins of the documents are classified as follows:

- World
- Asia
- Europe
- Africa
- America
- Australia

It is obvious from the above that the scope of the database is much wider than what can be achieved in this Project.

Keywords for Database

DOCUMENT TYPE

- **Existing Regulation**: Prescribed rule for common and repeated use (concerning sustainability) in building construction that is currently in force.
- **Proposed Regulation**: Prescribed rule for common and repeated use (concerning sustainability) in building construction that has been proposed but not enacted.
- **Guideline/Code of Practice**: Non-mandatory document that provides, for common and repeated use, rules for activities aimed at the achievement of certain objectives (in this case - sustainability) in a given context.
- **Best practice/Case study**: Specific example of how certain objectives (in this case - sustainability) are achieved in a given context.
- **Research report**: Publication of work still under technical development or collection of data.
- **Impact report**: Report on the effects of activities or prescribed rules on environmental, social or economic sustainability (in building construction)
- **Policy statement**: Statement (by an authoritative body) on courses of action that could or should to be taken to improve the environmental performance of the building construction sector
- **Other report**: Report not fitted to any of the above categories
- **Benchmark statistics**: Statistics that can be used as benchmark to measure sustainability performance

SUSTAINABILITY KEYWORD

- **Environmental**: impact of a building in terms of the use of natural resources, pollution, and/or biodiversity from life-cycle point of view (adapted from ISO/AWI 21932)
- **Social**: impact of a building in terms of the well-being of the users eg. health, comfort and accessibility and other building performance attributes including cultural values (adapted from ISO/AWI 21932)
- **Economic**: impact of a building in terms of cost management and/or return from a whole life point of view (adapted from ISO/AWI 21932)

- **Triple bottom line**: impact of a building regarding environmental, social and economic aspects
- **General**

LIFE CYCLE KEYWORD

- **Materials**: substance that can be used to form products or construction works (ISO6707/1)
- **Design**
- **Construction**
- **Maintenance**: combination of all technical and associated administrative actions during the service life to retain a building or its parts in a state in which it can perform its required functions (ISO 15686)
- **Demolition**
- **Disposal**

ENVIRONMENTAL KEYWORD

- **Waste**: any material where the holder has an intention to discard as no longer part of the normal commercial cycle or chain of utility (EC Framework directive)
  - Generation
  - Reuse
  - Solid
  - Liquid
  - Hazardous
  - Minimisation
  - Recycling
- **Water**
  - Consumption
  - Quality
  - General
- **Climate Change**
- **Air Quality**
  - Indoor
  - Pollution
  - General
- **Energy**
  - Embodied
  - Operating
  - Lifecycle
  - General
- **Biodiversity**: the variability among living organisms from all sources including: terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems (ISO/TC59/SC3 - N4).
- **Noise**
- **Thermal Performance**

PERFORMANCE KEYWORD

- **Durability**: capacity of a building or its parts to perform its required function over a specified period of time under the influence of the agents anticipated in service (ISO 15686).
- **Service life**: period of time after installation during which a building or its parts meets or exceeds the performance requirements (ISO 15686).
- **Reliability**: ability of a building or its parts to fulfil the specified requirements for which it has been designed (ISO 2394)

- **Adaptability/Flexibility**: ability of a building to be changed or modified to make it suitable for a purpose not originally envisaged.
- **System performance**: performance of an element which has more than one attribute or performance of a system of more than one element

REGION OF ORIGIN

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