

# Ecocents Living

Affordable and Sustainable Housing for South Australia



**Final Report**

**December 2009**



**Government of South Australia**  
Department for Families  
and Communities

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Leadership at work.



University of  
South Australia

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# Ecocents Living

Affordable and Sustainable Housing for South Australia



*The Ecocents Living Research Project was undertaken by the University of South Australia in partnership with and on behalf of Housing SA, Department for Families and Communities and Hindmarsh.*



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- Associate Professor Jon Kellett, Head of Urban and Regional Planning, University of South Australia

The authors also wish to acknowledge the contributions to the project by 12 representatives from the development, planning and housing sectors at the discussion forum held in September 2009.

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## Limitations of this Research Project

- In this project, we have applied a triple-bottom-line approach to sustainability, and attempted, where possible, to give equal and balanced consideration to environmental, social and economic concerns. Thus we have not attempted to prioritise one component of sustainability over another.
- Sustainability and affordability are both complex issues at both conceptual and practical levels. As a result and due to the project's limited scope, the research has attempted to address many of the related issues, even if these have not been analysed in depth.
- The research has been guided by the need to facilitate affordable and sustainable housing in both public and private housing markets. Developing housing solutions for both markets may have limited the development of more comprehensive solutions.
- The assessment framework and index scores are very rudimentary and have been developed making a series of assumptions
  - Many of the indicators are complex and our assessment using three possible options (the  $\checkmark$ ,  $\Delta$  or  $x$ ) does not reflect the complexity of each of the measures
  - There are strong inter-relationships between many of the indicators
  - There are strong inter-relationships between economic, social and environmental sustainability which is not recognised in the 'silo' approach of triple-bottom-line sustainability
  - Many of the indicators have flow-on effects, whereby meeting one indicator has impacts on how well another indicator is met
  - The equal weighting of economic, social and environmental components may need consideration. Indeed, a stronger emphasis on affordable housing may result in a need for a stronger weighting economic sustainability.
- The possible models of affordable and sustainable housing derived from this research are intended to suggest conceptual aspects only and not physical design solutions.

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# Executive Summary and Recommendations

## Introduction

The Ecocents Living project is the result of collaboration between the Department for Families & Communities, Hindmarsh and the University of South Australia. The purpose of the research program was to identify a suite of built forms for housing that are both affordable and sustainable. The project arose out of the observation that affordability and sustainability are rarely considered in the same context despite the importance of both to housing policy makers and the construction industry.

More specifically, the research strategy was to triangulate data and information on affordable and sustainable building systems based on the best international and national knowledge and experience. The research methodology included:

- A review of literature and policy documents;
- Analysis and in some cases inspection of affordable and/or sustainable housing developments;
- Industry input by means of a discussion forum involving various participants with an interest in affordable and sustainable housing.

## Report Structure

**Chapter 1** provides the background to the report and summarises the report structure.

**Chapter 2** of the report provides a theoretical foundation for the report by summarising the comprehensive literature review undertaken to understand the concepts of affordability and sustainability, and how they relate.

**Chapter 3** builds on the conceptual research by specifically analysing key characteristics of affordable and sustainable housing, and in the process, develops an assessment framework.

**Chapter 4** summarises the analysis and in some cases reports on inspection of 9 local, national and international housing developments that exemplify current best practice in one or more criteria of affordable and sustainable housing. These developments are assessed against the framework developed in Chapter 3.

**Chapter 5** summarises the industry input into the project by addressing the feedback from industry representatives provided at the discussion forum held at the University of South Australia in October 2009.

**Chapter 6** links chapters 2-6 by suggesting three possible conceptual models for affordable and sustainable housing for South Australia

**Chapter 7** draws conclusions and suggests some future directions, in terms of delivering affordable and sustainable housing and future research options.

## Project Findings and Recommendations

The Ecocents research project has provided a preliminary investigation of the issues concerned with affordability and sustainability in housing at a time when both areas are highly relevant in the Australian context. The project has bridged these complex areas (affordability and sustainability) and provided a way forward to integrate the two in a logical manner. This has involved the consideration of both conceptual and practical matters.

The project has been based on an initial analysis of the concepts of affordability and sustainability in housing and it has been found that their objectives are similar in many ways and should be considered mutually supporting. Furthermore, sustainability must be considered in a context that recognises the inter-dependence between economic, social and environmental sustainability. Housing affordability is thus an intrinsic component of sustainability.

The conceptual analysis resulted in the identification of ten key characteristics which were the basis of subsequent research into indicators of affordable and sustainable housing. Indicators were developed which, whilst preliminary in nature, spanned the spectrum of sustainability and included environmental, social and economic components. At this stage, 24 sub-indicators have been nominated.

It has been found that those indicators dealing with environmental sustainability are reasonably well defined in the research literature as are the levels of performance required for each sub-indicator. This is not the case with the indicators dealing with economic and especially social sustainability. These indicators require further definition and the methods for measuring performance are in need of considerable research to render the indicators useful when assessing affordable and sustainable housing.

The derivation of preliminary indicators has raised the question of weightings of sub-indicators and subjectivity and complexity of assessment frameworks in general. This suggests that more research is needed in this area to determine a comprehensive and objective framework which provides a balanced assessment method of affordability and sustainability.

The main features of affordable and sustainable housing were also studied using nine existing developments with affordable and sustainable features selected from South Australia, interstate and overseas. This has enabled an initial testing of the assessment framework of indicators to take place and has highlighted different emphases on the three components of environmental, social and economic sustainability by the different developments. While our initial conclusions were based on an

equal weighting of the economic, environmental and social components of housing, there is a need to empirically establish an appropriate weighting of the various components. The exercise also illustrated a range of solutions to the challenge of developing affordable and sustainable housing according to location and urban density.

A further mechanism to canvass issues and test the validity of the assessment framework of indicators was provided by the Discussion Group comprising a broad spectrum of interested parties. This reinforced the initial findings of the research and identified further issues which require further investigation. In summary, the issues are:

- Durability, robustness and maintenance of dwellings.
- Governance issues including restrictions caused by the Building Code of Australia, financial procurement, planning policy and unionisation in the construction industry.
- Use of universal design principles to encourage adaptability.
- Social factors i.e. safety, quality of life, quality of place and health.
- Life cycle costs for households including transportation.
- Importance of private and public spaces as well as intermediate zones.
- Importance of community consultation.

Models for affordable and sustainable housing have been derived to summarise the concepts arising from the research. These are not intended as physical designs but are aimed at demonstrating possible conceptual solutions to affordable and sustainable housing corresponding to different location and urban densities. They reflect the ideas generated by the research project particularly in terms of achieving successful neighbourhoods.

The success of affordable and sustainable housing projects can be confirmed post- construction when performance, as defined by indicators, can actually be measured. This suggests that monitoring of the performance of new and existing developments by means of post occupancy analysis should be considered in further research.

## Recommendations

1. **Development and refinement of economic and social indicators. These are currently underdeveloped but are required to achieve a balanced approach to sustainability in housing developments.**
2. **Determination of weightings for sub-indicators so that relative importance can be assigned to the sustainability features of housing developments.**
3. **Maintain observation of new affordable and sustainable developments to ensure that the most recent knowledge is incorporated and to avoid duplicating research effort.**
4. **Include the suggestions of the Discussion Group in further research particularly with respect to:**
  - **governance issues eg Building Code of Australia, financial procurement and planning policy**
  - **universal design principles in both housing and neighbourhood environment to encourage adaptability and quality of place**
  - **life cycle approach to the performance of housing from a cost to household perspective.**
5. **Consider post occupancy analysis of new and existing affordable and sustainable housing projects as part of further research to test the validity of performance frameworks.**
6. **Incorporate all of these recommendations into a research project of national significance by means of an ARC Linkage grant with industry partners thus ensuring that the most recent research is channelled into new affordable and sustainable housing developments.**



# Chapter 1: Introduction

## 1.1 Background to the Ecocents Living Project

The Ecocents Living project is the result of collaboration between the Department for Families & Communities, Hindmarsh and the University of South Australia. The purpose of the research program was to identify a suite of built forms for housing that are both affordable and sustainable. The project arose out of the observation that affordability and sustainability are rarely considered in the same context despite the importance of both to housing policy makers and the construction industry.

Interest in environmentally sustainable housing has risen dramatically in recent years, as one response to the global goal of attaining sustainable development. Such a trend, in policy, regulation and practice, is founded on an assumption that reducing the environmental impact of housing will result in long-term benefits to the broader public. Sustainable housing discourse and practice is largely focused on the physical application of well-grounded principles in the design of homes and the methods and materials used in construction.

At the same time, contemporary housing policy debate in Australia has emphasised the social and economic sustainability implications of a growing challenge to housing affordability without addressing environmental objectives. At a very practical level, these two factors have resulted in a reluctance to consider housing sustainability in the same context as housing affordability, even though both are high-priority housing challenges. The Ecocents project has sought to bridge the parallel issues of affordability and sustainability in housing.

## 1.2 Research Strategy

More specifically, the research strategy was to triangulate data and information on affordable and sustainable building systems based on the best international and national knowledge and experience.

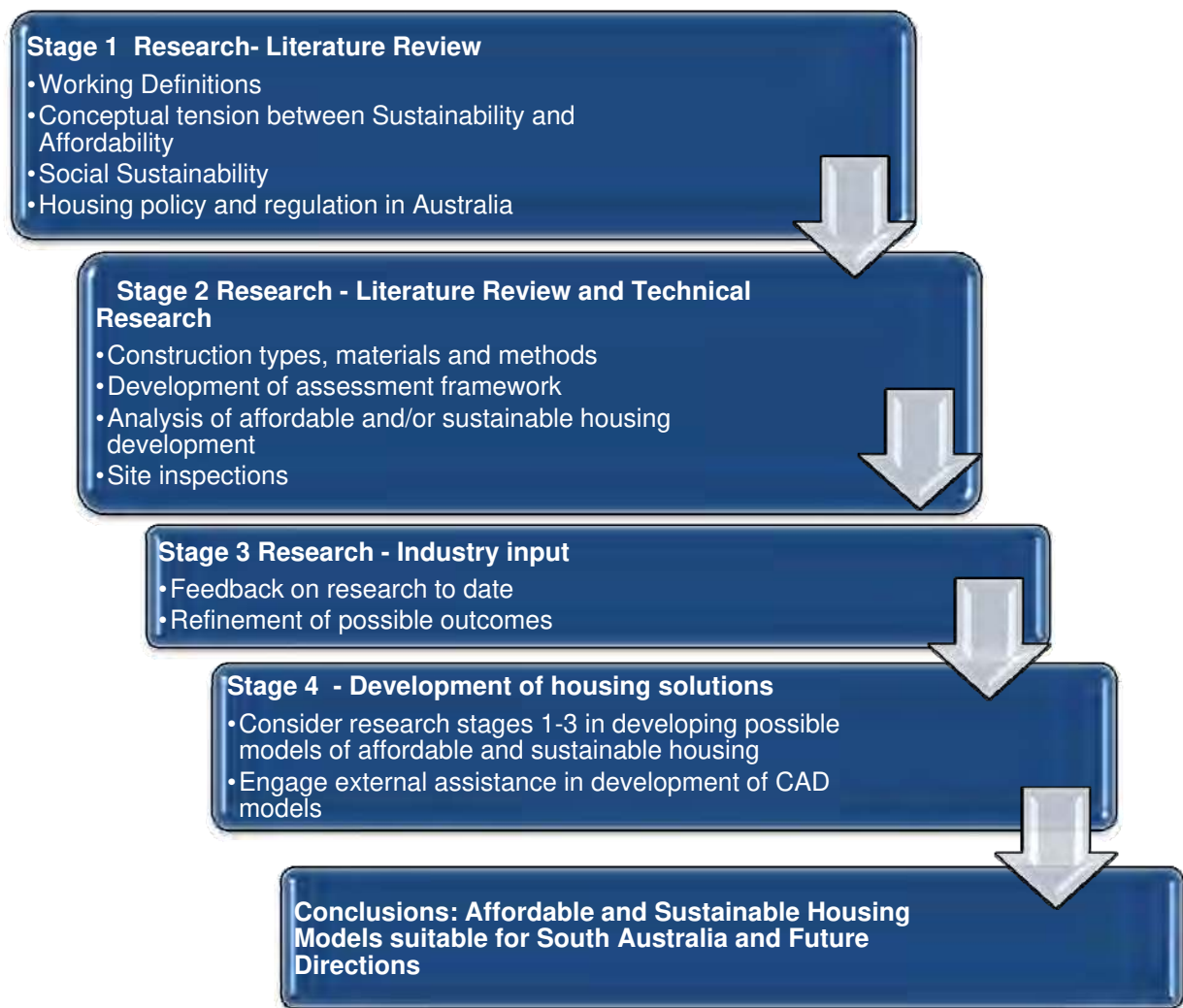
The research methodology included:

- A review of literature and policy documents;
- Analysis and in some cases inspection of affordable and/or sustainable housing developments;
- Industry input by means of a discussion forum involving various participants with an interest in affordable and sustainable housing.

The research was guided by a stakeholder advisory group and by the following principles:

1. Consider innovative as well as conventional housing solutions
2. Consider housing solutions that may have demonstration potential
3. Address housing solutions that are deliverable across a number of
  - a. Target groups;
  - b. Tenures;
  - c. Locations (considering solutions for inner, middle-ring and outer suburbs).
4. Consider possible planning and regulatory initiatives and necessary reform of these.

The research methodology is summarised in Figure 1:



**Figure 1: Research Methodology**

Although this was a comprehensive one year stand-alone project, it was from its inception always intended as a preliminary research program, with interim conclusions and identified knowledge gaps to be pursued more comprehensively in a future project subject to significant further funding. The project has resulted in the publication of four peer-reviewed academic papers while a paper and a book chapter are currently review. An Interim Report was presented to the Stakeholder Advisory Group in April 2009.

## 1.3 Report Structure

This report is structured as follows

**Chapter 1** is the introduction to the report and provides a background for the project as well as outlining the research methodology and the report structure.

**Chapter 2** provides a theoretical foundation for the report by summarising the comprehensive literature review undertaken to understand the concepts of affordability and sustainability, and how they relate.

Specifically, this chapter addresses

- Background and definitions;
- The state of housing affordability in Australia;
- Sustainability (as a concept and implications for the Ecocents project);
- Housing policy context;
- Guiding principles for subsequent research.

**Chapter 3** builds on the conceptual research by specifically analysing key characteristics of affordable and sustainable housing, and in the process, develops an assessment framework.

Specifically, this chapter addresses:

- Energy efficiency
- Water efficiency
- Construction materials
- Construction methods
- Biodiversity
- Affordability
- Desirability
- Density and Urban Form
- Dwelling size
- Adaptability
- Social Acceptability

**Chapter 4** summarises the analysis and in some cases reports on inspection of 9 local, national and international housing developments that exemplify current best practice in one or more criteria of affordable and sustainable housing.

Specifically, this chapter addresses the following developments:

- Inspire at Noarlunga (middle-ring suburb), South Australia;

- Lochiel Park at Campbelltown (middle-ring suburb), South Australia;
- Christie Walk, Adelaide (city centre development), South Australia;
- Mawson Lakes (middle-ring suburb), South Australia;
- Aldinga Arts Eco Village (outer suburb), South Australia;
- Landcom NSW designs (various city and suburban);
- K2 (inner suburb), Melbourne, Victoria;
- BedZED (inner suburb), London, UK;
- Oxley Park, (outer suburb), Milton Keynes, UK.

This chapter analyses each of the above developments in the assessment framework developed in chapter 3, and in the process, indicates which of these developments best reflect the identified affordability and sustainability criteria.

**Chapter 5** summarises the industry input into the project by addressing the feedback from industry representatives provided at the discussion forum held at the University of South Australia in October 2009.

Specifically, this chapter addresses

- Background to the discussion group;
- Key outcomes of the discussion group;
- Implication of the discussion group findings for the Ecocents Living project.

**Chapter 6** links chapters 2-5 by suggesting three models, or solutions for affordable and sustainable housing for South Australia. Specifically, this chapter addresses

- Background to the housing solutions;
- Option 1: Affordable and sustainable housing in an inner-city location;
- Option 2: Affordable and sustainable housing in a middle-ring suburb;
- Option 3: Affordable and sustainable housing on the urban fringe.

**Chapter 7** concludes and suggests future directions in terms of delivering affordable and sustainable housing and future research options.

## Chapter 2: Theoretical Foundations

This chapter sets the foundation for the project by summarising the conceptual research aimed at understanding the concepts of affordability and sustainability, and how they relate.

The chapter begins by situating the Ecocents Living project in the context of other research and industry projects and initiatives in terms of housing affordability and sustainability. Following this, a broader background is provided, as are definitions for key concepts and terms used throughout the report. The concept of affordability and, more specifically, housing affordability is then analysed. Sustainability is considered and placed in an appropriate context for the Ecocents Living project. The following section provides a useful perspective for affordable and sustainable housing in South Australia by summarising the current housing policy context. This is followed by a summary of how affordable and sustainable housing might be delivered through considering, at a conceptual level, issues associated with regulation and financial procurement. The final section summarises the theoretical foundation ideas by concluding with a series of guiding principles to link the parallel objectives of affordability and sustainability in later stages of the report.

## 2.1 Context

There are many existing research documents originating from both academic and industry environments that consider housing sustainability and affordability. While the findings of existing research permeate this chapter, and to a lesser extent, the entire report, this section of the report seeks to provide a necessary context for the project by providing a succinct summary of existing research projects and documents.

### 2.1.1 Lifetime Affordable Housing (2008-ongoing)

*RMIT University, UniSA, VicUrban, Victorian Building Commission and South Australian Land Management Corporation*

Lifetime Affordable Housing is a 3-year research program funded by the Australian Research Council in conjunction with industry partners VicUrban, the Building Commission of Victoria and the Land Management Corporation in South Australia. The project is in its second year and is looking at the integration of environmental sustainability and affordability at the dwelling scale. At the heart of the project is the analysis and quantification of the costs and environmental savings for different stages and types of housing provision throughout the housing life cycle.

Lifetime Affordable Housing has four key themes:

- Housing life cycle costs and benefits
- Locational efficiency costs and benefits
- Affordability
- Policy and transition mechanisms

The Ecocents Living research team has collaborated with researchers in this project and early in the research process, synergies between the projects, as well as points of difference, were identified. Specifically, the Lifetime Affordable Housing project has emphasised conventional design and the analysis has focused on necessary changes to conventional house design to facilitate better affordability and sustainability outcomes. In contrast, the Ecocents Living project has taken a much broader approach in developing housing solutions that are somewhat different from conventional housing in Australia. Additionally, the Lifetime Affordable Housing project has had a strong focus on energy use in dwellings in response to climate change, whereas the Ecocents Living project is seeking to address sustainability in a much broader context.

### 2.1.2 Affordability and Sustainability outcomes: a triple bottom line assessment of traditional development and master planned communities (2004)

This project was the first comprehensive project in Australia to consider affordability and sustainability in the same context. The project sought to apply a triple bottom line analysis of the sustainability of housing by comparing 'traditional' regulatory subdivision with a master planned community.

The project identified the economic, social and environmental components of sustainable housing and in the process, developed a set of indicators used to analyse six developments across Australia. In total, there were 37 equally weighted indicators which were categorised as follows:

- Housing affordability (n=12)
- Sense of community, neighbourhood safety, and satisfaction (n=8)
- Transportation (n=3)
- Environment – biodiversity (n=2)
- Environment – energy (n=6)
- Environment – resources consciousness (n=4)
- Environment – wastewater/stormwater control (n=2)

Like many Triple Bottom Line (TBL) analyses, the project found that it was difficult to keep the assessment framework manageable while still being comprehensive. There were also challenges associated with differing levels of sophistication between the indicators. A key conclusion of the project was that master planned communities rank higher than traditional subdivisions in terms of TBL sustainability. The project, like many others, highlighted that it is very difficult to develop a truly rigorous TBL assessment that gives sufficient consideration to economic, social and environmental criteria.

The project also arrived at some interesting conclusions about affordability and sustainability, some of which are addressed later in this report. They suggested that the most powerful way to improve affordability and environmental sustainability is to work towards increased densities and smaller housing.

In summary, the project provides a useful and comprehensive background to the assessment of affordability and sustainability outcomes. Although being dated and not reflecting recent research and outcomes, especially in terms of social sustainability and indicators, it nonetheless highlights issues to be explored in the Ecocents Living project.

### **2.1.3 Sustaining Fair Shares: the Australian housing system and intergenerational sustainability (2008)**



'Sustaining Fair Shares' was a comprehensive academic exercise which sought to consider the economic sustainability of Australia's housing system over the next forty years. The Commonwealth Government had conducted intergenerational reports that considered the fiscal implications of an ageing population and this report sought to write "the missing housing chapter".

The project worked the common Brundtland definition of sustainability into a useable statement for housing by suggesting that economically sustainable housing occurs where the current system of housing provision prevents any increase in housing stress – that is, in the proportion of households who are paying 30 per cent or more of their incomes on housing – with a focus on lower-income households. In terms of housing assistance, they suggested that sustainability is defined in terms of the "ability to maintain the current policy settings without any increase in demands on government expenditure, consistent with the definition of fiscal sustainability that means all obligations, current and future, can be met without changing current policy settings" (Yates et al. 2008).

The project resulted in some findings in terms of the anticipated demand for housing and the likely rise in housing stress. The project also addresses some likely demographic changes; the differential effects felt by the different housing tenures and derived some policy implications.

#### **2.1.4 EnviroDevelopment (ongoing)**

*Urban Development Institute of Australia*

EnviroDevelopment was released by the Urban Development Institute of Australia as a marketing branding for an evidence-based assessment system of the sustainability of housing. Assessment against the framework is voluntary but provides consumers with accurate knowledge to compare different developments. Although the measurement process is complex like other frameworks, the UDIA has gone to great lengths to ensure the system is user-friendly.

The standards have been developed through a collaboration between industry, government and other experts. The system has six categories which can be accredited in various developments. These include:

- Water
- Energy
- Ecosystems
- Community
- Materials
- Waste

While EnviroDevelopment has a strong emphasis on environmental sustainability and gives limited consideration to social and economic issues, it nonetheless currently represents best practice in terms of environmental sustainability assessment and provides useful metrics and indicators. The

project is commendable insomuch as it is evidence-based and comprehensive although appears to be aimed primarily at consumers and developers.

### **2.1.5 Sustainable Community Rating (ongoing)**

#### *VicUrban*

The sustainable community rating system has been developed to provide a common language about sustainability in the planning and delivery of development and communities.

The assessment tool has been applied in three main contexts:

- Master planned communities;
- Urban renewal communities;
- Provincial communities (outside metropolitan area).

The sustainable community rating systems is built around the following objectives, each of which has several priorities.

- Commercial success;
- Housing affordability;
- Urban design excellence;
- Community well-being;
- Environment.

As part of the assessment tools, for each core objective, there are several priorities (indicators), aspects (sub-indicators), performance measures (including some targets) and the actual rating scores.

VicUrban is also working with the Green Building Council of Australia and the development industry to establish a sustainable precinct tool based on the Sustainable Community Rating. To this end, a visioning workshop was held in June 2009 with a large group of leading built environment professionals and experts from around Australia. The group considered issues including key principles, current initiatives, a 'best-case-scenario' framework, whether it should be voluntary or regulatory and future directions.

## 2.2 Background and Definitions

It has become apparent that interest in environmentally sustainable housing has risen dramatically in recent years, as one response to the global goal of attaining sustainable development. Such a trend, in policy, regulation and practice, is founded on an assumption that reducing the environmental impact of housing will result in long-term benefits to the broader public. Sustainable housing discourse and practice is largely focused on the physical application of well-grounded principles in the design of homes and the methods and materials used in construction (Randolph et al, 2008).

Conversely, contemporary housing policy debate in Australia has emphasised the social and economic sustainability implications of a growing housing affordability challenge, without addressing environmental objectives. At a very practical level, these two factors have resulted in a reluctance to consider housing sustainability in the same context as housing affordability, even though both are high-priority housing challenges (Arman et al, 2009). It is the purpose of this section to conceptually consider housing affordability and sustainability, and how, if at all, they may be complementary objectives.

Working definitions are required to correctly frame the research. Many researchers have grappled to define the terms “sustainable development” and “affordable housing”. Conceptual definitions currently in use for these phenomena are generally vague and often acknowledged as such by these very same researchers in the field. The debate tends to be over whether this vagueness offers “creative tensions” (Kates et al., 2005) that might offer new ways forward or is simply an attempt to dodge the issue of differences between the values and interests of diverse stakeholders, which are considered to be too difficult to resolve (Davidson, 2005).

### 2.2.1 Defining ‘affordable’

Affordable housing is best described in a way that reflects common public usage and supports key policy objectives (Disney, 2007). The most common definition of affordable housing in Australia, that has been endorsed by the Housing, Local Government and Planning Minister’s Council and was the focus of the 2006 National Housing Affordability Summit, is housing that

- is reasonably adequate in standard and location for a lower or middle-income household; and
- does not cost so much that such a household is unlikely to be able to meet other basic living costs on a sustainable basis.

(National Summit on Housing Affordability 2006a).

This definition was first coined in the 1991 Commonwealth Government National Housing Strategy and has since been widely used and elaborated on (Berry et al. 2004). By being tenure neutral and establishing a clear but nonspecific link between household income and expenditure on suitable

housing, the definition maximises “public, political and business commitment and . . . encourage[s] innovation, flexibility and cooperation” (National Summit on Housing Affordability 2006b; Yates et al. 2007).

Although this qualitative definition can generate discussion, meaningful policy and action can only occur when what constitutes lower to middle income households and prohibitive housing costs are defined.

Lower and middle income households were defined as households within the lower 60% of all income ranges by the National Summit on Housing Affordability (2006b). In a similar vein, the South Australian Department of Families and Communities (2008a) defines “low to moderate incomes” as up to 120% of gross annual median incomes. The department suggests housing stress is experienced when such households spend more than 30% of their income on housing. For 2009-2010, it has been stipulated that in Adelaide, a house is affordable for a low income household if the purchase cost is less than \$170,000 or the rent does not exceed \$255 per week.

Housing Stress is most commonly defined using the ‘30/40 split’, whereby more than 30% of household income is spent on housing costs for the bottom 40% of household incomes. Although this figure is conservative, it is the most commonly used in literature (as in AMP.NATSEM 2008; Australian Government 2008a; Beer et al 2007; Berry et al. 2004; Disney 2007; Gurrán et al. 2008; Yates et al. 2007; Yates et al. 2008), and significantly, is used by the Australian Government.

The ‘30/40 Split’ is conservative in two ways; firstly, by only considering the bottom 40% of income categories, there is a tendency to underestimate the extent of the issue; secondly, it does not consider those households who spend less than 30% of their income on housing costs (and thus are not experiencing housing stress) but still experience hardship due to factors such as house size and quality, location, access to employment and proximity to family and social networks (Yates et al., 2007).

### **2.2.2 Defining ‘sustainable’**

The World Commission on the Environment and Development (WCED) was established in 1982 by the United Nations with the lofty goal of linking together the aspirations of humankind (Kates et al. 2005). The Commission’s report, *Our Common Future*, was published in 1987 and established a definition for sustainable development that has been described as “the standard definition when judged by its widespread use and frequency of citation” (ibid p.10). It described sustainable development as

*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs* (WCED 1987).

Sustainability and what the concept means for the Ecocents projects is discussed in depth in section 2.3.

Sustainable housing options are those which reflect the sentiment of the sustainable development discourse. Therefore, the WCED definition might be slightly modified to

*Development that meets the housing needs and demands of the present generation without compromising the ability of future generations to meet their needs and demands* (Chiu, 2004, p. 65; See also Priemus, 2005, p.6)

The key components of sustainable housing are discussed in depth in chapter 3.

### **2.2.3 Defining Affordable and Sustainable Housing**

Achieving agreement on what is considered to be sustainable is difficult as different stakeholder values and interests come into conflict (Kates et al., 2005). In this sense, definitions of sustainability such as that forwarded by the Brundtland commission are deliberately vague because of the impossibility of arriving at a consensus on what is socially, economically and environmentally sustainable (Davidson 2005a).

Definitions of affordable housing such as that offered by the 2006 National Housing Affordability Summit are similarly vague, perhaps for the same reason. What might be considered to be reasonably adequate in standard and location for a lower or middle-income household and does not cost so much that such a household is unlikely to be able to meet other basic living costs on a sustainable basis might vary considerably depending on location, relative income, individual needs and local area issues. In this sense affordable housing for working families in Sydney has quite different dimensions to that faced by similar families in smaller cities such as Adelaide.

A general definition of affordable and sustainable housing might only be possible in terms of setting out core principles, which are open to interpretation and adaptation to different social, economic, political and environmental contexts. Sparks (2007 p.8), for example, defines green affordable housing as housing that

“...is better designed and built, more durable, not significantly more expensive, cheaper to operate, healthier, more environmentally sound, and less risky”.

This typifies conceptual definitions as it considers the key objectives of affordability and sustainability but does not specify what, for example “better designed and built” actually means. The corpus of knowledge in this area suggests that a general definition of affordable and sustainable housing might refer to;

***Housing that meets the needs and demands of the present generation without compromising the ability of future generations to meet their housing needs and demands. Affordable and sustainable housing has strong and inter-related economic, social and environmental components.***

This definition might be offered as an aspirational aim for general policy on sustainable and affordable housing with more tightly defined definitional objectives related to location, relative income, individual needs, and local area issues. However, like the broad definitions of affordability and sustainability, it lacks the pragmatic clarity needed to facilitate meaningful change.

Although it may create tensions and conflict between various stakeholders, it is necessary to clearly specify what constitutes affordable and sustainable housing. Specified criteria can serve as a guide to further research, policy development and ultimately practical implementation, whether in a demonstration or large-scale capacity.

Explicitly describing what constitutes affordable and sustainable housing may prove unpopular with opposing interest groups who would prefer an unspecific definition which can easily be interpreted to meet predetermined goals. However, as Kates et al. (2005 p.20) point out, there is little point in having such terms and definitions if “anyone can reapply and redefine [them]... to fit their own purposes”.

It is acknowledged that a checklist of what constitutes affordable and sustainable housing may fail to consider all aspects of affordability and sustainability. This is because broad, all-encompassing concepts are narrowed into workable attributes. What a working model does do, however, is set clear parameters for affordable and sustainable housing to facilitate meaningful responses in government policy and the construction industry.

The following characteristics have been developed as a checklist of key characteristics to guide the research process. The first four characteristics seek to reflect literature regarding housing affordability; the fifth seeks to reflect economic sustainability; the sixth and seventh seek to reflect social sustainability while final three characteristic seek to reflect environmental sustainability.

#### **2.2.4 Working Checklist of Affordable and Sustainable Housing Characteristics**

1. A product where the rent or mortgage repayments do not exceed 30% of household incomes for the bottom 40% of income groups.
2. A product that is appropriately located in terms of accessing key services, transport and employment.
3. A product that is of a suitable size and quality for its occupants.

4. A product that does not increase the incidence of housing stress over the life cycle of the house.
5. A product where individual and government financial obligations can be met on an ongoing basis without policy change.
6. A product that is socially acceptable and desirable.
7. A product that does not increase social exclusion or polarisation.
8. A product that is located on a site that minimises biodiversity losses.
9. A product that is located on a site that maximises low-energy transportation options.
10. A product that encompasses the following environmental features
  - Energy efficiency;
  - Passive Solar Design;
  - Sun Shading;
  - Water Conservation
  - Appropriate Waste Management during construction, occupation and deconstruction.

## 2.3 Housing affordability

Affordability could be simply defined as the ability to pay. However, this definition is limited and does not take into consideration whether the consumption of the good or service would seriously compromise the consumer's ability to consume other goods and services.

Affordability, therefore, needs to relate to the price and consumption of a particular good or service, such as housing relative to disposable income. Incorporating disposable income ensures there is a mechanism, such as the percentage of income spent on the product, to determine if there will be enough income left to buy other essential goods and services (Davidson 2005b).

The variables associated with housing affordability and their related contributing factors include:

- Price: market competition; access to public housing.
- Usage: demographics; household needs; supply of suitable housing; and opportunity cost of consumption.
- Disposable income: Commonwealth support payments; government grants and/or concessions; support from welfare agencies.

(Davidson 2005b)

Affordability like sustainability is a complex concept involving the consideration of a number of variables. For example, household needs in relation to style of housing and location differ between a couple with children who might require more rooms, or a retired couple wishing to live near family and support networks. Satisfying household needs varies depending on the price of housing stock, which is in turn influenced by the availability and price of private rental accommodation or public housing, and market variables in the housing market. Usage and price of housing is also dependent on disposable income.

Housing affordability is a relatively recent policy concern for Australia. Since the Second World War, Australians have enjoyed high rates of home ownership and relatively low housing costs, facilitated by cheap and plentiful land for urban development (Beer et al., 2007). However, housing affordability is currently at an all time low with more than one million low and middle income households, in a variety of housing tenures, now experiencing housing stress (Australian Government, 2008a).

A recent international study comparing housing affordability in the developed world ranked no Australian urban area as 'affordable' and 25 of Australia's 28 urban areas as 'severely unaffordable' (Cox and Pavletich 2008 in AMP.NATSEM 2008). Although this level of affordability was also found in New Zealand and the United Kingdom, most developed countries had a much smaller proportion of 'severely unaffordable' urban areas. The United States, for example, had only 30 'severely unaffordable' areas out of 129 studied (ibid), as shown in Table 1.



Nation	Affordable	Moderately unaffordable	Seriously unaffordable	Severely unaffordable	Total
Australia	0	0	3	25	28
Canada	13	9	3	4	29
Ireland	0	1	4	1	6
New Zealand	0	0	0	7	7
United Kingdom	0	0	3	25	28
United States	46	30	23	30	129
Total	59	40	36	92	227

**Table 1: Affordability in urban regions in selected countries in 2007.**

Affordability was determined by using ratios of median house prices to median gross household incomes. The rating was as follows: affordable: median multiple 3.0 or less, moderately unaffordable: 3.1-4.0, seriously unaffordable 4.1-5.0, severely unaffordable 5.1 or higher. (Data source: Cox and Pavletich 2008 in AMP.NATSEM 2008 p.5)

Real house (that is inflation adjusted) prices in Australia have averaged an annual increase of 2.7% between 1960 and 2006, while over the same time period, real household incomes have risen a modest 1.9% per annum (Beer et al. 2007). Significant affordability problems have also emerged in the rental sector. Whereas traditionally renting was largely a short-term transitional tenure in Australia, there is an increasing trend toward long-term renting (Beer et al. 2007). Furthermore, in the decade to 2007, public rental opportunities dropped by more than 30% and the proportion of low-rent homes fell by at least 15% (Disney 2007).

The challenges of declining housing affordability are not expected to be addressed quickly. Strikingly, in considering the relationship between housing affordability and intergenerational sustainability, Yates et al. (2008) suggest that there will be no net improvement in housing affordability in the next four decades to 2045. With continued population and household formation growth, in coming decades the number of households experiencing household stress will increase by 77%, or 18,500 households per year. This impact is expected to be particularly felt by private rental households, with the proportion experiencing housing stress forecast to increase by 120%, or 12,000 households annually (Yates et al. 2008).

In commenting on the impact of the global financial crisis and the recessionary impacts on Australia, Braddik et al. (2009) note that while dropping interest rates may improve housing affordability, a larger problem remains in maintaining affordability in the light of a nation-wide undersupply of housing. The shortfall between housing supply and demand appears to be widening, with a industry property market report estimating that Australia will have a shortage of 250,000 dwellings by the middle of

2010 (ibid). This is alarming considering that dwelling approvals have dropped considerably, as shown in Figure 2 below, with, for example, new dwelling approvals dropping by 2.0% in February 2009 (ABS 2009a).

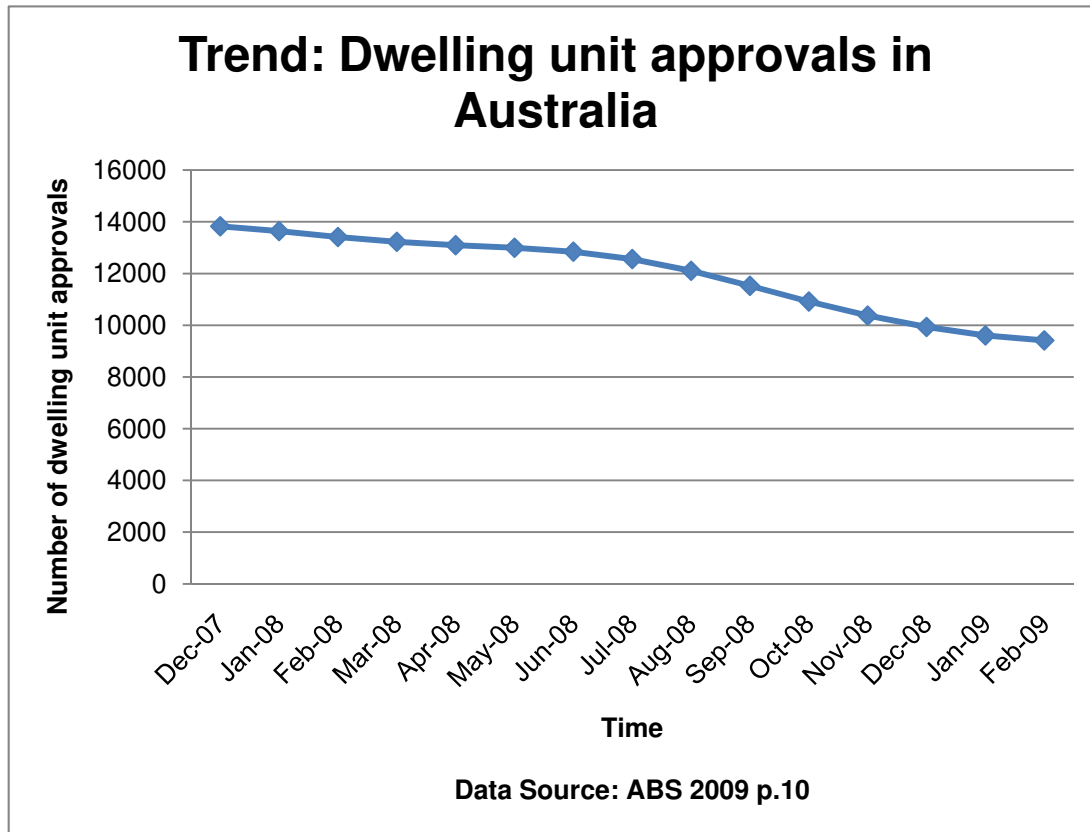


Figure 2: Trend in the number of dwelling units approved per month in Australia between December 2007 and February 2009, exacerbating the shortfall of dwellings in Australia

Low levels of housing affordability cause financial stress on households. This results in meals being skipped, children missing school activities and limited mobility (Yates et al 2007). Limited low-income rental and home purchase opportunities exacerbate existing socio-spatial inequalities (Gurran et al., 2008) and failure to improve housing affordability will have broader repercussions for Australia, impacting on long-term economic development and competitiveness, urban development, fertility rates, family cohesion, retirement security and intergenerational equity (Disney 2007).

Improving Housing Affordability is one of the most pressing challenges for modern Australia. As discussed in section 2.5, a variety of policy mechanisms are currently being developed at all levels of government to facilitate affordable housing outcomes.

## 2.4 Sustainability in the context of the project

### 2.4.1 Triple bottom line sustainability

Sustainable development, being development that “meets the needs of the present generation without compromising the ability of future generations to meet their own needs” (WCED 1987) established the concept of intergenerational equity. The subsequent text in the Bruntland report then addressed development and the environment. It was suggested that economic growth is required to sustain basic human needs and that there are finite limits to environmental resources (Kates et al., 2005). The definition, thus, seeks to somehow facilitate improvement without jeopardising what already exists (Brandon and Lombardi 2005).

**...economic growth is required to sustain basic human needs and...there are finite limits to environmental resources.**

In contrast to the earlier polarisation of economic and environmental interests, the WCED sought to reconcile conflicting interests. By linking the words *sustainable* and *development*, it is possible to be “rich and green” (Jacobs 1991 in Davidson 2005a). However, linking environmental quality with development necessarily relegates the environment to a passive role, with, for example, the use of economic language in referring to the environment, with terms such as natural *resources* (Davidson 2005a).

Sustainable development is remarkably ambiguous in terms of what actions it seeks to induce. There are major implications of specifying what is to be sustained and what is to be developed. At one end, conservation-at-all-cost is proposed whereby consumption is limited through reduced economic growth. At the other end, it is thought that sustainable development will involve a technical fix as market prices for non-renewable resources increase, providing the impetus for the development of sensible alternatives (Brandon and Lombardi 2005). At the very core, there exists a tension between a few core principles and openness to reinterpretation and adaptation (Kates et al 2005).

The 2002 World Summit on Sustainable Development further delineated the concept, suggesting that it applies to the three mutually reinforcing pillars of economic, social and environmental development (Kates et al., 2005), where equal consideration is given to “profit, people and planet” (Priemus 2005 p.5) (Figure 3 below). The use of such criteria is known as the triple-bottom-line (TBL).

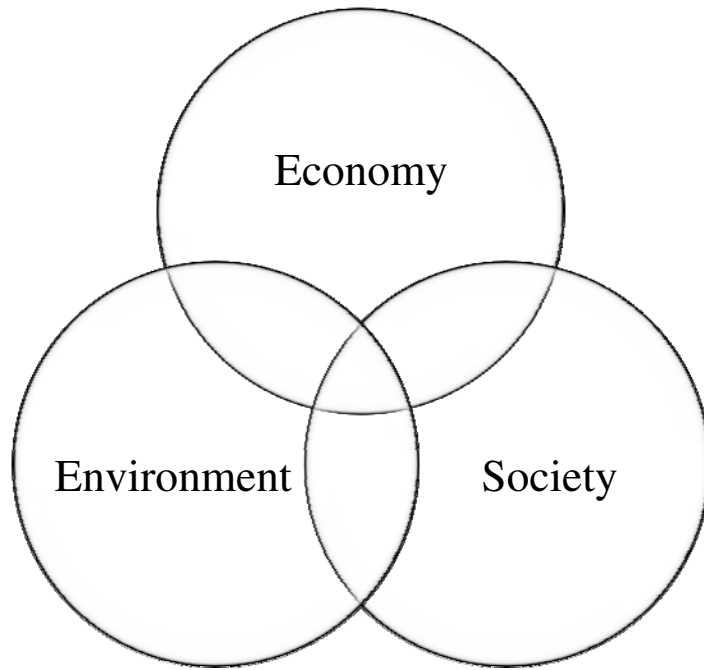


Figure 3: The mutual-reinforcement model of triple-bottom-line sustainability. Adapted from Priemus 2005)

The TBL is sometimes portrayed in a hierarchical model, as in Figure 4 below, whereby economic development is restricted by social constraints, which are limited by ecological capacity (McManus, 2005).

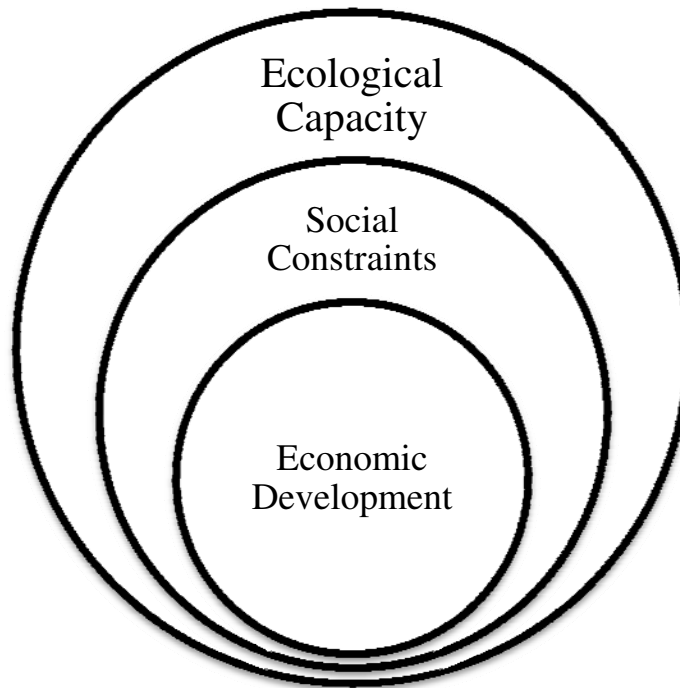


Figure 4: The hierarchical model of triple-bottom-line sustainability. Adapted from McManus 2005

If the Brundtland definition of sustainable development focused on reconciling development and the environment, the TBL approach separates development into social and economic factors, recognising that gains do not necessarily reflect human well-being (Pope et al, 2004). For example, as Yates et al (2008) point out, “environmental considerations can involve economic costs that fall unevenly on

**“...environmental considerations can involve economic costs that fall unevenly on social groups and translate into substantial social costs and accentuate inequalities”**  
**(Yates et al., 2008)**

social groups and translate into substantial social costs and accentuate inequalities”. Applying the TBL clearly adds complexity to decision making.

The TBL is justified on two grounds – firstly and most commonly, social and economic components of society are perceived to have a value that is comparable to environmental resources, which must be preserved for the benefit of future generations (Littig and Griessler, 2005). Thus, the mutual-reinforcement model attempts to correct interpretations of sustainability that exclusively suggest

conserving the environment is humanity’s primary concern.

The other related justification suggests that environmental, social and economic systems must all “remain stable in the long term so as not to jeopardise the achievements of civilisation” (ibid). That is, the equal weighting in the mutual-reinforcement model ensures that enhancing one component of society, such as the environment, will not inhibit the functioning of another system which equally requires long-term stability.

The TBL was initially used in accounting for an organisation or company’s financial, social and environmental performance, whereby a single measurement would consider all factors that are value-adding, including those which are non-economic (Low et al., 2005). However, it has been applied more generally as an explanation of sustainability and the term has become interchangeable with the word ‘sustainability’ itself (Blair et al, 2004).

There are a series of both tensions and convergence of objectives encountered when considering each component of TBL sustainability in the context of affordable housing.

#### **2.4.2 Economic sustainability and affordable housing**

Development is economically sustainable “if it does not decrease the capacity to provide non-declining per capita utility for infinity” (Neumayer 2003), whereby human utility, well-being or welfare is provided by the various forms of capital, including natural, social, built and financial capital (ibid). Sustainability exists when the *capacity* to provide utility, rather than the utility itself, is maintained. This means that while it is prudent to maintain some levels of capital, the greater need is to maintain the ability to generate capital.

The Australian Government Treasury considers economic sustainability in the Intergenerational Reports. In that context, fiscal sustainability exists when “present generations do not impose budgetary burdens on future generations, thus requiring them to bear higher tax burdens than the current generation” (Yates et al, 2008).

This can be then be applied, as in Yates et al (2008), to analyses of the sustainability of housing. Housing is economically sustainable when future generations can afford the same housing standards as current and past generations. This can be measured by monitoring the incidence of housing stress as sustainability exists when it does not increase. In terms of financial housing assistance mechanisms, it is suggested that sustainability exists when “all obligations, current and future, can be met without changing current policy settings” (ibid).

***Housing is economically sustainable when future generations can afford the same housing standards as current and past generations.***

Although the actual values used in definitions vary between jurisdictions and organisations, the defining parameter of affordability is an economic one, whereby affordable housing exists when the housing costs are within a certain threshold. For example, the commonly used 30/40 split can also be used to define affordability. **Since economic sustainability means that current and future financial obligations are met without policy change, the emphasis in housing affordability literature on maintaining a certain level of housing costs represents, possibly unintentionally, economic sustainability.**

### 2.4.3 Social sustainability and affordable housing

Social sustainability is not as well understood as economic and environmental sustainability because the social components of “society” are less tangible and measurable than the environment or economy. Chiu (2004) argues that social sustainability is regularly interpreted from three perspectives; the development-oriented interpretation emphasises social acceptability, in noting that development is socially sustainable when it keeps to social relations, customs, structures and values. The environment-oriented perspective suggests that development is sustainable when it meets social conditions, norms and preferences required for people to support ecologically sustainable actions regarding resource distribution and intergenerational equality. Finally, the people-oriented interpretation of social sustainability emphasises maintaining levels of social cohesion in society and preventing social polarisation and exclusion.

***...any affordable housing model must be socially acceptable to be economically viable.***

Social acceptability has an important role in affordable housing. Because consumers will only purchase or rent homes considered acceptable, any affordable housing model must be socially acceptable to be economically viable. This is illustrated in how the public houses in Australia that have been sold to the private market are those

which are deemed to be of a higher quality and amenity (Arthurson, 2008) and thus more socially acceptable.

Further, the emphasis on reducing inequality and social exclusion would suggest that historical Australian models of affordable housing are socially unsustainable. The concentration of public rental properties in estates has resulted in the concentration of socio-economic disadvantage and stigma (Palmer et al, 2004).

McKenzie (2004) has developed a set of indicators of social sustainability. Interestingly, in suggesting that equality in accessing key services is an indicator of social sustainability, housing is included as an example of one such service. Since government initiatives (such as Department for Families and Communities, 2008a; Australian Government, 2008a) are seeking to create opportunities for affordable housing, social sustainability is being fostered.

Affordable housing seeks to provide a product that is affordable and appropriate in terms of size, quality and location (Yates et al, 2007). It is underwritten by concerns for equality, in that the cost of housing should not result in further disadvantage. Practical approaches to improve affordability (such as Australian Government, 2008a; Department for Families and Communities, 2008a) seek to improve housing affordability in all sectors, not exclusively, for example, in the provision of public housing or the release of land on the urban fringe.

**Thus, affordable housing already addresses the social sustainability objectives of promoting equality by facilitating affordable housing options in a variety of locations, tenures and contexts.**

#### **2.4.4 Environmental sustainability and affordable housing**

The term environmentally appropriate has many interpretations, depending on whether the environment is perceived to have intrinsic value, or value only because of its use to humans (Payne and Raiborn, 2001). It has been suggested that environmental sustainability depends on preserving a series of inter-related dynamic equilibriums:

1. Between human populations living at higher consumption levels and the ability of nature to provide resources and services
2. Between human populations and pathogenic microorganisms
3. Between human populations and those of other plant and animal species
4. Among human populations

(Pirages, 2005).

Human activities and behaviours are regularly altering these equilibriums, with for example, increases in human populations degrading the resources and services provided by natural capital. Considering such equilibriums demonstrates that the debate over sustainability should consider inherent tensions, which alter the equilibriums, a notion argued by Davidson (2005a). Indeed Davidson (2005a) argued that sustainability should not be thought of as an end goal but as a dynamic process.

Housing is one of the more neglected aspects of sustainability despite its potential to make a positive contribution (Winston and Eastaway, 2007). They go on to suggest that the environmental impacts of housing depend on

- Land and associated impact on wildlife, landscape and amenity
- Access to public transport
- Previous land uses
- Density and associated access to services
- Construction materials as some hardwoods are unsustainably sourced from tropical forests
- CFC's which are embodied in some air conditioning, refrigeration and insulation
- Energy consumption
- Water consumption
- Waste generation

(Winston and Eastaway, 2007)

***Housing is one of the most neglected aspects of sustainability, despite its potential to make a substantial contribution.***

Although affordable housing discourse reflects the objectives of economic and social sustainability, the relationship between environmental sustainability and housing affordability is limited. Although regulatory changes are ensuring gradual improvements in the environmental performance of all housing, sustainable housing has not been widely developed in Australia. This is perhaps due to the perceived additional costs and lower levels of social acceptability (Buys et al, 2005). This is particularly the case at the lower end of the housing market, where despite many demonstration projects highlighting the benefits of even basic environmental features, the take-up of such features is low, perhaps owing to deeper structural and cultural factors (Sibley et al, 2003). Consumer preferences, especially in outer suburban estates, seem to have contributed to the "prioritisation of factors such as size, comfort and affordability over sustainability outcomes" (ibid, p.4). Thus, there appears to be a widening gap between show case, architecturally designed environmental housing

***...there appears to be a widening gap between showcase, architecturally designed environmental housing and the mass housing of the everyday population...***

and the mass housing of the everyday population.

Paradoxically, the need for environmentally sustainable housing is greatest in the affordable housing sector. This is because improvements to the environmental performance of housing, such as energy efficiency, provide particular economic benefits to lower-income households.

Such households spend a greater proportion of their income on utilities and are least likely to be in a position to afford energy efficiency improvements without assistance (Winston and



Eastaway, 2007). Likewise, locating housing in convenient locations near employment has a similar effect (Global Green USA, 2007).

**The application of economic, social and environmental sustainability to the affordable housing debate has demonstrated that popular affordable housing discourse is encouraging, possibly unintentionally, aspects of economic and social sustainability but not environmental sustainability.**

#### **2.4.5 Practical change ‘in the name of sustainable development’**

The Bruntland definition of sustainable development is well understood and evokes thoughts about intergenerational equality that few can disagree with. It is a moral imperative to leave the environment at least in the same position, if not a better position for future generations (Brandon and Lombardi, 2005).

However, when organisations, businesses and politicians attempt to make any changes on the ground in the name of sustainability, criticism often results, as actions are perceived to be doing too little or too much. Further, ambiguity exists in interpreting what the concept means for policy and action, particularly when the scale shifts from a global goal to local change.

It is in this context that the debate intensifies because proponents of ‘weak sustainability’ suggest that because different forms of capital can be substituted, sustainability exists so long as the benefits exceed the net costs (Figge and Hahn 2004). In contrast, ‘strong sustainability’ postulates that natural and man-made capital are complimentary and both must be maintained (Brand, 2009). There are critical forms of natural capital that cannot be lost by substitution, reflected in measures such as safe minimum standards. Ambiguity exists in determining when natural capital becomes critical but it may be related to the degree of ecological resilience (ibid).

For any given issue, there is not a single and all encompassing response that represents sustainability. To the contrary, there are a variety of potentially sustainable responses, each of which has positive and negative economic, social and environmental ramifications. Sustainability is thus more of a process than an end goal (Baker, 2006) and involves achieving a balance between conflicting needs and aspirations (Brandon and Lombardi, 2005). However, before any tensions in the process of developing sustainable policies and actions can be debated, there are a series of obstacles to overcome.

***...there are a variety of potentially sustainable responses, each of which has positive and negative economic, social and environmental ramifications.***

There are a multitude of conceptual or pragmatic challenges which inhibit real-world application of sustainability, and these are well discussed in the literature (such as Arman et al, 2009). Conceptual challenges consider why sustainability should occur, while pragmatic challenges consider how it might happen. These are summarised in Table 2 below:

<b>Challenge</b>	<b>Questions raised</b>	<b>Housing implication</b>
<b>Separating needs from wants</b>	Sustainable development means that development should meet the <i>needs</i> of the present generation without inhibiting the ability of future generations to meet their needs. However, what actually constitutes a need to be met by development? How can <i>needs</i> to be met by development be subjectively determined?	Affordable housing, as defined in the literature, is housing that is <i>affordable</i> and <i>appropriate</i> in terms of size and location and accordingly should be considered a need and not a want. However, housing outcomes today should not limit the capacity of future generations to meet their housing needs.
<b>Sustainability and consumption</b>	Are the concepts of growth and consumption incompatible with sustainability?	Housing contributes to overconsumption in Australia, due to structural factors and “luxury fever”. However, access to housing of some form is a basic human need.
<b>Concern for the future</b>	Although actions today may have an irreversible impact on the livelihoods of future generations, why cannot the welfare of future generations be left to their own care? How can sustainability ‘sacrifices’ be perpetuated indefinitely?	Existing and historical housing outcomes already reflect a concern for the future. Further, sustainability decisions to assist future generations will have immediate benefits to the present generation.
<b>Unnecessary poverty</b>	In the interests of sustainability, are we unnecessarily locking ourselves and future generations into eternal poverty?	Our role in terms of sustainable housing is not to determine future outcomes, but provide the capacity for the future to meet their own needs.
<b>Meeting multiple targets</b>	Is it really possible to “have it all” in simultaneously promoting economic growth and environmental protection?	Such questions need further debate in the context of affordable and sustainable housing – affordable <i>and</i> sustainable housing has a difficult mandate.
<b>Global inequality</b>	Will sustainability ever be achievable when extreme poverty remains? Is sustainable development a luxury of the rich as poorer people are more interested in eating than environmental quality?	Research needs to quantify whether sustainable housing is a luxury for the rich in an Australian context.
<b>A competitive market</b>	Do high levels of competition prevent innovative sustainable solutions from being developed?	Australia’s highly competitive ‘cottage home building’ industry may provide little incentive to try new ideas in developing comparatively risky environmentally sustainable housing.
<b>Limited knowledge</b>	Decisions made in response to sustainable development, particularly at larger scales, must be made on an infinite amount of knowledge.	Developing sustainable housing largely is a physical manifestation of the precautionary principle – a prudent management technique.

**Table 2: Conceptual and pragmatic challenges raised in criticism of sustainable development and their implication to housing debates.**

Thus, evident in Table 2 above, some of the challenges are conceptual and have ethical dimensions. For example we must debate why we should care about future generations, or make positive contributions to the world when we ourselves will receive no measurable benefit from our actions. We also need to consider practical challenges, such as how sustainability can be implemented in a world characterised by competition, inequality, limited resources and finite information.

However, rather than inhibiting sustainable development, debates surrounding the challenges to sustainability are an exciting indicator of progress toward attaining sustainable development because they serve as focal points of necessary debate about how a commitment to sustainability is going to change our society.

For example, the debate about separating needs from wants (Brandon and Lombardi, 2005; Littig and Griessler, 2005) adds complexity to sustainability responses, but does not prevent sustainable outcomes. It creates a realisation that our assessment of our needs is inherently subjective. This debate allows us to differentiate, albeit subjectively, when housing might be considered a need and when it is a want. Likewise, when it is suggested that perhaps the very concept of growth needs to be contested in view of sustainability (McManus, 2005), a door is opened for heated discourse about whether our consumption patterns are symbolic and must change. Such debate necessarily engages interests from a wide cross-section of society. The concern over current levels of global inequality (Sneddon et al., 2006; Pirages, 2005) might just result in governments seriously reconsidering their dwindling (in % of GDP terms) contributions to overseas aid, not for altruistic reasons but in the interests of global sustainability. Again, we see the need to engage in discourse about our current course of action; why it might need to change and what implications this will have.

Sustainability is at its strongest where there is such debate, because as Davidson (2005) argues, sustainable outcomes only occur as the result of debate between opposing interests. She suggests that 'by not debating the tensions between the society, economy and the ecology . . . we might not be able to provide the solutions, which ensure a genuinely sustainable future' (Davidson, 2005a, p.5). More than a blunt imposition of policy or action, sustainability requires debate, compromise and negotiation (Brandon and Lombardi, 2005).

***More than a blunt imposition of policy or action, sustainability requires debate, compromise and negotiation.***

Crucially, sustainability debates engage wide-ranging interest groups at different scales, for example, neoliberal economists and conservation-at-all-costs environmentalists who are seriously considering what sustainability will mean for existing economic, societal and environmental systems.

Thus, as long as contested debate is occurring, so too is the process of sustainability. Decisions made in response to sustainability must necessarily prioritise economic, social and environmental objectives. Therefore, in the interests of facilitating change that results in a sustainable future, debate and discourse must be encouraged. It is unlikely that any organisational or public policy commitment to sustainable development that does not catalyse contested debate is truly reflecting sustainability. Acting on sustainability should be tension ridden.

There is thus a need to respond to sustainability in a way that is strong enough that sustainability is not compromised or used to justify predetermined objectives but flexible enough so that concepts can be challenged and ideologies contested. To this end, Sneddon et al. (2006) suggest that the only way that the ideological 'straitjackets' surrounding sustainability can be overcome is by embracing a pluralistic and transdisciplinary approach.

## 2.5 Housing policy in Australia

Housing that is affordable and sustainable will only ever be deliverable when it is supported by well considered housing policy at all levels of government. Government intervention in housing in Australia has historically been in the provision of public housing, a 'supply-side' mechanism. More recently, 'demand-side' mechanisms have taken precedence, with tax incentives encouraging investment in the private rental market, first-home-owners' grants and Commonwealth Rent Assistance (CRA), a subsidy for low-income renters in the private market. Funding for public and social housing has been provided by Commonwealth Government to the state housing authorities under five-year agreements called the Commonwealth-State Housing Agreement (CSHA). CSHA funding agreements have continuously evolved with changing social, political and economic conditions.

### 2.5.1 Background to Public Housing

Across Australia, public rental housing has never been a significant tenure, representing a small 8% of all dwellings at its 1966 peak, and currently 4.5% of all households (Arthurson, 2008). By comparison, social housing accounted for 80% of new construction in Britain in 1950, and it still represented 20% of the housing stock by 1970 (Winter and Bryson, 1998). Whereas initially the CSHA assisted the home ownership process, from the 1970's, funding has been targeted at providing basic accommodation for low-income earners. This meant that after the 1973 CSHA, modified funding resulted in the state government housing agencies shifting their focus "from [providing] a secure alternative to home ownership for all low income households to a sector only for tenants with complex and multiple needs" (Arthurson, 2008, p.486).

The changes to the CSHA occurred at the end of the long post-war period of economic expansion and high employment levels. It was a period of economic restructuring and recessions in 1973-74 and 1982-83 resulted in job losses in the manufacturing sector, which naturally affected lower-income public housing estates to a greater extent. In South Australia, for example, it has been estimated that the "restructuring and closure of the manufacturing industry in the five-year period from 1979 to 1984 resulted in the percentage of SAHT (South Australian Housing Trust) tenants receiving rental rebates increasing from 35 percent to 64 percent" (Arthurson, 2008, p.495).

From 1978, state governments were required to match Commonwealth Government funding in the CSHA. In addition, the charging of market rental rates resulted in the wealthier tenants moving to other housing tenures, meaning that public housing was only desirable to the poorest of households (Winter and Bryson, 1998). Changing funding arrangements have reduced the levels of public housing, with waiting lists continuing to grow. In June 2008, across Australia, there were 177 652 households on waiting lists for public rental housing, 14 638 of which were classified as having "greatest need" (Webb et al, 2009, Wilson 2007).

### 2.5.2 Commonwealth Rental Assistance and the private rental market

From the late 1980's, a shift in policy commenced, directing funding away from 'supply' measures of affordable housing, that is, support of public housing, to 'demand' measures, predominantly Commonwealth Rental Assistance (CRA). It has been estimated that expenditure on CRA has increased from a quarter of CSHA expenditure in 1984-85 to more than one and a half times CSHA expenditure in 2001-02 (Nygaard et al, 2007). In 2006–07, the federal Government provided \$2.2 billion in CRA funding, compared with \$970.6 million in CSHA funding (Webb et al, 2009).

This process of increasingly meeting housing needs through CRA instead of public housing has had a noticeable impact on housing affordability because whereas public housing rents are set at a fixed

***...increasingly meeting housing needs through CRA instead of public housing has had a noticeable impact on housing affordability***

percentage of income and thus directly reduce housing stress, CRA is not directly linked with income. This results in a system where there is a mismatch between households experiencing housing stress and households receiving

sufficient CRA (Department of Families and Community Services, 2005).

Further, while CRA has alleviated some affordability issues, it has not prevented the growth of both CRA recipients and non-recipients experiencing housing stress (Yates et al, 2007). In addition, it is lump subsidy on rent payments, meaning that it does not necessarily increase with rental escalation, and thus in periods of high rental growth, its effect is minimised or contributes to rental escalation as the market works to absorb a subsidy. Additionally, it is paid at a universal rate across the nation and indexed to CPI and not rental escalation (Webb et al, 2009).

Finally, CRA, being a demand-driven measure, is only effective when affordable dwellings are available at the bottom end of the private rental market (Berry, 2003). This is a real challenge because while the supply of private rental dwellings has been continually rising, they are not being supplied at the bottom end of the market (Jacobs et al, 2007). This increases the demand for the limited affordable housing stock, inevitably driving up prices.

Yates and Wulff (2005) note that the private rental market cannot be relied upon to provide affordable housing opportunities because the supply is inadequate and the limited stock is poorly distributed. To this end, it has been estimated that more than half of the affordable stock is unavailable to low income households because it is occupied by higher income households.

CRA is targeted toward households receiving welfare benefits or pensions and largely excludes low-income working households. Such households are priced out of home ownership and thus cannot obtain assistance such as the first home owners grant and do not qualify for public housing – the forgotten sector in housing policy (Randolph and Holloway, 2007).

In summary, the existing forms of housing assistance do not have the capacity to adequately address the housing affordability challenges because the measures do not address the issues facing a significant number of low income households. Housing affordability is no longer a challenge for the most vulnerable in our society in public housing; it is affecting the so-called 'middle Australia'. The

emphasis on high-needs social housing has created a 'gap' of households requiring only a small amount of assistance to be alleviated from housing stress but unable to receive assistance because they do not meet Commonwealth and State eligibility criteria. In addition, CSHA and CRA mechanisms offer little assistance to low income renters and struggling first home purchasers whose long term housing costs might not be economically sustainable (Yates et al, 2007).

### **2.5.3 Recent affordable housing policy and initiatives**

Wide-ranging policy responses are being developed to improve housing affordability. At a local government level, for example, efforts to respond to housing affordability generally relate to the provision of infrastructure, infrastructure changes and planning conditions and approvals (Disney, 2007). Some local governments also partner in specific housing initiatives. The City of Salisbury in South Australia, for example, is currently establishing a pilot project in providing a small number of affordable homes on council land. Although they will be sold at market rates, loan repayments will be reduced as the council will retain some equity in the homes until subsequent sale (City of Salisbury, 2008).

State governments, the jurisdictions traditionally responsible for housing, are likewise developing a variety of responses. South Australia, for example, has created an 'Affordable Housing Innovations Unit' within its housing department. Actions have included developing a mechanism to link eligible households with affordable housing and creating legislative links between land use planning and housing by mandating 15% affordable housing in all new developments (Department for Families and Communities, 2008a) .

At a national level, although the historical role in housing has generally been limited to developing funding models with state governments, there is renewed interest in housing. For the first time since 1996, there is a federal minister for Housing and four major new initiatives are:

1. First Home Saver Accounts – whereby bigger deposits can be saved through low tax superannuation-style savings accounts where the government will make additional contributions.
2. Housing Affordability Fund – aims to lower the cost of building new homes by working with all levels of government to reform infrastructure and planning requirements.
3. National Rental Affordability Scheme – seeks to increase the supply of affordable rental dwellings by providing tax incentives to encourage investment in properties rented to eligible tenants at 20% below the market rate.
4. Land release – releasing surplus commonwealth land for development to increase the overall land supply.

(Australian Government, 2008a)

In 2009, the Rudd government released the successor to the CSHA, a National Affordable Housing Agreement (NAHA). The NAHA is one component of a broader agenda aiming to reform financial relations between the Commonwealth and States.

The NAHA represents a significant progression in Australian housing policy. For the first time, housing is being considered holistically as a single policy concern, for which there are a variety of issues such as homelessness, social housing, rental assistance, home purchase assistance and indigenous housing. Considering all measures at all levels of government affecting affordability, it replaces a long tradition of addressing housing policy in a piecemeal manner.

***For the first time, housing is being considered holistically as a single policy concern, for which there are a variety of issues...***

The objective of the NAHA is that “all Australians have access to affordable, safe, sustainable housing that contributes to social and economic participation” (COAG, 2009b, p.3). Interestingly, this objective states that all Australians require access to ‘sustainable’ housing and that housing is inextricably linked with other basic forms of well being. The objective is linked to a series of outcomes, for which there are the following measurable outputs (Figure 5).

#### **Outputs**

- (a) number of people who are homeless or at risk of homelessness who are assisted to secure and sustain their tenancies;
- (b) number of people who are assisted to move from crisis accommodation or primary homelessness to sustainable accommodation;
- (c) number of households assisted in social housing;
- (d) number of households in private rental receiving subsidies;
- (e) number of people receiving home purchase assistance;
- (f) number of zoned lots available for residential construction; and
- (g) number of Indigenous households provided with safe and appropriate housing.

(Source: COAG, 2009b, p.4)

**Figure 5: Outputs identified in the new National Affordable Housing Agreement.**

A strength of the NAHA is how it establishes the roles and responsibilities of Commonwealth, State and Local governments in the provision of affordable housing. Doing so recognises the role that different jurisdictions play in providing affordable housing and how successful provision requires collaboration.



The NAHA notes that “all parties are accountable to the community for their performance” (ibid, p.6) in meeting the agreed objectives and outcomes, and the agreement includes a list of performance indicators. The indicators are shown in Figure 6.

<p><b>Performance indicators</b></p> <ul style="list-style-type: none"><li>(a) proportion of low income households in rental stress;</li><li>(b) proportion of homes sold or built that are affordable by low and moderate income households;</li><li>(c) proportion of Australians who are homeless;</li><li>(d) proportion of people experiencing repeat periods of homelessness;</li><li>(e) proportion of Australian households owning or purchasing a home;</li><li>(f) proportion of Indigenous households owning or purchasing a home;</li><li>(g) proportion of Indigenous households living in overcrowded conditions; and</li><li>(h) proportion of Indigenous households living in houses of an acceptable standard.</li></ul> <p>(Source: COAG, 2009, p.6)</p>
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**Figure 6: Indicators to measure the performance of governments in meeting the objectives and outcomes of the NAHA**

The final component of the NAHA summarises an agreed reform agenda of the housing sector. This includes agreements on improving integration between the homelessness and mainstream services, reducing concentrations of disadvantage in social housing estates, improving Indigenous access to mainstream housing; enhancing the capacity and growth of the not-for-profit housing sector and planning reform for greater efficiency in the supply of housing (COAG, 2009b, p.7).

As well as developing agreements such as the NAHA, COAG has developed ‘National Partnerships’ to provide specific funding as well as to facilitate and reward States that deliver reform of national significance. There are a range of national partnerships, covering areas such as preventative health, smarter schools, homelessness, early childhood education, remote indigenous housing, and indigenous economic participation (COAG, 2009a).

One such partnerships is the National Partnership Agreement on Social Housing (NPASH). This agreement seeks to increase the supply of new social housing units. Under the scheme, a ‘Social Housing Growth Fund’ will provide capital to construct new social housing units, contributing to a reduction in homelessness and improved housing outcomes for indigenous Australians (COAG,

2009c). The funding of \$200 million per financial year is for capital costs only. Funding has been committed for two years as a “down payment on longer term reform” (Pilbersek, 2008).

Under the scheme, states and territories will submit proposals for funding to the Federal Government. The requirements set out in the agreement are quite specific, including

- Construction of new social housing dwellings;
- Increase the supply of social housing dwellings;
- Projects must be completed and ready for occupation within two years of the allocation of funding;
- Respond to an area of unmet need for social housing;
- Meet one of the following criteria
  - Facilitate the transition of homeless or those at risk of homelessness to secure long term accommodation;
  - Embody universal design principles;
  - Improve housing opportunities for indigenous Australians;
  - Support the growth of the not-for-profit housing sector; or
  - Innovations to support a more effective and efficient provision of social housing

(COAG, 2009c)

More recently, in response to the global financial crisis and Australia’s economic slowdown, COAG has further invested in housing reform as part of a broader economic stimulus package, developed using the same ‘national partnerships’ framework. The Economic Stimulus National Partnership Agreement (ESNPA) was written up using the same format as the NAHA and NPASH and serves as the guiding framework of the \$42 Billion Nation Building and Jobs Plan.

COAG estimated that the \$400 Million of NPASH funding would result in the construction of 1600-2100 dwellings by 2009-10 (COAG, 2008). This has effectively been magnified several times, with social housing funding increased to \$6.4 Billion, increasing the number of new social housing units to 20, 000 dwellings by 2012. In addition, a new \$400 Million measure will fund maintenance and repairs to refurbish approximately 2,500 social dwellings that otherwise would be unfit for occupation (COAG, 2009d).

\$692 million will be injected immediately for suitable projects in the development stage that can be fast-tracked. The majority of the funding will be allocated between 2009-10 and 2011-12, with tight deadlines given to the states to submit proposals. 75% of the new dwellings will be constructed by December 2010 (COAG, 2009d; 2009e).

The new measures have conditions attached that any proposals must meet and are not dissimilar to the earlier conditions outlined in the NPASH. Interestingly, for the first time, new dwellings must be environmentally sustainable (COAG, 2009e) and built to a six-star energy efficiency rating.

While funding is being delivered as part of an economic stimulus package, it is anticipated that there will be positive housing improvements. Specifically, the new dwellings are expected to reduce public housing waiting list times by 50% and reduce the number of low income households experiencing housing stress (ibid).

Although it is beyond the scope of this project to conduct an analysis of this component, the package also included a new Energy Efficient Homes Package to improve the energy performance of both existing and new homes, through retrofitting measures and establishing new standards through means such as the Building Code of Australia (COAG, 2009d).

The package also agreed to progress some of the reforms mooted in the NAHA, such as the integration of public and community housing waiting lists and improving the social and economic participation of social housing tenants by locating social housing strategically in terms of transport, services and employment opportunities (COAG, 2009d).

#### **2.5.4 Analysis of recent Commonwealth housing policy**

Economically, it is difficult to analyse the sustainability of the NAHA and associated national partnerships. This is because the mechanisms are vague and non-specific about the housing and tenure models envisaged. Indeed, it is likely that the recent measures will facilitate the development of affordable housing in a variety of tenures. For instance, the ESNPA that outlines the investment in 20,000 new social housing units intentionally establishes that not-for-profit organisations and small to medium enterprises will play a role in such new dwellings (COAG, 2009e). It is thus unlikely that these new social housing units will be developed and managed wholly by state governments like the post-war public housing estates. This has implications for economic sustainability because such organisations, as well as being more innovative and flexible, are better able to leverage finance than governments (Disney, 2007).

Perhaps the greatest shortcoming of the recent measures is the unrealistic timeframes. Prior to the economic stimulus package, the target of approximately 2000 new social housing dwellings was ambitious but generally well-received as a 'down-payment' on a larger reform agenda. The later, larger, investment has come early thanks to a \$6.4 Billion investment in new social housing as part of the Economic stimulus package (COAG, 2009d). While such an investment in public housing is a

***...a longer term investment program, with ongoing social housing construction is what is required to improve Australia's housing affordability and supply challenges.***

welcomed contribution to a sector that has been declining for some time, what is concerning is that all the dwellings are to be constructed in the near future.

75% of the approximately 20,000 new dwellings must be completed by December 2010 to provide the necessary

stimulus to the construction industry and create jobs (COAG, 2009d). While this may redress homelessness and create affordable housing solutions, it is short-sighted in that a longer term investment program, with ongoing social housing construction is what is required to improve Australia's housing affordability and supply challenges.

Furthermore, the sustainability of such new dwellings is concerning. Although it is likely that many of the homes will be absorbed into the not-for-profit housing sector, the scheme is not directly supported by funding mechanisms to support the ongoing maintenance of such properties. While benchmarks have been set for improved maintenance of social housing, the absence of direct funding may present concerns for the ongoing quality of such homes (Webb et al, 2009).

Additionally, concern has been raised about the environmental sustainability of new dwellings beyond the six-star rating. In order to meet the tight time deadlines, the package is allowing agencies to fast-track developments in the planning stage and even purchase new homes in the open market. Such short-sighted notions fail to consider that the construction of social housing is a long-term investment and decisions made in selecting locations, as well as in the design and construction stages, have lasting impacts for the life of the building, over the next fifty or more years.

Additionally, allowing such ad-hoc construction and purchase of new social housing dwellings on such a short timeframe may result in social housing dwellings being acquired that will not result in long-term social sustainability. The construction and acquisition of cheap house and land packages on the urban fringe to quickly acquire social housing dwellings and stimulate the construction industry might undermine long term NAHA reform agenda proposals, such as "creating mixed communities that promote social and economic opportunities by reducing concentrations of disadvantage that exist in some social housing estates" (COAG, 2009b, p.7).

Further, the rapid construction and acquisition of social housing under the ESNPA may result in homes that are typical to the norm; resource intensive with the "prioritisation of factors such as size, comfort and affordability over sustainability outcomes" (Sibley et al. 2003 p.4). Although mandating a six-star energy efficiency rating is commendable, this alone will not result in truly sustainable housing. Broader reforms to legislation and building codes are slowly occurring and are needed to improve the broader environmental performance of housing. Such long-term objectives appear to be a secondary consideration in the funding for the construction of 20,000 new social houses.

Australia still requires a wide-ranging national housing policy that addresses the housing needs of the entire community, not merely those seeking affordable or crisis accommodation. Although middle and higher income households may not be experiencing housing stress in a financial, definitional sense, their housing situations may be far from ideal because of design, location or a simple inability of the market to meet their needs.

Supply and demand for housing are continually changing with factors such as consumer preferences, an ageing population, labour market characteristic, employment locations and fertility and migration rates. Commenting on Australia's property market in the light of the global financial crisis, Braddik et al. (2009) found that while dropping interest rates are improving affordability, the gap between housing supply and demand is widening (Braddik et al. 2009). Affordability may improve or worsen over time, but the deeper structural challenges remain in ensuring housing supply is meeting demand. There is thus a need for a broader, federal-government level policy on housing, of which affordable housing is only one component. The recently released 'State of the Supply' report (National Housing Supply Council, 2009) which projects housing supply and demand to 2028 may form an important empirical basis for housing reform and the development of comprehensive national policy.

## 2.6 Delivering Affordable and Sustainable Housing: Regulation and Procurement

An appropriate policy context is not the only requirement for the effective delivery of affordable and sustainable housing. Building regulation plays an increasingly important role, especially regarding the environmental performance of housing. This section also addresses financial procurement, and the debate regarding creative mechanisms to deliver affordable and sustainable housing.

### 2.6.1 Role of Regulation

Building control surveying has existed for many years and there is evidence of it in ancient Babylon (some 2000BC) where the building rules of the day required a builder who made a mistake to be punished. That punishment could be death: *“Such rules would certainly have been a strong warning against shoddy construction and would have eliminated the possibility of repetitive malpractice”* (Nassau & Hendry 1994, p. 1.1).

Ancient Rome also had building rules as early as 300BC which were intended to guard against fire spread in buildings throughout the city (Atkinson 1993, Bannister Fletcher 1973). Similarly, many cities of medieval Europe imposed some form of control relating to fire danger but, as evidenced by the fact that 80% of medieval London was devastated by the Great Fire of London in 1666 (Nassau & Hendry 1994) these controls were not always adequate. The positive outcome of this fire was that the city upgraded its building regulations so that property damage and fire spread could be considered and controlled (Atkinson 1993). Accordingly regulations were introduced to ensure minimum separation between buildings in order to prevent the spread of fire and to prevent the overhang of upper floors that had been a traditional architectural feature used to maximise the floor space without being liable for a floor tax related to the site area (Knott 2005). These regulations subsequently found their way to Australia with British settlement (Atkinson 1993, Nassau & Hendry 1994).

As cities in 18<sup>th</sup> and 19<sup>th</sup> Century Europe grew, the issue of health and the spread of disease came to the fore as the mass urbanisation that was occurring did not always take into account the issues of public health, sanitation, sewerage and natural lighting and there were continuous outbreaks of epidemics and loss of life (Nassau & Hendry 1994, Cowan 1977). With the passage of time legislation was introduced to cover these issues and the cities became a much healthier place to live (Nassau & Hendry 1994). With the 20<sup>th</sup> century came a greater realisation that there was a real need for the consideration of life safety, in addition to property protection and other legislation such as Health Acts and, more recently in Australia, the Occupational Health Safety and Welfare Acts were gradually introduced (Atkinson 1993).

Regulation has arisen in the construction industry as a key mechanism to deliver sustainable housing outcomes out of the observation that barriers currently exist that inhibit the reduction of the environmental impact of buildings through market mechanisms. Such barriers relate to the unique

characteristics of the building sector in terms of its product, production processes and the way the product is used (OECD n.d.). Further, as argued by Chiu (2004 p.71), while regulation and codes typically reflect social and cultural norms of a society, “they require efforts and commitments from the governments to formulate and enforce them”.

The commitment to attaining sustainable development as per the Brundtland definition has been worked into more practical frameworks to facilitate tangible outcomes. For example, the CIB Agenda 21 on Sustainable Construction sought to be a “global intermediary between those general agendas in existence, i.e. the Brundtland Report and the Habitat Agenda, and the required national/regional Agendas for the built environment and the construction sector” (CIB n.d.). The CIB agenda is a conceptual framework that establishes clear links between the global sustainability discourse and the construction sector and it is envisaged that this will assist defining detailed measures in the various local contexts.

In the case of Australia, the Building Code of Australia (BCA) contains a set of technical rules for the design and construction of buildings, which is given legal effect by building regulatory legislation in the state and territory governments. The system of a national code has created national consistency in building regulation, allowing for variations in climate, geological and geographical conditions.

The goal of the BCA is to “enable the achievement of nationally consistent, minimum necessary standards of relevant, health, safety (including structural safety and safety from fire), amenity and sustainability objectives efficiently” (ABCB 2009)

The technical provisions related to the design and construction of buildings and structure considers matters including structure, fire resistance, access and egress, services and equipment, and energy efficiency as well as certain aspects of health and amenity. The BCA is performance based which facilitates cost savings in building construction by allowing innovate or alternative materials, forms of constructions or designs and allowing site-specific designs which ensure that the “intent of the BCA is met...while still allowing acceptable existing building practices” (ABCB 2009). That being said the majority of housing in Australia is still designed according to the traditional “deemed to satisfy” specifications laid out in the BCA and rarely use the performance approach.. In fact this requirement from the housing industry to have very clear and specific residential design considerations has led to South Australia adopting its own Housing Code which has the same status as the BCA housing provisions in South Australia alone.

The BCA is limited to technical components of the design and construction of buildings, and other aspects of construction, such as administrative provisions, procurement, planning, occupational health and safety, consumer protection are outside its scope. Some issues, such as durability, adaptability, have a non-mandatory route and instead of being addressed in the building code, are addressed in ABCB guidelines. Some issues are not at all addressed by the building code (e.g. waste management issues, design for disassembly, re-use of materials).

Changes to the building code are often requested by COAG. Energy efficiency measures for housing were first introduced to the code in 2003. More recently, COAG has requested that the energy efficiency requirements be amended in the 2010 edition of the BCA to require all residences meet a 6 star rating subject to cost effectiveness.

## 2.6.2 Financial Procurement

The term financial procurement in this project relates to how affordable and sustainable housing outcomes can be delivered through various government, private and public-private-partnership development projects (Susilawati and Armitage, 2004). The mechanism for funding will depend, to some extent, on the type of affordable housing i.e. whether it is low cost private sector dwellings intended for purchase, social housing which caters to the less well off in the community or houses for essential services workers on limited incomes in expensive urban areas.

Mechanisms for providing the financial resources will depend on the nature of the development. State governments have a critical role to play in the controlled release of Crown land for development according to certain criteria e.g. Lochiel Park in South Australia which features sustainability credentials although the affordability component is a small portion of the development. Federal government has a part to play in providing demand-side subsidies for housing via the First Home Owner's Grant and the Commonwealth Rental Assistance Scheme.

In a study of a number of affordable housing schemes in Australia, Milligan et al (2004) identified a number of innovative levers or mechanisms which can provide cost advantages compared with conventional private developments. These include no land sales levy, equity contribution from government by way of capital or land, goods and services tax exemptions and cross subsidy between low income and medium income tenants in rental schemes.

Berry et al (2004) summarised a number of models for leveraging private finance into the affordable housing development. These include a consortium model, retail investment vehicle, tax relief targeted to retail investors, low income tax credit scheme, capital gains partial exemption and a shared equity model.

In a later paper which analyses the provision of affordable housing, Berry et al (2006) concluded that:

*...a concerted effort by the Commonwealth, the States and Local government is required if available resources are to be used effectively to lever in private funding and investment. First the Commonwealth government must make a commitment to an effective regulatory regime which supports the provision of affordable housing; then it must modify and increase current demand-side benefits to ensure greater certainty of revenue streams to the point where asset values are positive and private finance can be levered into the sector.*



A comparison of the provision of affordable housing in Australia with the UK was carried out by Berry et al (2006). Initiatives in the UK include the use of planning regulations to ensure that private developers provide a proportion of their dwellings which is affordable. In this case affordable means social rented housing or low cost home ownership. Public-private partnerships, the fine-tuning of taxation regimes and public borrowing programs are seen as possible mechanisms to lever private investment into affordable housing. Gurrán et al (2008) comment on a number of planning levers used in some Australian capital cities such as planning agreements for affordable housing, incentives, protective mechanisms and limited inclusionary schemes. Based on a study of overseas experience, they advocated system wide strategies and improved needs assessment and planning methodologies.

Innovative funding models for affordable housing are less well developed in Australia compared with overseas. This is partly because of the relatively small portion of the housing market that is taken up by social housing and the fact that the size of the private rental market is significant. However, this represents an opportunity to introduce new methods for the financial procurement of affordable and sustainable housing to alleviate housing stress and promote sustainable outcomes. Clearly, the research and development of innovative funding schemes are an integral part of the move towards affordable and sustainable housing.

## 2.7 Summary: Guiding principles to link the parallel objectives of affordability and sustainability

This section provides a theoretical foundation for the subsequent analysis of affordable and sustainable building materials, techniques and procurement methods in a South Australian context. Through a review of relevant literature, it has been demonstrated that affordability and sustainability need not be considered conceptually inconsistent.

Section 2.1 provided a necessary context for the Ecocents Living project by summarising relevant government and industry research and initiatives in terms of affordability and/or sustainability.

Section 2.2 summarised common definitions of affordability and sustainability and derived both a conceptual definition of affordable and sustainable housing for the purposes of this project, as well as a checklist of ten essential characteristics that future housing models should reflect.

Section 2.3 considered the state of housing affordability in Australia and provided a brief summary of how this has arisen. In addition to identifying some of the broader impacts of a housing affordability crisis, the discussion highlighted some of the structural problems in Australia's housing system, such as a widening gap between housing supply and demand.

Section 2.4 analysed the concept of sustainability and the implications of this for housing. The triple-bottom-line approach was considered, and related to affordable housing. This process demonstrated how many components of economic and social sustainability are already reflected in popular affordable housing discourse. This, therefore, squarely positioned environmental sustainability as a primary consideration in the project, with economic and social sustainability to play secondary roles. This is reflected in the consideration given to different areas in chapter 3. Section 2.4 also investigated common conceptual and pragmatic objections to facilitating sustainable development and concluded that such challenges form an integral part of the transition to a sustainable society, since sustainability is more of a process than some end state.

Section 2.5 summarised and critically analysed housing policy in Australia. While summarising traditional forms of policy, such as public housing and Commonwealth Rent Assistance, the discussion centred on more recent policy initiatives and the new National Affordable Housing Agreement. It was concluded that although housing is moving in a positive direction in becoming a more central policy concern, comprehensive policy regarding the entire housing system is nonetheless required to address long-standing structural issues.

Section 2.6 looked at how affordable and sustainable housing can be practically delivered through analysis of the role of regulation and financial procurement.

The literature review and analysis has thus highlighted the following as guiding principles for a model of affordable and sustainable housing:

1. There are remarkable areas where the objectives of sustainable housing and affordable housing converge and that rather than being potentially conflicting, they should be considered mutually supporting objectives.
2. Sustainability must be considered in a context that recognises the inter-dependence between economic, social and environmental sustainability. Housing affordability is thus an intrinsic component of sustainability.
3. Affordable housing discourse in Australia, possibly unintentionally, reflects many of the objectives of economic and social sustainability. This is because proposed models of affordable housing seek to avoid the financial and social failures of historic models of affordable housing in Australia. Therefore, improving the sustainability of affordable housing largely rests on incorporating environmental sustainability.
4. Social acceptability is a key challenge that new housing innovations must address. Sustainable housing techniques have had a remarkably low take up despite successful demonstration projects, highlighting deeper socio-cultural factors.
5. Australia's housing affordability challenges are being felt in sectors of the community that traditionally are not associated with disadvantage. Future affordable and sustainable housing models must respond to this by being tailored to a larger section of the community and be aimed at home-purchaser and private rental markets, as well as public housing.
6. There is the particular benefit of developing affordable environmentally sustainable housing because low-income households spend a larger portion of their income on utilities and transport.
7. There are structural problems in Australia's housing systems, such as a growing gap between housing supply and demand, that need resolving at a federal government level through a deliberate policy that addresses the housing needs of the entire community. Any policy and action regarding affordable and sustainable housing will naturally be subject to such structural challenges.
8. Housing policy in Australia is evolving with increasing government interest. Likewise, regulatory mechanisms are gradually improving the environmental performance of housing. Both broader, strategic housing policy and regulatory mechanism may play an important role in facilitating affordable and sustainable housing.

## Chapter 3: Indicators of Affordable and Sustainable Housing

### 3.1 Background to Indicators

This chapter of the report builds on the theoretical foundations established in chapter 2 by specifically analysing 10 different components of affordable and sustainable housing, and in the process, developing an assessment framework.

Section 2.2 discussed various definitions of affordability, affordable housing, sustainable development and sustainable housing and worked these towards a conceptual definition of housing that is both affordable and sustainable. It was defined as

*Housing that meets the needs and demands of the present generation without compromising the ability of future generations to meet their housing needs and demands. Affordable and sustainable housing has strong and inter-related economic, social and environmental components.*

This definition encapsulates the overall objectives of affordability and sustainability and might be an aspirational aim for possible housing solutions. However, the discussion also suggested that more specific criteria may be required to ensure the definition doesn't become policy dogma but actually results in housing that is both affordable and sustainable.

To this end, a 'checklist' of 10 key characteristics was developed, with the first four characteristics seeking to reflect literature regarding housing affordability; the fifth seeks to reflect economic sustainability; the sixth and seventh seek to reflect social sustainability while the final three characteristic seek to reflect environmental sustainability. The characteristics are:

1. A product where the rent or mortgage repayments do not exceed 30% of household incomes for the bottom 40% of income groups.
2. A product that is appropriately located in terms of accessing key services, transport and employment.
3. A product that is of a suitable size and quality for its occupants.
4. A product that does not increase the incidence of Housing Stress over the life cycle of the house.
5. A product where individual and government financial obligations can be met on an ongoing basis without policy change.
6. A product that is socially acceptable and desirable.
7. A product that does not increase social exclusion or polarisation.
8. A product that is located on a site that minimises biodiversity losses.

9. A product that is located on a site that maximises low-energy transportation options.
10. A product that encompasses the following environmental features
  - Energy efficiency;
  - Passive Solar Design;
  - Sun Shading;
  - Water Conservation
  - Appropriate Waste Management during construction, occupation and deconstruction.

This section of the report, therefore, seeks to build upon these broad characteristics of affordable and sustainable housing and further identify and understand the key components of affordability and sustainability. This is done by developing a series of indicators, and in some cases, sub-indicators, for the various aspects of affordable and sustainable housing highlighted in the above checklist.

The indicators have been developed as a result of a comprehensive review of academic and industry literature as well as, where appropriate, government policy. Emphasis is placed both on specifying current best practice for each of the characteristics, as well as explaining how it forms an indicator that can be assessed in an assessment framework. Like the checklist developed in chapter 2, each of the indicators can be aligned to one of the economic, environmental or social components, although it is noted that there are many inter-relationships between the three with, for example, certain economic components having strong bearings on the effectiveness of the environmental components.

Due to the limited scope of this project, focus has been given to developing indicators for the different facets of affordability and sustainability which, when compounded, form the basis of the desired housing solutions outlined in chapter 6. As such, it must be noted that indicators discussed in this chapter combine to give an *indication* of how well or otherwise particular housing outcomes reflects the affordability and sustainability criteria, rather than developing specific measurements.

The characteristics addressed in detail in this chapter are:

- Energy efficiency
- Water efficiency
- Construction materials
- Construction methods
- Biodiversity
- Affordability
- Desirability
- Density and Urban Form
- Dwelling size
- Adaptability
- Social Acceptability

The chapter has adopted the following structure: A definition is provided for each indicator and that indicator is given context via some background information and a discussion about its importance to affordable and sustainable housing. Where appropriate this is followed by sub-indicators that assist with the metrics of the overall indicator.

## 3.2 Energy Efficiency

**Definition:** Energy Efficiency encompasses active and passive measures to reduce the dwellings recurrent energy costs and greenhouse gas emissions.

A significant challenge for building professionals is to create a low energy profile for sustainable housing. As Kibert (2008) pointed out, energy consumption is one of the most important sustainable housing issues, not only because of its associated environmental impacts, but also due to the likely higher future energy cost. As an example of the significance of energy consumption in the built environment, buildings consumed approximately 37% of total energy in the European Union in 2004, which is bigger than the industrial (28%) and transport sectors (32%) (Pérez-Lombard et al. 2008). At the level of the individual dwelling, recent per capita energy consumption in the US was reported as 42 gigajoules (GJ) for detached housing residents and 28GJ for apartment dwellers (WBCSD 2009). Similarly, it was recommended that on-site renewable energy be adopted to reduce greenhouse gas emissions.

In 2007, the major end uses of energy for residential buildings in Australia were : Appliances (32%), Space Heating (38%), Water heating (23%). These figures are projected to be 37%, 36% and 18% respectively in 2020 (Department of the Environment, Water, Heritage and the Arts 2008). According to ABARE's latest estimates of Australian energy consumption by industry and fuel type (Syed et al 2007), the residential sector accounted for 451 petajoules (PJ) or 12% of Australia's total energy consumption of 3642PJ in 2007. The trend in per capita residential energy consumption indicates a steady but modest increase from 17GJ per capita in 1990 to 20 GJ per person predicted for 2020.

The energy efficiency of housing needs to be seen in the wider context of the environmental impact of modern lifestyles. The use of per capita carbon dioxide equivalent (CO<sub>2</sub>-e) emissions as a measure of this impact is one way to quantify the impact. Housing generates CO<sub>2</sub>-e emissions during the phases of construction, operation and decommissioning. While it is important to consider all three phases, this performance indicator focuses primarily on the operational phase. In the context of affordable and sustainable housing the operational phase is of particular importance as energy bills account for a significant proportion of expenses for lower-income households.

The energy efficiency of a house is the product of a complex set of relationships emanating from the site, climate, lifestyle, design and materials right down to the level of individual appliances and light bulbs. The actual amount of energy used for artificial heating and cooling is influenced by the behaviour of the occupants and efficiency of appliances, in addition to the thermal performance of the building.

Rating tools attempt to predict the performance of buildings against a set of indicators. Internationally, there are a number of rating tools which encompass the energy efficiency performance in buildings. These include; the Building Research Establishment Environmental Assessment Method (BREEAM), the Australian Building Greenhouse Rating (AGBR), the Building Sustainability Index (BASIX), the

Building Environmental Performance Assessment Criteria (BEPAC), the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE), the Comprehensive Environmental Performance Assessment Scheme (CEPAS), Leadership in Energy and Environmental Design (LEED) and the Sustainable Building Assessment Tool (SBAT) (Ding 2008). Lee and Burnett (2008) compared the Hong Kong Building Environmental Assessment Method (HK-BEAM), the Building Research Establishment Environmental Assessment Method (BREEAM) and LEED through case studies and found that the three rating tools were compatible.

In most areas of Australia the Building Code of Australia (BCA) now requires a minimum energy star rating for new single dwellings of 5 stars as assessed by the Nationwide House Energy Rating Scheme (NatHERS). The standard of 5 out of 10 stars available is a minimum and there are current examples that achieve considerably higher scores. AccuRate is a commercial software package, which is an enhanced version of the NatHERS rating tool. In AccuRate, a star rating is assigned to a residential building based on its calculated annual heating and cooling energy requirements so that the energy inputs required to maintain thermal comfort can be measured (Gregory et al. 2008). It is worth noting that in South Australia, heating and cooling energy (which is that component of residential energy consumption addressed by NATHERS) accounts for around 36% of total energy consumption of typical housing. Lighting and appliances consume a larger proportion i.e. in the order of 40% (DTEI 2009).

Australian regulation of building energy efficiency commenced in January 2003. The current benchmark of 5 stars is likely to be increased to 6 stars from 2010. At the COAG meeting of the 30<sup>th</sup> April 2009 the Government proposed increased standards to improve the energy efficiency of residential and commercial buildings across Australia (COAG 2009). Those measures (currently the subject of a regulatory impact assessment) include:

- an increase in energy efficiency requirements for new residential buildings to six stars, or equivalent, nationally from the 2010 update to the Building Code of Australia. These are to be implemented by May 2011. The government also gave notice of its intention to introduce new efficiency requirements for hot-water systems and lighting; and
- the phasing -in of mandatory disclosure of residential building energy, greenhouse and water performance measures at the time of sale or lease,. These are proposed to be introduced with the implementation of the new energy efficiency requirements scheduled for May 2011.

In the international context there are some clear and sometimes high level guidelines and benchmarks for residential energy efficiency. For example the UK Government has set an ambitious target of zero carbon housing within 10 years:

*We therefore believe we need to set a target now for moving to zero carbon housing within 10 years. We would propose to achieve this in three steps: moving first, in 2010 to a 25% improvement in the energy/carbon performance set in building regulations; then second, in 2013, to a 44% improvement; then, finally, in 2016, to zero carbon. Zero carbon means that,*



*over a year, the net carbon emissions from energy use in the home would be zero.*  
(Department for Communities and Local Government 2006).

Osmani and O'Reilly (2009) conducted a questionnaire survey and in-depth semi-structured interviews with the major UK housing developers to investigate the feasibility of building zero carbon homes in England by 2016. Their results indicate that although zero carbon housing is technically achievable clear and concise action must be taken early by both the government and the house building industry if the target is to be achieved. .

This suggests that if Australia is to follow this international standard, energy goals for Australian housing developments beyond 2011 may need to be set sooner than expected.

Given the climate change implications (IPCC 2007) consideration needs to be given now to establishing increased levels of energy efficiency for Australian housing. The zero carbon initiative adopted by the UK can act as an exemplar catalyst for such an action.

### **Sub-Indicators**

#### **3.2.1**      7.5 Star or equivalent

There are best practice examples of housing developments in Australia that are at the cutting edge of energy efficiency design. An example is the Lochiel Park housing development in South Australia which has set a benchmark of 7.5 stars for the energy efficiency rating. There are also international examples which are designed to achieve similar high performance standards, such as the BedZED development in London. Collectively, these developments describe a level of energy efficiency that should be considered in the context of new sustainable housing.

#### **3.2.2**      6 star or equivalent

Bearing in mind the proposed increase in energy efficiency standards in the Building Code of Australia from 5 star to 6 star, it is considered that the proposed level of performance now constitutes the baseline for housing projects designed specifically with a focus on sustainability.

#### **3.2.3**      Active solar electricity generation and/or water heating

The need to minimise the use of fossil fuel based energy in the operation of dwellings is highly desirable for a number of reasons, not least of which are the environmental impacts of extracting and consuming non-renewable energy resources (Kibert 2008). In summarising the adoption of renewable energy generation, Kibert (2008) stated that the three most popular systems currently being employed in green buildings are based on photovoltaics, wind energy, and biomass. In the UK, Caird et al. (2008) surveyed the adoption of low and zero carbon technologies and their research found that there were approximately 82,200 domestic micro-generation and renewable energy systems, with solar thermal water heating accounting for 95% of the total. In Australia, the

K2 apartment project in Melbourne uses renewable energy to provide about a tenth of its total electricity consumption. This comes from the photovoltaic panels installed on the north-facing building roofs and pods facades (Ghosh and Gabe 2007). The flat-plate solar collector array is designed to meet at least 50% of the domestic hot water demand. Similarly, the development achieves a 46% gas energy saving by using of a solar hot water system.

Bearing in mind the relatively high levels of insulation available in urban Australia, it makes sense that solar electricity generation and/or water heating form part of the energy mix in sustainable housing to reduce the use of fossil fuel based energy.



**Plate 1: Photo voltaic cells on dwellings in Woking, England.**

### **3.2.4** Passive Design

Passive design is “the design of the building’s heating, cooling, lighting, and ventilation systems, relying on sunlight, wind, vegetation, and other naturally occurring resources on the building site” (Kibert 2008, p.167). In essence, passive design aims to use all possible measures to reduce energy consumption prior to considering artificial external energy sources. Passive design strategies can effectively reduce the building energy consumption (Larsen et al. 2008). Houses that use passive design take advantage of the climate to maintain thermal comfort. Good passive design maximises cooling air movement and excludes the sun in summer. In winter, it traps and stores heat from the sun and minimises heat loss to the outside. The main principles of passive design are:

- design for climate
- orientation

- shading
- passive solar heating
- passive cooling
- insulation
- thermal mass
- Glazing design. (Australian Government 2008).

Kibert (2008), suggests that the development of passive design can help to dramatically reduce building energy consumption.

This indicator is complied with by developments that have housing designs which take these principles into consideration.



**Plate 2: Passive Solar Orientation (at Aldinga Arts Eco Village)**

### 3.3 Water Efficiency

**Definition:** Water Efficiency encompasses water conservation, storage and re-use measures as well as water sensitive urban design techniques.

Australia is the driest inhabited continent therefore it is imperative to consider water efficiency in housing developments. According to ABS data, households consumed 2,108,263 megalitres of water in 2004-05. This accounted for 11% of the total water consumed in Australia in that year (ABS 2008).

Housing developments that are designed using water efficiency principles can greatly reduce the amount of water used and the degree of contamination caused to water resources. Water conservation, storage and re-use can be applied at the scale of the whole development and at the scale of individual lots, as identified in the subindicators below.

The domestic water consumption of 11% corresponds to an average of 285 litres per person per day (National Water Commission 2005). Approximately 40% of household water is used indoors (Australian Government 2008). The main means of reducing indoor water use is by the installation of water efficient appliances. There are also other creative ways to reduce outdoor water consumption for the remaining 60% of household water consumption.

#### Sub-Indicators

##### 3.3.1 Rainwater storage and re-use

Water harvested onsite from buildings is arguably the cleanest alternative water source as it requires little treatment to be used for a wide variety of uses (Apostolidis and Hutton, 2006). Zhang et al. (2009) investigated the rainwater use in high-rise residential buildings in four Australian cities, i.e. Melbourne, Sydney, Perth and Darwin. Their results indicated that Sydney has the shortest financial payback period compared to other cities.

Ryan et al. (2009) reported an internet survey completed by 354 households in the Australian Capital Territory and surrounding regions concerned with domestic greywater and rainwater collection. Residents who used tank water on their gardens were found to have a higher understanding of the range of water supply options. In 2007, more than 20% of all households reported that their dwelling had a rainwater tank. South Australia had by far the highest proportion of dwellings with a rainwater tank (40.2% in Adelaide and 74.7% in the rest of the state) (ABS 2008).

In urban areas rainwater storage and re-use can reduce demand on reticulated water by 50 percent depending on roof catchment area, tank size and climate (Australian Government 2008b). The Australian Government is supporting rainwater tank installation under the *National Rainwater and Greywater Initiative*. Rebates are available for the purchase of rain water tanks.

An example of a recent development exploiting the use of rainwater is the K2 apartments in Melbourne which were designed for a 53% reduction in water from the mains water supply compared with a conventional development. This corresponds to a saving of approximately 44% per person per annum (excluding landscaping) and 68% including landscaping. The systems used in K2 include:

- water-efficient fittings reducing consumption by 28%
- rainwater collection resulting in an additional 8% reduction
- wastewater reuse for toilet flushing which contributed a 14% reduction and
- water-efficient irrigation that accounted for a further 3% reduction.

This indicator standard is achieved by developments that demonstrate rainwater storage and re-use at both the individual lot and the whole of development scales.

### **3.3.2** Water Efficient Appliances

The use of water efficient appliances in homes leads to substantial reductions in water consumption. In Australia, there is a Water Efficiency Labelling and Standards (WELS) scheme which rates the water efficiency of new taps, showers, toilets, urinals, clothes washing machines and dishwashers. A 6 star rating system indicates the relative efficiency of appliances.

By 2021 more than \$600 million should be saved through reduced water and energy bills if Australians choose more water efficient products. It is estimated that using water efficient products will help to:

- reduce domestic water use by five per cent or 87,200 megalitres each year; *and*
- Save some 610,000 megalitres of water i.e. more water than what is contained in Sydney Harbour. (Australian Government 2009)

Nearly half the water savings will come from more efficient washing machines, about 25 per cent will come from more efficient showers and some 22 per cent from more efficient toilets.

This indicator standard is achieved by developments that encourage the use of water efficient appliances and this could be by the use of by-laws or educational initiatives.

### **3.3.3** Water Sensitive Urban Design (WSUD)

Water efficient landscapes need to be considered at different levels i.e. the individual house lot, the whole development and in the urban context. Water Sensitive Urban Design seeks to approximate the water balance of natural ecosystems. It achieves this by slowing the water velocity of stormwater run-off, providing natural filtration, on-site detention and infiltration. The

objective is to minimise impervious surfaces so that the least amount of water flows off-site into the stormwater system (Australian Government 2008b; BEDP 2008)

This indicator standard is achieved by developments that demonstrate WSUD principles at the individual lot or whole of development scales.

### **3.3.4** Greywater re-use

Greywater is wastewater from household fixtures such as showers, basins and taps (AWA 2009). It is advisable to exclude water from kitchen sinks and dishwashers because of the potential for contamination by pathogens from pathogens from detergents, unless of course, a treatment system is specifically designed to cope with these conditions. Wastewater from toilets must not be included. The size of storage tank, and the inflow and outflow patterns affect the water saving efficiency (Liu et al. 2009).

The quality of the re-use water depends on the treatment system used, the water's first use and on any chemicals that are used in the house. Treatment systems can be biological, chemical,, mechanical, or a combination of these. Treated water can be re-used both outdoor and indoor depending on the level of treatment and the local regulations. The regulations for the re-use of grey water at a dwelling scale vary widely throughout Australia and this serves as a major disincentive to the re-use of grey water among householders.

Despite this, in 2007, grey water was the second most common source of water for households, after mains/town water. 54.5% of Australian households reported greywater as a source (ABS 2008).

This indicator standard is achieved by developments that demonstrate greywater re-use at both the individual lot or whole of development scales.



### 3.4 Construction Materials

**Definition:** Construction Materials relates to the selection of materials such as the use of low embodied energy new materials and the re-use and recycling of old materials. Reducing embodied energy can contribute to lowering the overall life cycle energy consumption of homes (Pullen et al, 2006).

In addition, careful analysis and selection of the materials used and the way they are combined can yield significant improvements in the comfort, cost effectiveness and energy efficiency of a home. Comfort in this context includes thermal comfort and indoor air quality. Consideration should also be given to the life cycle of materials from their production and transport to their use in buildings and eventual decommissioning.



**Plate 3: Building waste**

#### **Sub-Indicators**

##### **3.4.1 Recycled**

The embodied energy savings from recycling of building materials depends on the material in question and whether it is re-used or reprocessed. Re-use of building materials commonly saves about 95% of embodied energy. Savings from recycling of materials for reprocessing varies considerably with savings up to 95% for aluminium but only 20% for glass (Australian Government, 2008b).

This indicator standard is achieved by developments that demonstrate some use of recycled materials.

#### **3.4.2** Renewable

Considering the life cycle of building materials is important in order to assess the impact they have on the greater environment. Materials that come from a renewable resource have a reduced environmental impact. The building industry has a substantial impact on biodiversity and clearing native vegetation for timber is one of the most serious. Using timber from certified plantation forests is a good way to reduce the impact on biodiversity.

This indicator standard is achieved by developments that demonstrate the use of renewable materials for house construction.

#### **3.4.3** Low Embodied Energy

Embodied energy is a measure of the quantity of the energy: (1) bound into a product due to raw material extraction and manufacturing processes required to produce a finished product; (2) associated with transportation of raw materials to the factory and of finished products to the customer (Utama and Gheewala 2009). Bribián et al. (2009) found that the proportion of embodied energy in materials varies between 9 and 46% of the overall energy used in the building life span when dealing with low energy consumption buildings and between 2 and 38% in conventional buildings.

Embodied energy is the energy consumed by all of the processes associated with the production of a building, from the mining and processing of natural resources to manufacturing, transport and product delivery. It does not include the operational or decommissioning phase of a building. (Australian Government, 2008b). Embodied energy can be the equivalent of many years of operational energy and it is for this reason that it is important to consider when doing a life cycle analysis of a building (Pullen 2007).

This indicator is complied with by developments that demonstrate the use of low embodied energy materials.

#### **3.4.4** Low volatile organic compounds

Volatile organic compounds (VOCs) are indoor contaminants which can affect human health, comfort and productivity (Wang et al. 2008; Yan et al. 2009). The sources of VOCs include: outdoor air, building materials (floor materials, wallpapers, ceiling materials, sealants, coatings, etc.), air-conditioning components (air filters, ducts, etc.) and human beings (Kagi et al. 2009). The concentration of VOCs depends not only on emission and ventilation rates but also on the sorption/desorption rates to and from the surfaces of the rooms (Seo et al. 2009). The Kagi et al.



(2009) study found that VOCs could be emitted not only from the interior body of material but from surface finishes and by reaction on material surfaces with UV irradiation. Photocatalytic oxidation is an innovative and promising approach for the quick and economical removal of VOCs from indoor air (Mo et al. 2009).

Using certified products and building materials is an effective approach to reduce VOCs (Nicolle et al. 2008). The Green Building Council of Australia recommended a third party certification scheme supplied by Forest Stewardship Council (FSC) and Good Environmental Choice Australia (GECA) to select low VOCs products. Volatile Organic Compounds (VOC's) are chemicals containing carbon that evaporate into the atmosphere at room temperature. VOC's are present in a wide range of household products, construction materials and new furnishings. VOC's present in building products slowly 'offgas' into the surrounding air. The presence of VOC's in the air can lead to health problems including eye, nose and throat irritation, headaches and lethargy (Australian Government 2008b).

The indicator is complied with if a development addresses the reduction of VOC's in the materials used to construct the houses.

## 3.5 Construction Methods

**Definition:** Construction Methods relates to innovative methods and techniques that will contribute to improved affordability and environmental sustainability.

In order to develop housing that is more affordable and sustainable close attention must be given to construction methods. There are many methods in use in the Australian context and each has advantages and disadvantages depending on complex relationships between many factors including but not limited to climate, availability of materials and skilled labour, budget and social acceptability and desirability of the final appearance. Construction methods can be loosely divided into lightweight and heavyweight and in most climates a combination of these in any one dwelling will produce the best overall outcome in economic and environmental terms (Australian Government 2008b)

Innovation in construction methods must be considered in the context of triple bottom line sustainability rather than just as advancement in technology. For example prefabrication of buildings has the potential to maximise energy efficiency while minimising waste and controlling cost, but is it socially acceptable? Itard and Klunder (2007) argued that it is imperative to use appropriate construction methods to reduce the embodied energy, which is estimated to be about 20% of the total primary energy use of the building for a life cycle of 50 years.

### Sub-Indicators

#### 3.5.1 Alternative

Alternative construction methods in the context of this research are any methods that are not considered to be conventional for the local building industry. In Australia low and medium density housing is primarily of light weight timber or steel frame construction with a masonry skin. This conventional approach rarely delivers the most thermally appropriate or even the least expensive solutions for Australian housing needs.

An example of alternative construction in this context would be reverse masonry veneer. Such construction has the potential to offer high thermal performance while not greatly increasing construction costs as the methods are not far from being conventional. There are many other examples of alternative construction however the exploration of these is not the focus of this research.

The alternative construction methods available in the market include: rammed earth (Paul and Taylor 2008), adobe construction (Shukla et al. 2009), straw bale (Lawrence et al. 2009), tilt-up and recycled car tyres (Ganjian et al. 2009).

This indicator is complied with by developments that demonstrate some form of alternative construction.



**Plate 4: Rammed earth construction**

### **3.5.2 Internal Thermal Mass**

Thermal mass is the ability of a material to store heat energy. Appropriate use of thermal mass in house construction can result in considerable improvements to comfort levels and at the same time reductions in energy demand for heating and cooling. Thermal mass must always be used in conjunction with good passive design principles. Specifically, high internal thermal mass means walls constructed in concrete, brick and block (trombe walls). Thermal mass can be classified as external thermal mass (heat transfer through building envelopes) and internal thermal mass (indoor furniture which affects the indoor air temperature through the process of absorbing and releasing heat) (Zhou et al. 2008). Studying the Australian residential construction, Gregory et al. (2008) found that the thermal mass had a dramatic impact on the thermal behaviour of construction modules. The reverse brick veneer (RBV) and cavity brick (CB) constructions were found to be the most effective walling systems in this regard.

Peterkin (2009) studied a sample of Perth houses and concluded that summer cooling is substantially dominated by the internal mass of the building (including the mass of the internal walls), and to a lesser degree by the passive solar design strategy that requires reduced windows on the east and west walls.

This indicator is complied with by developments that demonstrate the use of high thermal mass materials that are exposed to the indoor air and insulated from the temperature fluctuations of the external air.

### **3.5.3 Conventional**

Conventional construction methods in the context of this research are any methods that are considered to be conventional for the local building industry. Conventional methods need to be considered carefully before innovative alternatives are recommended. In the interests of affordability there are advantages to conventional methods in that they allow accurate budget forecasting and result in socially acceptable housing forms. These advantages must be weighed up against the ability of conventional methods in meeting energy efficiency benchmarks, and against the potential for innovative methods to reduce construction costs.

This indicator is complied with by developments that use conventional construction methods.

### **3.5.4 Prefabrication**

One construction method that has the potential to contribute to improved affordability and environmental sustainability is prefabrication. Many parts of a house made using conventional construction methods are already prefabricated. Prefabricated houses can offer the benefits of mass production- faster construction, greater quality control, waste minimisation, cost minimisation, better systems integration etc. The potential to maximise energy efficiency of a house by using the benefits of mass production while minimising waste and controlling cost is very attractive, so why is it not happening on a larger scale? Currently only a very small percentage of houses are constructed this way, and mostly at the high end of the market. Is this because the cost of a prefabricated home is not actually lower, or because the perception of the prefabricated home is such that buyers at the lower end of the market feel that there is a stigma associated with this type of construction?

The use of prefabrication can significantly reduce the waste generation on construction sites (Poon 2007). Based on a study in Hong Kong, Tam et al. (2007) found that up to 84.7% of construction waste can be reduced by adopting prefabrication. Jaillon et al. (2009) reports an ongoing study on the use of prefabrication in buildings and its impact on waste reduction in Hong Kong. Prefabrication is a possible solution to major causes of waste arising during both the design and construction stages. Prefabrication also contributes to other benefits on-site such as improved quality control, tidier and safer working environment, improved environmental performance, and reduction in construction time and labour requirements. Use of prefabricated building component is considered as the major effective measure to encourage the implementation of waste management plans (Tam 2008). Use of prefabricated units is rated by architects as one of critical waste minimisation design strategies (Osmani & Price 2008).

This indicator is complied with by developments that demonstrate some form of prefabrication in house construction.



**Plate 5: Prefabrication Construction Techniques (at Oxley Park, UK)**

### 3.6 Biodiversity

There are basic ethical reasons for the protection and enhancement of biodiversity in housing developments as this contributes to environmental sustainability in the broadest sense. The impact of development in general on the loss of species of flora and fauna has been observed around the world and there is an imperative with enlightened urban design and construction to minimise this phenomenon.

What may be a greater motivator for communities to consider the preservation and encouragement of biodiversity in developments is the gain of so-called ecosystem services (Roetman, 2008). These are numerous and include moderating effects on climates and micro-climates, the enrichment of earth and soils, the cleaning and purification of water and air, and the decomposition of waste materials. The tangible benefits of these ecosystem services to urban developments are a general improvement to the amenity of a locality through the conservation of nature leading to a greater sense of community wellbeing (Roetman and Daniels, 2008). In terms of financial benefit, the promotion of biodiversity can result in improved land value, desirability of a location and increased marketability of dwellings.

Roetman and Daniels (2008) have suggested some design features which should be considered in new urban developments. These were not generally part of design briefs in previous decades which tended to modify the topography of a development site rather than mould the streets and infrastructure to the natural contours. Similarly, riparian features should be retained and vegetation along waterways maintained. This should be coupled with the limitation of impervious surfaces to limit the impact on aquatic biodiversity in accordance to water sensitive urban design (WSUD) principles. Greenfield developments should incorporate biodiversity corridors that connect with surrounding undeveloped land to maintain continuity and avoid fragmentation.

Brownfield developments also have potential for reinstating vegetation which is water sensitive and predominantly native but with some exotics. A comprehensive set of indicators has been developed by the Urban Development Institute of Australia in the EnviroDevelopment (2009) framework, which includes the use of green walls and roofs incorporating native plant species, community gardens, reduction of heat island effect by the minimisation of pavement and car parks and the use of mature trees in landscaping.

For developments in general, an ecological assessment should be made as part of the preliminary work. The assessment classifies ecological features and processes, identifies possible environmental impacts and describes the impact mitigation strategies.

The encouragement of biodiversity is an indicator of environmental sustainability which has not been comprehensively developed in this research but may be addressed in future work.

### 3.7 Affordability

**Definition:** Affordable housing is housing that is reasonably adequate in standard and location for a lower or middle-income household; and does not cost so much that such a household is unlikely to be able to meet other basic living costs on a sustainable basis.

As already discussed in Chapter 2 of this report, there are difficulties in quantifying what constitutes 'affordable housing'. While common conceptual definitions like the one above are worked into ratios of income to housing costs, in many instances, this is a limited indicator of housing affordability as it fails to consider other issues, such as costs of running a home and associated travel over the life of the household. Thus, while a home may be affordable in a strict financial sense at the time of purchase, it may well be unaffordable over the lifetime of the household living in that dwelling due to energy, maintenance and transport costs.

Affordability is strongly influenced by land cost since this is a significant part of the total cost of housing, and it is this cost of this component of housing, rather than construction costs, which has dramatically increased in recent years. The cost of the dwellings themselves (on a cost per square metre basis) will be influenced by the design and choice of materials. However, durable houses where ongoing maintenance costs are kept to a minimum dictate good design with robust materials which often means higher construction costs.

Other indicator frameworks have grappled with how to quantify affordability, recognising that it represents something more than income to housing costs ratios. For example, a 2004 AHURI report (Blair et al, 2004) identified 12 indicators of housing affordability, including median house prices, income to housing cost ratios, development costs, housing assistance, and returns on investments. Even 12 inter-related indicators, however, struggled to address affordability in a broader context.

More recent work undertaken by VicUrban (Victorian Government 2009) has gone part of the way to identify and attempt to quantify some of these factors. 'Housing affordability' is broken down into the following performance measures:

- Widening housing choice within developments
- Proportion of adaptable and accessible housing
- Proportion of affordable rental housing provided through accredited non-for-profit housing agencies
- Demonstrated 'whole of life' savings in terms of household expenditure and energy savings
- Location of housing with respect to transportation, employment and other services

However, even in this framework, it is difficult to adequately measure these aspects of housing in the same context of some of the more technical indicators regarding environmental sustainability which are well developed.



In the absence of the resources to effectively develop a more rigorous series of indicators around affordability, we have rested on the well accepted and widely used '30/40 split'. The '30/40 split' is an indicator of housing stress, which is experienced when more than 30% of household income is spent on housing costs for the bottom 40% of household incomes. Although this figure is conservative, it is the most commonly used in literature (as in AMP.NATSEM 2008; Australian Government 2008a; Department for Families and Communities 2009; Beer et al 2007; Berry et al. 2004; Disney 2007; Gurran et al. 2008; Yates et al. 2007; Yates et al. 2008) and significantly is used by the Australian Government. It is noteworthy, however, that income-to-cost ratios such as this are by no means a long-term international standard. Although the benchmark of 30% of household income is regularly used in Australia, it is in many ways socially defined as a socially acceptable amount of income that should be spent on housing. In years gone by, the socially acceptable figure has been less.

The '30/40 split' has been adopted and adapted by the South Australian Government in developing actual figures for what constitutes an affordable home for purchase or rent, presented in the below tables. These have been developed for both low and moderate income households as per the following definition:

*In South Australia, a low income is up to 80% of the gross annual median household income, and a moderate income household is between 80 and 120% of the gross annual median income.*

Affordability indicators	2009-2010	
	Metropolitan and Outer Adelaide	Rest of State
<b>Low Income (80% of median annual)</b>		
Annual median income	\$44,231	\$37,522
Indicative house purchase price	\$170,000	\$144,000
<b>Moderate Income (120% of median annual)</b>		
Annual median income	\$66,346	\$56,283
Indicative house purchase price	\$255,000	\$216,000

**Table 3: Figures for affordable housing for purchase in South Australia for 2009-10 (Department for Families and Communities, 2009)**



Affordability indicators	2009-2010	
	Metropolitan and Outer Adelaide	Rest of State
<b>Low Income (80% of median annual)</b>		
Annual median income	\$44,231	\$37,522
Indicative weekly rental	\$255	\$216
<b>Moderate Income (120% of median annual)</b>		
Annual median income	\$66,346	\$56,283
Indicative weekly rental	\$383	\$325

**Table 4: Figures for affordable housing for rent in South Australia for 2009-10. (Department for Families and Communities, 2009)**

### 3.8 Desirability

**Definition:** Desirability of a dwelling refers to how it exceeds the consumers' expectations. The desirability of a dwelling is typically reflected in its market value and interest from buyers and renters.

The price people will pay for a property is an indication of how desirable it is. The market is an excellent indicator of desirability (i.e. do people want to buy this product, as distinct from do they need this product) and is a measure of desirability that is not dependent on some form of subjective assessment. It can be measured by the average price paid for a property in a development through auctions or sales, or by average rents. It might also be measured by the average appreciation (or depreciation) in the value of homes in the development over time. In some government developments where the homes sales are restricted to low income earners the average time a property remains on the market in comparison with similar properties in developments in the proximity might become a measure or the appreciation of homes in the development over time might serve the same function. The key indicator is the price mechanism.

### 3.9 Density and Urban Form

When considering potential affordable and sustainable housing solutions, it is necessary to consider housing density and possible changes to the urban form considering the well-documented link between spiralling land costs and the housing unaffordability (see, for example, Yates, 2007, Australian Government 2008a).

Density is often a controversial term and it is poorly understood. As Forsyth (2003) notes, it is often feared by those imaging ugly, overshadowing buildings, and promoted by those who value urbane streetscapes and efficient infrastructure supply. While at a simple level it refers to the number of (housing) units in a given area, there are no agreed upon standard definitions. What constitutes medium or high density in Adelaide may not be so in Singapore or Tokyo. Additionally, there are issues when density is confused with levels of crowding (for example within a dwelling) or specific building types (Forsyth 2003). Compared with international cities, the density of the residential areas in Australian cities is relatively low. Cities such as Beijing, Singapore and Tokyo have average densities between 60 and 110 dwellings per hectare: Barcelona, London and Paris around 40 to 50 dwellings per hectare while Sydney, Melbourne and Adelaide average around 15 to 20 dwellings per hectare (SA Government, 2009). Increased densities have been linked to improved environmental sustainability. Specifically, as densities increase, the costs of servicing key infrastructure drops. Additionally, per capita energy consumption drops, especially when residents make a transition from private vehicles to public transport and increased levels of walking and cycling (Towers 2002).

Generally, conventional housing in Australia consisting of detached houses is not greater than 12 dwellings/hectare (2900 people/km<sup>2</sup>), semi-detached housing not greater than 18 dwellings/hectare (4200 people/km<sup>2</sup>), row housing about 46 dwellings/hectare (8000 people/km<sup>2</sup>) and apartments about 152 dwellings/hectare (22,000 people/km<sup>2</sup>). For a mixed residential development, a typical density would be 58 dwellings/hectare (9000 people/km<sup>2</sup>). The following photographs illustrate typical built forms at different densities.



Plate 6: Low density development (5 dph)



Plate 7: High density development (135 dph)

The international benchmark for 'sustainable density' based on a number of pieces of research is approximately 25 – 35 dwellings per hectare (Hall 2001). In other words a medium density is suggested as the optimum and this is endorsed by Australian research by Myers et al (2005) and Perkins et al (2009) who looked at energy consumption and greenhouse gas emissions of outer and inner suburban dwellings and city apartments. The draft 30-year Plan for Greater Adelaide which is seeking to increase densities to up to 35 dwellings per hectare along transit corridors is one such policy response which reflects this research.

In a British context, Towers (2002) cites work by Llewellyn-Davies (2000) who link densities with certain housing forms:

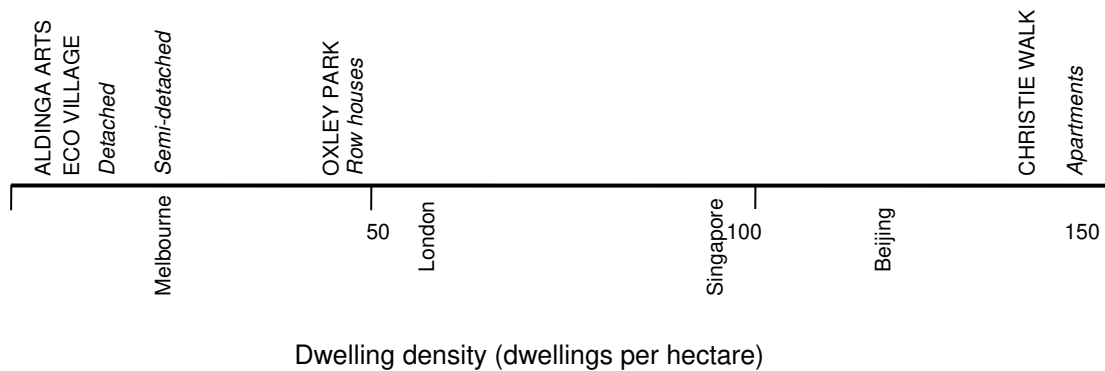
- Detached dwellings can achieve a maximum density of 10 dph
- Semi-detached dwellings can achieve a maximum density of 16 dph
- Terrace dwellings can achieve a maximum density of 53 dph
- 4-storey flats can achieve a maximum density of 155 dph
- Mixed houses and flats can achieve a maximum density of 140 dph.

Combining this data with the 'sustainable density' figure argued by Hall (2001), it would suggest that, in a very general sense, the most urban form would be terrace/row dwellings, such as those shown below in Plate 8. However, considerations of affordability, as well as many other variables will influence any housing outcomes.



**Plate 8: Medium density development (45 dph)**

Figure 7 below places Australian developments in context by highlighting where specific developments and housing forms fit in comparison with the average densities of Melbourne, London, Singapore and Beijing. It is notable that the inner-city development of Christie Walk in Adelaide is substantially higher than stereotypically “high density” cities such as Singapore.



**Figure 7: Comparison of densities**

The derivation of densities can be problematic. While terms such as low/medium/high density are regularly used, these terms are poorly understood and vary considerably between jurisdictions. Table 4 below outlines what is considered very low, low, medium and high density in locations in Australia, the UK and the USA. There are also issues regarding whether gross or net densities are used when stating the overall density. Differing inclusions in the base land area calculation (such as roads and public open space) can result in huge variations in the final density (Forsyth 2003). In South Australia, gross density refers to “the density of a given area, including infrastructure such as public roads, public open space and in some instances non-residential development such as schools and shops” whereas net density refers more explicitly to the number of dwellings (and their private open space) per hectare of land (SA Government 2009 p.5)..

Density has more recently been calculated by considering the number of habitable rooms per hectare. This measure is particularly useful in medium and high density developments and is able to provide a better indication of the intensity of a land use and comparative sizes of developments. This measure can also be a more effective way of determining the potential population (Towers 2002). A habitable room is any room in a dwelling used for living accommodation (e.g living rooms, bedrooms etc) but excluded bathrooms, toilets and kitchens less than 2 meters wide. Planners at Woking Borough Council in southern England use both a dwelling per hectare and a habitable room per hectare to understand density (Woking Borough Council 2000). Other measures of density include people per unit area, bed spaces per unit area and housing floor space per unit area (Towers 2002 p.147).

	South Australia		Woking Borough Council, UK		Pleasant Grove City, Utah, USA
	Gross	Net	Net	Habitable rooms	Net
Very Low	<11 dph	< 17 dph			1-2 dpa 2-5dph*
Low	11-22 dph	17-33 dph	< 25 dph	<100 hrph	2-4 dpa 5-10 dph*
Medium	23-45 dph	34-67 dph	25-50 dph	100-173 hrph	5-6 dpa 10-15 dph*
High	> 45 dph	> 67 dph	47-74 dph	173-247 hrph	>6 dpa >15 dph*

**Table 5: Comparison of densities in Australia, England and the USA.**

Source: SA Government 2006; Woking Borough Council 2000; Pleasant Grove City 2008

Note:

Dph: Dwellings per hectare

Hrph: Habitable rooms per hectare

Dpa: Dwellings per acre

\*Dpa has been converted approximately to Dph on the assumption that 1 Ha = 2.47 Acres

The ideal dwelling density required from the point of view of human needs is debatable as it will depend on many issues including cultural, personal and climatic factors and no attempt is made here to identify a minimum. Indeed, the question of density and 'liveability' is one that is subject to research and it is likely that increased density produces both positive and negative outcomes (Betanzo, 2009). Some of these issues are discussed further in the context of dwelling size and social acceptability.



### 3.10 Dwelling Size

**Definition:** Dwelling Size- increasing floor areas can unnecessarily reduce affordability and environmental sustainability. Conversely minimum floor areas are required for health and well-being. Floor area requirements can depend on the number of occupants but Australia has no such regulatory standards.

There is no provision within the current Building Code of Australia (2009) for a minimum dwelling size albeit there has been provision made in the past (for example, the South Australian Building Act 1923-53). However most European countries with the exception of England and Wales have minimum dwelling sizes. Average useful floor space in Europe is around 100 square metres, with Belgium and Luxembourg having an average floor space of 130 square metres. In Scandinavia, the Netherlands and Germany the building regulations also cover minimum room size and regulations require the provision of lifts in blocks of flats, disabled persons access, the size of door and stair openings and level or near level access at the front door (Goodchild 1997, Oxley and Smith 1996). These latter requirements are consistent with the requirements for commercial housing in Australia (ABCB 2009).

Minimum dwelling size regulations ensure that the size of rooms and storage spaces in residential developments provide for the well-being of residents. They are intended to ensure sustainable development that provides a useable and flexible environment, and which allows residents to undertake a range of activities. These activities include bringing up families, enabling home work opportunities and social activities. Moreover space in a dwelling should be sufficient to provide for residents' changing needs. In this sense, minimum dwelling sizes are about making provision for adaptability.

Of interest here is the UK Code for Sustainable Homes, which states that local authorities should encourage new housing that incorporates design principles that address health and well-being, energy/CO<sub>2</sub> and waste. These items are linked to the space provided in dwellings. The design principle of health and well-being encourages the provision of homes that are adaptable for future needs. Similarly the energy/CO<sub>2</sub> category requires drying space for clothes, storage space for bicycles, and the space for occupants to set up a home office in a quiet room. The waste category supports the inclusion of space for the separation and storage of recyclable materials (CSH 2006).

Minimum dwelling size requirements give an indication of what are considered to be socially acceptable standards by a given community. European dwelling standards suggest that on average a minimum useful floor space of 100 square metres is required for a sustainable dwelling.

## **Sub-Indicators**

As discussed above there are no legislated minimum dwelling sizes for housing in Australia. The closest indicators often occur in different Council Development Plans which may relate the number of bedrooms or occupants in a dwelling to the number of required carparks. Unfortunately this is not consistent amongst Councils in South Australia however it does provide a clue as to the thinking of some of our legislators who clearly link the number of occupants to the number of bedrooms which in turn are linked to the number of required car parking spaces. Greater alignment may be achieved in time with the 'Better Development Plan' program seeking to create a greater degree of consistency between councils' development plans. Given that the general minimum number of car parking spaces for a residence is 2 except for some forms of public housing (SA Housing Trust) which can be granted an exception for 1 only car parking space it is reasonable to assume that a sub-indicator for dwelling size is the number of car parking spaces required by the development.

### 3.11 Adaptability

**Definition:** Adaptability is used to describe a house that has been constructed to allow low-cost and low-energy modifications, to suit the changing needs of the occupants. Examples include additional bedrooms, home offices and modifications for elderly residents.

Building adaptation has attracted attention from both academics and industry practitioners in recent decades. Wilkinson et al. (2009) investigated all the buildings in the Melbourne CBD including details of physical, social, economic and technological attributes. Their findings indicated that building adaptation is necessary to meet the targets already set for carbon neutrality by 2020.

There are social, environmental and economic benefits associated with building adaptation. As part of urban regeneration, adaptation helps to retain the social and cultural capital embodied in buildings (Bullen, 2007). Adaptation is inherently sustainable as it involves less resource consumption, less energy consumption and less pollution (Mercer et al. 2007). According to the Australian Greenhouse Office estimation, the reuse of building materials saves approximately 95 per cent of embodied energy. In addition, adaptability increases the value of the building (Yau et al., 2008).

Mercer et al. (2007) argued that adaptability should be one of the key criteria of design competition for 'affordable green housing' so that ecological, socio-cultural and built contexts can be creatively adapted (see also Williamson et al. 2003). Minami (2007) studied the post occupancy changes in housing units which had employed a KEP (Kodan Experimental-housing Project) movable partitioning system. KEP design principles make it easy to adjust room arrangements to fit lifestyles changes.

Adaptable house design allows the house to meet the specific needs of the user, while maintaining the appearance of the house until more obvious accessibility features are needed (Demirkan 2007). An adaptable house is one which is able to respond effectively to changing household needs without requiring costly and energy intensive alterations. Australian demographics are changing rapidly with average households becoming both smaller and older, with an increasing number of people living independently in their later years. The balance between home and work life also places altering demand on houses as many people choose to work from home offices. A single space may act at different times as a home office, a teenage retreat, a family study or a bedroom for an elderly relative (Your Home Tech Manual).

This indicator standard is achieved by developments that require at least some proportion of housing to be designed for adaptability. Adaptability is often reflected by the application of 'Universal Design Principles'. These Universal Design Principles mean that the dwelling is designed to be useable by most people over their lifetime without the need for major adaptation or specialised design (Landcom). The Australian Network for Universal Housing Design (2009) has identified 7 key universal design principles. The principles are:

- **Equitable to use** (Housing design should be useful, appealing, and marketable to all potential home occupants with diverse abilities)
- **Flexible in use** (Housing design and product selection should accommodate a wide range of individual preferences and abilities)
- **Simple and intuitive to use** (Housing design and layout should accommodate all home occupants regardless of their past experience, familiarity or cognitive ability)
- **Easy to interpret** (Housing design should communicate environmental information to the home occupant, regardless of ambient conditions and ability)
- **Safe and sensible to use** (Housing design minimises hazards and adverse consequences of unintended actions)
- **Requires low physical effort** (Housing design and product selection should be easy, comfortable, and efficient to use to accommodate a wide range of individual preferences and abilities.)
- **Promotes ease of approach to housing features and elements** (Living spaces designed to ensure sufficient area is provided for the home occupant to easily approach, reach, and manipulate the elements within their home environment.)

Some housing providers, such as Housing SA, have adaptable housing policies which reflect these principles, as well as various Australian standards and guidelines, including:

- Australian Standard AS4299-1995 Adaptable House.
- AS1428.1-2001 Design for Access and Mobility.
- AS 1428 (Set)-2003 : Design for access and mobility Set
- AS 1428.2-1992: Design for access and mobility - Enhanced and additional requirements - Buildings and facilities.
- Your Home: Design for lifestyle and the future / © Commonwealth of Australia 2008 ISBN 978-1-921298-01-1

Currently, despite the fact that adaptability and the application of universal design principles is becoming an increasingly important concern of developers, planners and policy makers, there is limited empirical research on how adherence to these can be effectively validated. Future research should address this issue.

### 3.12 Social Acceptability

**Definition:** Social Acceptability is defined as the acceptability of a development by the surrounding community. This can be reflected in formal actions (e.g. submissions to a development assessment panel) or informal behaviour (community perception and local responses).

There are also measures of housing utilisation that are salient to social acceptability. Such measures are based on subjective assessments of the acceptable size of a household in relation to the size of the dwelling.

The concept of housing utilisation is used in the ABS' Survey of Income and Housing (SIH) and is based upon a comparison of the number of bedrooms in a dwelling with a series of household demographics such as the number of usual residents, their relationship to one another, age and sex. There is no single standard of measure for housing utilisation.

The Canadian National Occupancy Standard for housing appropriateness is sensitive to both household size and composition. The measure assesses the bedroom requirements of a household by specifying that:

- there should be no more than two persons per bedroom
- children less than 5 years of age of different sexes may reasonably share a bedroom
- children less than 18 years of age and of the same sex may reasonably share a bedroom
- single household members 18 years and over should have a separate bedroom, as should parents or couples.
- a lone person household may reasonably occupy a bed sitter

Households living in dwellings where this standard cannot be met are considered to be overcrowded.

The standard itself is a subjective measure based on community norms and social mores. A more objective measure might be developed for the assessment framework relative to the scale of social acceptability of a development. For example is the proposed sale of the St Clair reserve at Woodville to developers for a TOD in return for the LMC buying contaminated land at the Actil site for redevelopment as open space more or less acceptable? A number of community consultations have been held all of which indicate majority community disapproval of the sale as have most formal submissions to the council by concerned residents. Despite this the Charles Sturt Council has approved the development and the South Australian government recently gave its assent to the land swap to proceed.

In this sense the development is acceptable because it has been approved by the elected members (both Local and State) and the council planners, because in their expert opinion it is acceptable but it

is not from the perspective of most of the participants who took part in the community consultations and who have consistently rejected it. So who in this case best represents the community? If there are few or no objections to the development from the community and the council approves it then there would be no argument. But if there are community objections expressed in a public forum or through submissions to council then even if the council or another structure of government approves a development then it cannot be said that the development is completely socially acceptable.

Some developments such as Newport Quays, and the development of the Le Cornu's site in North Adelaide have been rejected at community consultations and by the local council because the development was in breach of the local development plan. Such developments have nevertheless gone ahead because the state government has pushed it through by granting the developer major project status and effectively taken those developments out of the normal planning assessment and approval system. Such developments might be considered to have lower social acceptability than the development at Woodville since both the community and a layer of government have raised objections. Thus indications of social acceptance might be scaled according to the level of objection and acceptance. A project attracting the support of the community, local government and state government might rate highly on a scale of social acceptability. A development that was supported by the state government and local government but not by the local community might rank lower and a development rejected by the community and local government but supported by the state might rank lower again.

### **Sub-Indicators**

**3.12.1** Social acceptability to surrounding communities as measured by submissions to development assessment panels

**Social acceptability** as measured by submissions from the local community to local government development assessment panels. Formal objections to a development submitted to a DAP are frequently submitted by members of the community as an expression of perceptions of the development.

**3.12.2** Social acceptability as expressed in community consultations

Responses to local or state government community consultations on significant developments are an expression of social acceptability. Consultations are often in the form of community meetings, surveys or focus groups with concerned residents.

**3.12.3** Social acceptability to Local Government

Social acceptability as measured by the acceptance or rejection of a proposed development by a local government DAP or other local planning authority with regulatory powers.

#### **3.12.4** Social acceptability to State Government

Social acceptability as measured by the acceptance or rejection of a proposed development by State Government.

#### **3.12.5** Granting of major project status

In South Australia, the granting of major project status to a development by the State Government takes dilutes the role of local government and local communities in the planning process and is often an indication that the State wishes to override the objections of local communities to a development that the State Government perceives to be in the interests of the state.

#### **3.12.6** Canadian National Occupancy Standard

A subjective measure of social acceptability that sets normative standards that are used to assess overcrowding. The CNOS indicates how many rooms are needed to accommodate a household of a given size in reference to subjective norms for the number of people who will sleep in each bedroom. Households living in dwellings where these norms are breached are considered to be overcrowded. A development marketed to a particular demographic group would be required under CNOS to have dwellings that have enough bedrooms to suit the socially acceptable norms for the people that are meant to utilise these dwellings.

### 3.13 Summary: The Assessment of Affordability and Sustainability

This chapter has undertaken a comprehensive analysis of the many different components of affordability and sustainability. In some instances, this has taken shape in the form of some technical specifications and well-researched metrics. In others cases, the analysis has been more descriptive, seeking to define ‘jargon’ in a way that enables the indicator to be understood. In some instances, the analysis has not progressed beyond a discussion of definitions because the means for effective measurement are not currently well developed. Occasionally we have offered suggestions of possible measurement mechanisms as outlined in our research. Naturally these will require further research.

The over-riding purpose of this chapter is to delineate the notion of affordable and sustainable housing into a series of indicators that can assist to produce housing solutions that are affordable and sustainable in the economic, social and environmental spheres. The theoretical research in Chapter 2 identified that there are areas where the objectives of affordability and sustainability converge. Accordingly it is appropriate, when considering whether a particular dwelling or development is affordable and sustainable, to treat each of the above as indicators, which when combined give an indicative measure of the extent to which the proposal accords with best practice in terms of affordability and sustainability.

The following table provides an assessment framework that could be developed as a tool for industry to better understand how their products reflect the joint goals of affordability and sustainability – issues which have traditionally been considered in isolation.





## Chapter 4: Case Studies – Current Best Practice in Affordability and Sustainability

### 4.1 Introduction

The purpose of this chapter is to test the usefulness of the indicator framework presented at the conclusion of chapter 3 using recent housing developments which demonstrate current best practice in one or more components of affordability and sustainability. The selection of the recent and/or progressive housing developments was carried out to include:

- several South Australian housing developments which have some affordable and/or sustainable housing characteristics
- reference to interstate developments to provide a national perspective
- two overseas developments to give an international comparison

These developments, their locations and size are summarised in Table 7.

The approach undertaken in analysing the nine cases studies is to identify and assess the key elements of economic, social and environmental sustainability in these projects. The cases are compared around the following broad indicators identified in Chapter 3: Energy efficiency; Water efficiency; Construction materials; Construction methods; Financial procurement; Affordability; Desirability; Dwelling size; Appropriate density and Social acceptability.

No	Name	State/ country	Location	Development Size
1	Inspire	South Australia	Noarlunga, 30km to south of Adelaide CBD	28 dwellings in Stage 1
2	Lochiel Park	South Australia	Campbelltown, 8km to north east of Adelaide CBD	100 dwellings when complete
3	Christie Walk	South Australia	Adelaide CBD	24 dwellings of various forms
4	Mawson Lakes	South Australia	12km to the north of Adelaide CBD	4,000 dwellings by 2010
5	Aldinga Arts Eco Village	South Australia	45km to the south of Adelaide CBD	Currently 55 dwellings
6	Landcom NSW designs	New South Wales, Australia	Various across NSW	Various depending on particular project
7	K2 Melbourne	Victoria, Australia	5km to the south east of Melbourne CBD	96 apartments
8	BedZED	United Kingdom	14km to south of London CBD, near Mitcham	99 dwellings
9	Oxley Park	United Kingdom	70km to north west of London	145 dwellings

**Table 7: Housing developments selected for analysis and their location**

In this chapter, comparative analysis is used as a tool to examine the similarities and differences among the nine cases studies. The chapter contains a general discussion of each of the developments, while Appendix B summarises the analysis against each of the indicators in a tabular format. The analysis of each development is followed by a discussion about the emergent similarities and differences among the developments, before the Assessment Framework (presented in Chapter 3) is populated. Through this process, a summary score is derived for each development, and finally conclusions are drawn.

## 4.2 Discussion of local, national and international developments

### 4.2.1 Housing SA Project – Inspire (Noarlunga, SA Australia)

#### Project background

Inspire has recently been developed in the Adelaide suburb of Noarlunga, on the fringe of the Noarlunga Centre regional centre. Located near the Centro Colonnades shopping centre, Inspire is close to public transport and is readily accessible from the Southern Expressway. Although not a public housing development with most dwellings being sold to home purchasers, Inspire was developed by Housing SA.

Inspire is the culmination of four years of design and planning through a master planned approach to the development cycle. In 2005, Housing SA embarked on an ambitious project to reassess the housing models being developed with the intent to provide a model which had a balance of affordability and sustainability (Brock Harcourts n.d.).

The first footings were poured in February 2009 and the houses are now in various stages of construction. The first eight houses were due for completion in October of 2009 to coincide with the opening of the display homes and sales office for the development.

#### Addressing the Affordable housing and Sustainability Criteria

All houses are designed to achieve a 6.5 star energy rating. They are all well insulated and contain energy efficient appliances. Landscaping design is environmentally sensitive with water tolerant plantings, efficient irrigation systems, predominately native vegetation with a preference for local plants and a good integration of the development within its surrounds (ibid).

Water is collected at each dwelling and water efficient appliances have been chosen for the development. All homes have a 1000 litre rainwater tank plumbed to the toilet and drip irrigation systems for watering the front yard. Civil works have been designed to incorporate stormwater cleansing pollutant traps.

The land was subdivided to provide a range of small, well oriented and affordable Torrens Title allotments with the cheapest property priced at \$249,500. “Homezones” allow pedestrians and vehicles to share roadways. Pathways are integrated with the development and connect the development with the surrounding community (ibid).

Single storey homes within the project were carefully designed to meet the Housing SA requirements for adaptability. As such, the homes for purchase were built in such a way as to meet the needs of people who might otherwise be the clients of Housing SA’s rental services. The remaining homes

have been provided with accessible entries but there have been issues in achieving compliant paths from the boundary to the front doors of some of the dwellings.

In relation to material selections, the project has been certified as meeting the HIA Greensmart requirements, but in general terms construction materials are conventional except for the use of low VOC paints. According to Housing SA's estimates, more than 95% of all building waste generated by the project has been recycled.

The adaptability features of all dwellings single storey dwellings and the ground floors of two storey dwellings included:

- Accessible entry and sheltered porch.
- Enhanced design of doorways with a minimum 820mm leaf for all doors.
- Extra circulation space and offsets at doorways.
- Power points, fixtures and door furniture located and set out at universally acceptable heights, generally 900 to 1100mm above floor level, with wall power outlets 400 to 450mm above floor level.
- Spacious bathroom designed to meet all the accessibility requirements i.e. a step-free shower, a toilet within the bathroom and reinforced wall construction to accommodate future grab rails when required.
- Wider circulation space between kitchen benches (1500mm).
- Carport with widening at side and extended paving on dwellings with single garage.
- Minimum 1m wide external paving.

These features reflect the Housing SA "Design Criteria for Adaptable Housing" (Department for Families and Communities n.d.). The land was purchased by the South Australian Housing Trust in the 1970's, hence it is difficult to ascertain the true present value as it could not represent the tax advantages enjoyed by the government over that time. The only real figures available are those approved by the government i.e. \$3.5M for the land development cost and \$3.15M for the Stage 1 Construction costs.

Procurement was carried out according to Housing SA procedures.

#### 4.2.2 Lochiel Park at Campbelltown (middle-ring suburb), South Australia

The Lochiel Park development was intended as a mix of natural parklands linking directly with the River Torrens Linear Park and a small area of housing development. This development commenced in 2004. Lochiel Park is only 8 kilometres from the Adelaide Central Business District (CBD) and sits alongside the River Torrens in the suburb of Campbelltown. The site has been transformed from a former education institution to a model green village incorporating a raft of best practice sustainable technologies. On completion, Lochiel Park will serve as a model for other urban developments and assist in educating the public and the property development industry about sustainable housing and land development (LMC n.d., Lochiel Park Online n.d.).



Plate 9: Lochiel Park.

#### Addressing the Affordable housing and Sustainability Criteria

Some of the completed homes have used passive design techniques to achieve energy efficiency by maximising the thermal performance of the dwellings. This has been enhanced by a behavioural change of the homeowners and by the selection of materials with low embodied energy. Similarly, the aim of the development is to decrease the use of fossil fuel derived energy by increasing to 15% the energy generated via renewable techniques within ten years (LMC n.d., Garnaut Climate Change Review 2009).

Water management includes the adoption of design principles such as a fit-for-purpose approach. With respect to construction materials, building designers have had to consider the environmental effects of construction materials and products over their whole life cycle and then incorporate those considerations into a sustainability strategy. Other examples of sustainability include the creative use of building materials and methods, for example reverse brick veneer to maximise thermal mass and energy efficiency (LMC n.d.).



**Plate 10: Lochiel Park.**

Construction waste is aimed at reducing the amount of construction waste and conserve resources through re-use or recycling of materials to reduce the environmental impact from material manufacturing and transport.

Financial procurement was through The Land Management Corporation (LMC) under instruction from the Government.

The concept of Social Acceptability is demonstrated through the ‘community garden’ and private open space being provided to help foster a sense of community. The incorporation of Crime Prevention through Environmental Design (CPTED) principles has also contributed to this concept. Additional social benefits include the reduction of transport demand and provision of food production capability.



### 4.2.3 Christie Walk, Adelaide, South Australia

Christie Walk is an 'eco-city' development in Adelaide, South Australia. The goal of this housing project was to create a liveable, affordable and environmentally benign urban community that provides a practical prototype for the ecological development of Australian cities. The project consists of 27 dwellings, four of which are three-storey townhouses with full solar orientation, a three storey block of six apartments with east-west orientation, four standalone cottages and a 'community house'. Another 13 dwellings were added with the construction of Stage 3, a 5 storey apartment block facing onto Sturt Street. As of early 2007, some 42 people lived at Christie Walk, ranging in age from less than one year to over 80. Site population density is 210 people per hectare (42 people on a 2000 square metre site) (Urban Ecology 2007; Reid 2005).



Plate 11: Christie Walk.

#### Addressing the Affordable housing and Sustainability Criteria

Mains electricity is drawn from the grid but photovoltaic panels set on pergolas over the apartments' roof garden generate electricity for sale to the local energy utility. The expectation is that the site will be a net energy exporter for much of the year as the dwellings require little energy for space and water heating, cooling or lighting.



Additionally, the dwellings have solar hot water with electrical backup heating – gas backup was not practical for multi-storey use. The apartments have a shared system with banked solar panels and a single pump and backup heater. Low water use shower heads and in-line flow restrictors control the water supply. Under bench filters provide drinking water at very low flow rates (Urban Ecology 2007; Reid 2005)..

Christie walk has been carefully developed to reduce the environmental impact of construction materials. Construction materials and finishes used throughout are non-toxic in accordance with the policy of avoiding formaldehyde and PVC. . Timbers are plantation (pinus radiata) or recycled (typically, oregon). The environmental plus cost criteria for materials led to unexpected choices with aesthetic benefits, e.g. purpose-built spiral stairs in steel and recycled jarrah timber. All concrete in slabs and mass walls contained the maximum percentage of flyash that the engineers and suppliers (Pioneer Concrete) would allow. This is significant as cement production is one of the largest single global contributors to greenhouse gas emissions.

Some aspects of construction waste reduction are demonstrated through paving, carports and feature elements incorporating bricks, stone, steel and timber retrieved from demolition of existing structures on the site.

The financial procurement model adopted evolved around the project being designed for a group of clients represented by a development cooperative, Wirranendi Inc, created by Urban Ecology Australia. The clients included first-time home buyers, investment purchasers, experienced home owners seeking the advantages of an urban lifestyle and older people wanting to retire in the context of an active, mixed community. The land was owned by the Wirranendi development co-operative during construction and individual properties were then sold on a community title basis (Urban Ecology 2007; Reid 2005)..

With respect to affordability, the house prices (which include a share in community areas and facilities) range from \$150,000 to over \$400,000. The non-profit structure of the development cooperative and building company was an essential part of keeping house prices in a range comparable to conventional inner-city properties in Adelaide.

The social acceptability element is demonstrated through reduction of transport demand and provision of food production capability as part of the strategy for this project. The site's location within walking distance of good public transport meant fewer cars were needed and the Council planners supported a lower than usual car park provision (initially 10 spaces for 13 two and three bedroom dwellings). Despite extreme site limitations, it was possible to include a small community garden to demonstrate that even the tightest urban site can produce food.



Plate 12: Christie Walk.

#### 4.2.4 Mawson Lakes (middle-ring suburb), South Australia

This master planned residential development has its origins in the South Australian Government's plans for a Multifunction Polis (or MFP) where the aim was to develop a modern high-tech community of the future. After the MFP concept was abandoned, the site was taken on by the property developer Delfin Lend Lease who has a successful track record of residential development at Westlakes and Golden Grove in South Australia and several other developments throughout Australia.



Plate 13: Mawson Lakes.

#### Addressing the Affordable housing and Sustainability Criteria

Important characteristics of Mawson Lakes were urban design and character, information technology, access to education, business and employment, energy and environment and social development at the level of world's best practice in the early 2000s (Delfin n.d.). Mawson Lakes is 12km to the north of the city of Adelaide and includes Technology Park, the Mawson Lakes campus of the University of South Australia, Endeavour College, as well as growing residential and commercial zones. It also contains the public transport hub Mawson Interchange, which is expected to become one of the five busiest stations in Adelaide. Mawson Lakes is a fully planned 600 hectare community which, by 2010 will have 10,000 residents in up to 4,000 homes, and facilities for 7,000 workers and 7,500 students. A large proportion (30%) of open space has been set aside and this (189 hectares) includes 70

hectares of lakes, waterways and wetlands. A 26km network of bicycle trails links all residential villages with the community's recreational and sporting facilities as well as the commercial facilities (Delfin n.d)..

Homes have been designed for energy efficiency with Home Management Systems which have the ability to control irrigation, air-conditioning and energy usage. Base power load demand is believed to be lower than Adelaide's average per dwelling but this is offset somewhat by the high peak loads in summer and winter due to a reliance on air conditioning in most homes (Saman and Mudge 2003).



**Plate 14: Mawson Lakes.**

Water management includes connection to a recycled water system and mandatory solar hot water. All property titles have an encumbrance that requires each house to have a dual water supply at the time of construction. Non-potable water is delivered by a purple pipe system and permitted uses for this are for toilet flushing, garden watering and car washing. This water system which became available in 2005 is also used for irrigation of public open spaces and for the artificial lake top-up.

The development initially focussed on two storey houses but later stages included low rise multi-storey apartments, townhouses and units as well as retail and commercial properties. There is a Mawson Lakes Community website which provides advice and encourages further energy and water efficiency via detailed information sheets on being 'energy smart', shading and orientation, water and energy efficiency requirements and dwelling orientation (Delfin n.d.).

#### **4.2.5 Aldinga Arts Eco Village (outer suburb), South Australia**

The Aldinga Arts Eco Village is a 34.4 hectare site situated approximately 45 kilometres south of Adelaide, on the north Fleurieu Peninsula, at the southern extremity of metropolitan Adelaide. It is located adjacent to the township of Aldinga and the suburb of Port Willunga and is approximately 1km inland (AAEV 2009).

The Aldinga Arts Eco Village calls itself an “intentional community” with a strong emphasis on community events, common lands and participation in the day-to-day running of the village. It is the result of 15 years of planning and organisation and with construction of homes commencing in 2003, there are currently (2009) 55 completed houses, with a number in the planning and construction stages (ibid).

The development consists of 169 commercial and residential allotments, as well as communal neighbourhood orchards, eight stormwater collection points and an amphitheatre for outdoor events. A large area to the west of the site has been designated for a village farm, to be developed using permaculture principles with the goal that the village feeds itself by 2020. The site also has its own on-site wastewater treatment facility, allowing the re-use of water in food production (Xu 2008).

The majority of dwellings within the village have been developed privately and are detached dwellings. However, there is an exception i.e. a section known as the ‘terraces’ is providing house and land packages in the form of single and two storey apartments.





Plate 15: Aldinga Arts Eco Village

### **Addressing the Affordable housing and Sustainability Criteria**

Additionally, another site within the development is providing affordable housing that is consistent with the village by-laws in terms of environmental sustainability features. 'The cottages' as it is known is being developed by Co-built and will contain 24 detached and semi-detached homes, each containing 2-bedrooms and having a floor area of 76 m<sup>2</sup> (Co Built 2009). These cottages, which sold off the plan for approximately \$185,000 each, contain impressive environmental features, such as in-ground rainwater tanks, solar hot water, solar PV cells and internal thermal mass (being constructed as reverse brick-veneer) (ibid). Thus, these homes are affordable both in terms of construction and living costs.

The Aldinga Arts Eco Village was developed using a community title scheme, whereby residents purchase their individual allotment as well as a share in the common land. A legal entity was established called the Aldinga Arts Eco Village Community Corporation. Under the Community Corporation, the village is governed by a series of by-laws, in addition to the usual planning and regulatory constraints. This means that buildings must receive approval from the Community Corporation as well as from the local council. This ensures that buildings in the village reflect the desired environmental sustainability criteria (Xu 2008).

The by-laws cover a variety of areas, including:

- Village ethos and philosophy
- Common property
- Development of privately-owned allotments
- Ecologically sustainable development
- Use and maintenance of lots
- Control of pets
- Supply and maintenance of water treatment and sewerage
- Communications infrastructure
- Community Corporation
- Management and financial issues.



**Plate 16: Aldinga Arts Eco Village**

In terms of environmental sustainability, there are two factors that are emphasised in the village

1. Passive solar designs which maximise energy efficiency. This is facilitated by the site's geography (with the village being located on the northern face of a hillside) and a series of design techniques.

2. Open space considerations to enable the development of a village common, community garden, and horticultural and recreational areas

Some of the more technical components of the by laws regarding the construction of the homes are summarised in the design guidelines (AAEV 2008) and relate to:

- Materials, embodied energy, life cycle costs,
- Thermal mass and thermal comfort levels. Limiting thermal mass on southern and western walls.
- Insulating materials
- Size and placement of windows
- Orientation
- Implications for heating and cooling
- Rainwater storage (min 10000L)
- Solar hot water
- Solar PV cells
- Roof forms
- Relationship of building to common land
- Fencing
- Access to local cool breezes
- Gardens and landscaping
- Recycling
- Use and storage of chemicals and gas
- Orientation
- Use of PVC materials

(AAEV 2008)





Plate 17: Aldinga Arts Eco Village.

#### 4.2.6 Landcom NSW designs

Landcom (originally named the Land Commission) was established in 1975 to offer affordable houses on Sydney's fringe. From 2002, Landcom became a state owned corporation and a development arm of the New South Wales Government and today is a leading master planner, facilitator and developer of sustainable communities in NSW.



Plate 18: Landcom Designs (NSW)

#### Addressing the Affordable housing and Sustainability Criteria

Landcom claim that they are the only developer in the world that measures its performance of social and environmental achievements as well as financial outcomes (Landcom n.d.). They produce an annual sustainability report based on Triple Bottom Line reporting. There are 34 indicators covering urban water cycle management, moderate-income housing provision, effectiveness of community consultation, community facilities, welcome programmes, consumer education on sustainable living, recycling and reuse of construction materials, energy efficiency, influencing design, sustainable or renewable energy supply, native vegetation management, riparian corridor management, conservation of indigenous and non-indigenous heritage, regulatory compliance, profitability, financing capability, return to government, job creation, demonstration projects, internal and external training,



supplier pre-qualification, stakeholder relationship management, aboriginal employment opportunities, employee satisfaction, employee retention rate, internal energy use and greenhouse gas emissions, strategic and complex development (Landcom n.d.).

Whilst most of its projects are residential in nature, Landcom also engages in a range of industrial, commercial, retail and mixed-use developments. As such, it adopts a leadership role by taking on large and complex projects which are underpinned by commercial viability in conjunction with innovation in urban design, sustainability and affordability.



**Plate 19: Landcom Designs (NSW)**

#### **4.2.7 K2 (inner suburb), Melbourne, Victoria**

The K2 development has been described as the “most environmentally sustainable public housing development in Australia” (Victorian Government 2009). The development contains four buildings on a 4800 sqm site, housing 96 apartments. It is located in Windsor, an inner suburb that is walking distance from central Melbourne and due to the development’s inner-city location and proximity to public transport, only required 52 car parks to be provided for the 96 units. Pedestrians are given priority over vehicles in the development. There are currently (2009) some 150 people living in K2. The development has a strong focus on housing for the disabled, with 49 apartments being designed to be accessible to people with disabilities (Victorian Government 2009).

#### **Addressing the Affordable housing and Sustainability Criteria**

The orientation and positioning of the buildings themselves and each individual apartment in the buildings was carefully considered to ensure maximum amounts of natural light could be experienced by all. This has meant that each apartment facade has a slightly different facade orientation. The height of the buildings and the distance between the front and back pairs were calculated to ensure that every unit would receive northern sun all year round, thereby providing natural light to all residents and improving air quality throughout. The buildings are four, five and eight storeys tall. Consideration was also given to air temperature and quality, with apartments designed to allow cross-ventilation. Heat loss is minimised by limiting window areas on the south, east and western walls.

Because of rainwater harvesting, grey water re-use, solar water heating and photovoltaic panels, in comparison to a standard apartment, each year, each K2 Apartment is anticipated to use:

- 55 per cent less mains electricity
- 46 per cent less gas from the mains supply
- 53 per cent less mains water (Victorian Government 2009)

#### 4.2.8 BedZED (inner suburb), London, UK

BedZED is an eco community, consisting of 82 homes built on reclaimed land in Wallington, Surrey and was completed in 2002 (the Peabody Trust, the social minded housing association and charity in London behind the development). The BedZED development initially caused some disquiet in the media when it was finished and opened in 2002 but has since been praised for its environmental innovations. The BedZED design concept was driven by the desire to create a net 'zero fossil energy development', one that will produce at least as much energy from renewable sources as it consumes. Only energy from renewable sources is used to meet the energy needs of the development. BedZED is therefore a carbon neutral development - resulting in no net addition of carbon dioxide to the atmosphere (Twinn 2003, Arup 2002, Bioregional 2007.).



Plate 20: BedZED.

#### Addressing the Affordable housing and Sustainability Criteria

Homes have been designed for energy efficiency with the baseline for energy use in typical new households provided by the 2002 revisions to the Building Regulations. These already achieve significant energy savings for a new home, for example around 50 per cent savings compared to the 1990 Building Regulations (DTI, 2004). A typical 3-bedroom semi-detached house built to the 2002 Building Regulations with a gross floor area of 100 m<sup>2</sup> now produces around 0.47 tonnes of carbon



(tC) emissions per year on average (EST, 2003). This compares to the 1.8 tC for an average UK household built to non conforming standards (Lazrus 2002).

The finish in each property was designed with the environment in mind. This includes energy saving appliances and light bulbs as standard. The use of energy meters in each home helps make energy consumption more visible to the individuals in their homes thereby becoming more aware of the amount of energy used by different household tasks. Some of the good practices identified were as follows: (1) Energy saving appliances and light bulbs as standard; (2) Use of energy meters; (3) Combined heat and power plant (CHP) which harnesses the heat that is produced as a by-product of generating electricity and puts this to further use (Twinn 2003).



**Plate 21: BedZED.**

Water management within the homes addressed two important elements namely:

- pipe work, fittings and appliances that effectively and reliably fulfil their intended role;
- behaviour of the occupants.

The aim was a reduction in water use to 72 litres/person/day, which equates to a 58% reduction compared to the UK average consumption. Sustainable drainage systems (SUDS) reduced flooding whilst boosting biodiversity. Waste water recycling and efficient fixtures and fittings reduced mains water consumption. Some of the good practices identified were as follows: (1) restrictors to prevent

excess flows; (2) mains pressure water flow to showers (to avoid the use of individual power-showers); and (3) making consumption rates on water meters visible to consumers (Bioregional 2007.).

Construction materials were specially designed to store heat when warm and release heat during colder weather, therefore the BedZED eco community is built using renewable or recycled materials, sourced from sustainable forests and other sources.

The housing and sustainability criteria of construction methods for the ZED House types fits into the Housing Corporation “Modern Methods of Construction” Category and includes “Off Site Manufacture” sub assemblies and components.

#### 4.2.9 Oxley Park, (outer suburb), Milton Keynes, UK

Oxley Woods is an affordable and sustainable greenfields development in the UK developed as a result of a central-government sponsored competition. The “Designed for Manufacture” competition (DFMC) was developed to showcase “how to build cost effectively across a range of housing types without sacrificing quality and sustainability standards” (DFMC 2006). The competition is providing government funding to projects around the UK which will demonstrate that a high quality, environmentally sustainable home can be built for a construction cost of £60,000. The competition’s scope was broad, encouraging both traditional and contemporary construction materials and methods. Key criteria included a construction cost of £60,000 per dwelling for at least 30% of the dwellings, a minimum of two bedrooms and dwelling space of 76.5 sqm, high standards in terms of design and construction quality and set environmental sustainability benchmarks (DFMC 2006).



**Plate 22: Oxley Woods, Milton Keynes, UK.**

One winner was the residential construction company George Wimpey who, with the leading architectural practice Rogers Stirk Harbour and Partners (formerly Richard Rogers Partnership), came up with a ‘flat pack’ concept for starter homes. This concept is currently being developed at Oxley Park at Milton Keynes on a 3.6 ha site with 145 housing units, 43 of which will be affordable (22 shared ownership; 7 reduced cost sale; 7 low cost sale and 7 for affordable rent) (DFMC 2008). It is a greenfields site with minimal site preparation or remediation required. The DFMC site is one component of a larger development site and many homes have now been completed with construction commencing in 2006 and expected to be finalised by December 2010 (ibid).



In excess of the competition requirement, 38%, or 56 homes will be built for under £60,000. The densities will vary from 35-45 dwellings per hectare. The site involves a mixture of traditional brick construction, light steel and timber framed homes. The timber and steel frame designs come 'flat-packed' leading to economies of scale with the theoretical construction time reduced to 31 days. The proposal incorporates in-built flexibility with the option to physically bolt-on modifications, such as balconies, studies and canopies at a later stage. Further cost savings were made by designing homes in two distinct zones – a service zone with the complex but standardised features, such as plumbing and stairways, and a living zone designed as a flexible, open shell (George Wimpey n.d.).

### **Addressing the Affordable housing and Sustainability Criteria**

Although the DFMC was developed prior to the Code for Sustainable Homes, the standards are nonetheless high. Homes in Oxley Park will have low embodied energy materials, good solar orientation, high levels of insulation, air-tight construction, and 'EcoHats', which, being the 'next generation of chimney stacks', filter all incoming air, re-circulate hot air, maximise the intake of solar heat and provide passive solar water heating as an optional extra (George Wimpey n.d.). Reductions in the carbon footprint are claimed to be as follows: 27% from house construction, 40% with the inclusion of the EcoHat, 50% when the EcoHat is attached to top-up energy for a hot water system and 70% if the EcoHat uses geothermal energy sources through a local bore hole.



Plate 23: Oxley Woods, Milton Keynes, UK.

### 4.3 Similarities and differences

Initially, the nine case studies were analysed using the characteristics identified from the literature review which included measures of environmental, economic and social sustainability. Specifically, environmental characteristics consisted of energy efficiency, water efficiency, construction materials and construction methods. Economic sustainability, desirability (reflected in market value), financial procurement methods as well as affordability for both purchase or rent were considered. Dwelling size, adaptability, social acceptability and whether the design of the development was intended for outer or inner city locations were the social indicators.

While the nine developments are similar in the above mentioned sub-indicators, they differ in addressing the affordability criteria. Specifically, four of the local developments namely Inspire, Lochiel Park, Christie Walk and Mawson Lakes did not address this criterion. On the other hand, Aldinga Arts Eco Village and K2 Melbourne achieved this criterion with Landcom NSW Designs partly addressing the 'purchase' sub indicator.

Relative to the construction materials indicator, six of the developments including the two international developments met all the four sub-indicators of recycling, renewable, low embodied energy and low VOC's.. The international developments, as reviewed within this report, reflect the UK government's and Construction Industry targets and visions for sustainable construction and carbon neutrality to 2016 and beyond. The report 'a review of sustainable construction' published by the DTI (2006) highlighted the industry's vision with respect to materials as that of using sustainable materials/reduced primary materials consumption, and increased used of recovered materials. The UK government's vision was that of ensuring publicly funded houses to be in accordance with Codes for Sustainable Homes (CSH) level 3. On an overall comparative basis, the BedZED (UK) development performed much better across the full range of sub-indicators than all other developments reviewed. This initial analysis has highlighted the need to better define performance indicators and possibly introduce sub-indicators and specific metrics where appropriate.

## 4.4 Comparative Analysis of Affordability and Sustainability – An Assessment Framework

### 4.4.1 Background to the Assessment Framework

Chapter 3 concluded with an assessment framework based on the analysis of the various components of affordability and sustainability. In the assessment framework, individual dwellings or entire developments could be assessed qualitatively, and the various indicators given a ranking based on this assessment. A summary score would then provide an indication of which development best reflects current best practice in affordability and sustainability.

The comparative analysis of the nine developments in this chapter (including the information included in Appendix B) has been used to populate the assessment framework below. The limited scope of the research and the lack of empirically based measurement mechanisms for some indicators have prevented undertaking quantitative assessments and regression analysis. The purpose of the following analysis is not to quantify individual scores for affordability and sustainability for each project, but rather, to have an indicator of which developments seem to best reflect the objectives of affordability and sustainability.

To this end, the analysis has resulted in an assessment being made for each of the indicators and sub-indicators according to Table 8 below:

Assessment	Symbol	Ranking score
This development meets or exceeds the criteria of the indicator as outlined in Chapter 3. The project demonstrates current best practice in the field.	✓	2
This development goes some way to meeting the criteria of the indicator as outlined in Chapter 3. However, there is scope for substantial improvement.	Δ	1
This development does not meet the criteria of the indicator, as outlines in Chapter 3.	x	0
This symbol is used to display information for non-ranked indicators where it was not possible to make an assessment.	•	N/A

**Table 8: Classifications used in the affordability and sustainability assessment framework.**





The indicators in the assessment framework can be summarised as follows:

<b>Categorisation</b>	<b>Indicator</b>	<b>Sub indicator</b>
Environmental Sustainability	Energy Efficiency	7.5 Star or equivalent
Environmental Sustainability	Energy Efficiency	6 star or equivalent
Environmental Sustainability	Energy Efficiency	Active Solar electricity generation and/or water heating
Environmental Sustainability	Energy Efficiency	Solar Passive Design
Environmental Sustainability	Water Efficiency	Rain Water storage and re-use
Environmental Sustainability	Water Efficiency	Water Efficient Appliances
Environmental Sustainability	Water Efficiency	Water Efficient Landscapes (WSUD)
Environmental Sustainability	Water Efficiency	Grey water re-use
Environmental Sustainability	Construction Materials	Recycled
Environmental Sustainability	Construction Materials	Renewable
Environmental Sustainability	Construction Materials	Low Embodied Energy
Environmental Sustainability	Construction Materials	Low Volatile Organic Compounds (VOC's)
Environmental Sustainability	Construction Methods	Internal Thermal Mass
Environmental Sustainability	Construction Methods	Pre Fabrication
Environmental Sustainability	Construction Methods	Alternative/Convention (non-ranked)
Economic Sustainability	Financial Procurement	Government/Private/Public-Private Partnership (non-ranked)
Economic Sustainability	Affordability	Purchase
Economic Sustainability	Affordability	Rent
Economic Sustainability	Desirability	Market Value of dwelling
Social Sustainability	Dwelling Size	Diversity of dwelling sizes
Social Sustainability	Dwelling Size	Subjective size assessment
Social Sustainability	Appropriate Density	Low/Medium/High (non-ranked)
Social Sustainability	Adaptability	Universal Design Principles
Social Sustainability	Social Acceptability	Acceptability to the surrounding community

**Table 10: Summary of the indicators and sub indicators in the assessment framework.**

	Environmental Sustainability	Economic Sustainability	Social Sustainability	Total
<b>Indicators</b>	4	3	4	11
<b>Sub-indicators</b>	15	4	5	24

**Table 11: The number and categorisation of the various indicators.**

In analysing these indicators and sub-indicators, it should be noted that the framework was developed entirely on the basis of the research into the key characteristics of affordability and triple-bottom-line sustainability. It is noteworthy that the research yielded comparable numbers of indicators into each of the environmental, economic and social categories, suggesting that affordable and sustainable housing at a broad ‘indicator’ level, has balanced environmental, economic and social components. This supports the literature and theoretical research outlined in Chapter 2.

However, when analysing the sub-indicators which are performance measures used to identify whether a particular indicator has been met, there is not the same balance between the three categories. Specifically, with 15 environmental sub indicators, 4 economic sub indicators and 5 social sub indicators, it has been found that for every economic or social sub indicator, there are some 3 environmental sub indicators. This suggests that while there are important environmental, economic and social components to affordable and sustainable housing, the performance measures for the environmental components have been more thoroughly researched and developed. This may well have arisen because of the complexity associated with some economic and social sub-indicators, which, because of their nature, do not lend themselves to being as easily quantified as the environmental sub-indicators.

These factors have a strong bearing on deriving a summary score for each development in the assessment framework. Critically, as there are more environmental sub indicators than economic or social sub-indicators, a summary score may not give a true indication of how well a development reflects the indicators. Accordingly, in the summary scores, equal weighting has been assigned to environmental, economic and social components of affordable and sustainable housing. To arrive at a summary score, an individual score for each of the environmental, economic and social components was derived. The summary scores for each development in each of the environmental, economic and social categories was divided by the theoretical score for each component (that is, the maximum possible score by receiving a ‘tick’ against every indicator), and multiplied by 10. The summary weighted score out of 30 was then divided by 3 to provide an index out of a theoretical maximum weighted score of 10.



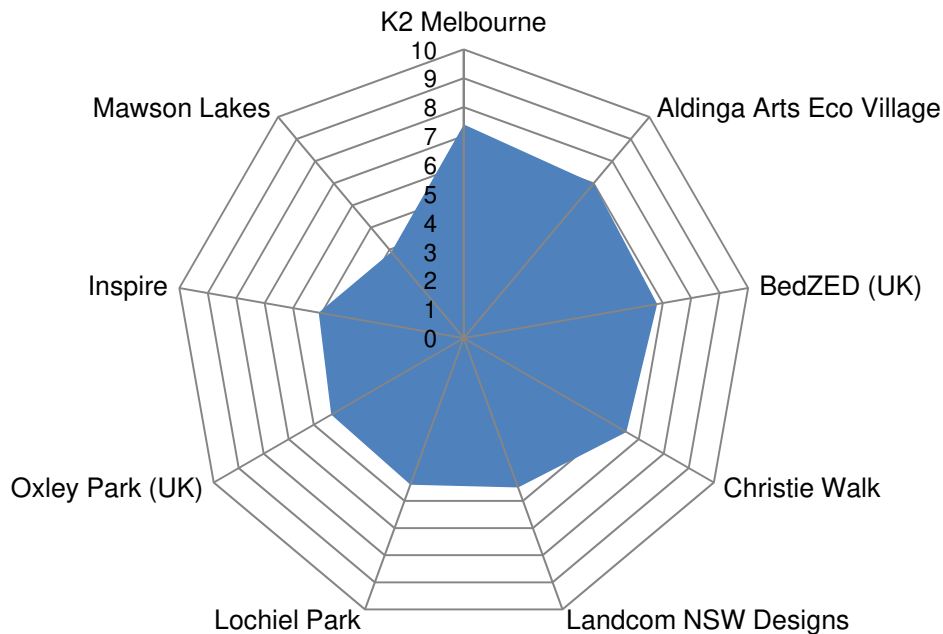
This summary score has then influenced a categorisation of each development, shown in Table 11 and Figure 8. Each development is categorised as a project which strongly, somewhat or does not reflect affordable and sustainable housing principles.

Projects which <b>strongly reflect</b> the principles of affordable and sustainable housing	Projects which <b>somewhat reflect</b> the principles of affordable and sustainable housing	Projects which <b>do not reflect</b> the principles of affordable and sustainable housing
K2 Melbourne	BedZED (UK)	Mawson Lakes
Aldinga Arts Eco Village	Christie Walk	
	Landcom NSW Designs	
	Lochiel Park	
	Oxley Park (UK)	
	Inspire	

**Table 12: The ranking and categorisation of each of the developments.**

The categorisation was developed as the result of analysis using the assessment framework with 24 sub-indicators. Equal weighting was given to economic, social and environmental indicators.

## Accordance with Affordable and Sustainable Housing Objectives



**Figure 8: The level of accordance with Affordable and Sustainable Housing Objectives of the nine case studies reviewed.**

When arriving at conclusions from these summary scores, it is necessary to be aware of the following limitations.

- The assessment framework and index scores are very rudimentary and have been developed making a series of assumptions
- Many of the indicators are complex and the assessment using three possible options (the ✓ Δ or x) does not reflect the complexity of each of the measures
- There are strong inter-relationships between many of the indicators
- There are strong inter-relationships between economic, social and environmental sustainability which are not recognised in the 'silo' approach of triple-bottom-line sustainability
- Many of the indicators have flow-on effects, whereby meeting one indicators has impacts on how well another indicator is met

- The equal weighting of economic, social and environmental components may need further consideration. Indeed, a stronger emphasis on affordable housing may result in a need for a stronger weighting for economic sustainability

Having acknowledged the above limitations of the weightings and summary scores, it is still possible to proceed with some general conclusions. The weighted summary scores provides an *indication* of which of the nine developments best reflect the identified characteristics of affordable and sustainable housing, in a context that provided equal emphasis on the environmental, economic and social components of housing.

The development that stands out is K2, the medium-to-high density public housing development in inner-Melbourne. The weighted summary score for this development suggests that the project reflects nearly three quarters of the affordability and sustainability criteria that were identified. On the basis of this analysis, this development is worthy of further, more detailed consideration. Other developments that scored well in our assessment include the Aldinga Arts Eco Village, BedZED in the UK and Christie Walk in inner Adelaide.

## 4.5 Summary

The purpose of reviewing the case studies was to identify and evaluate their similarities and differences using a comparative analysis in the form of the assessment framework. The basis for comparison was the extent to which the affordable housing and sustainable criteria had been addressed.

Although the methodology is limited, the assessment framework was used to derive a summary score for each development that gave equal weighting to the environmental, economic and social components of affordable and sustainable housing. These summary scores were then used to provide an indication of which projects best reflected the key aspects of affordable and sustainable housing identified in the research. As an interim conclusion, on balance, it seems that K2 and the Aldinga Arts Eco Village are the developments which best reflect the identified affordability and sustainability criteria.

In summation, the initial conclusions from the research carried out so far suggest that the indicators for *environmental* sustainability are quite well developed with substantial knowledge available on measurement and benchmarking of performance. However, it is likely that the benchmarks will need to be raised with time as higher levels of performance become desirable. The measurement of *social* sustainability on the other hand, is subject to differing interpretation and contemporary indicators will require further development. A comprehensive range of indicators and benchmarks will enable the identification of housing models which can provide affordable and sustainable outcomes across the full range of requirements.

## Chapter 5: Industry Input

This section of the report discusses the industry input into the project. It commences by providing a background to the industry discussion group, summarises the key outcomes of the group discussions and finishes by highlighting the implications of this input for the project.

### 5.1 Background to the discussion group

The Ecocents Living project, has, from the outset, been a collaboration involving academic, government and industry environments, which recognised the mutual benefits of a continual exchange of ideas. This has occurred in a significant way with the ongoing partnership between Hindmarsh and the Department for Families and Communities with the University of South Australia.

Broader industry engagement has also taken place in the form of an industry discussion group. On Wednesday 7 October 2009, an industry discussion group session was held at the University of South Australia to discuss the research findings to date, gain vital industry input and facilitate discourse among industry practitioners and the broader community about affordable and sustainable housing. The discussion group took place over a half day and began with a brief presentation summarising the project, before moving into a semi-structured discussion. The discussion was audio-recorded, and a summary of the key issues raised was distributed to participants after the event.

The discussion group was attended by 12 representatives from industry and the community, as well as six members of the research team. The industry and community sectors that were represented included:

- Construction firms
- Architectural firms
- Urban and social planning firms
- Local government
- Minister's Strategic Housing Advisory Committee
- Land Management Corporation, a government land development agency
- Housing SA, Department for Families and Communities
- 'Consumer' of sustainable housing

Prior to the discussion group, participants were provided with a briefing paper that outlined the project objectives and findings to date. Participants were also provided with a draft of the Affordability and Sustainability assessment framework. In preparation for the discussion group, participants were asked to reflect on the following questions:

- How well do the definitions (stated under the assessment framework) reflect your understanding of the terms?
- Are there any issues or indicators which have been overlooked in the assessment framework?
- How important is it to be able to measure “soft” indicators, such as social acceptability? How easily can this be done?
- In what ways could an affordability/sustainability assessment tool for housing work for you in the realisation of successful housing outcomes?
- What are appropriate housing solutions that are affordable and will be environmentally, socially and economically sustainable?

## 5.2 Key outcomes of the discussion group

The key outcomes of the discussion group can be broadly delineated into the following categories:

- Feedback on the affordability and sustainability assessment framework
- Housing Affordability
- The importance of design
- Other comments

### 5.2.1 Feedback on the affordability and assessment framework

The initial discussion focused on the draft affordability and assessment framework and participants were asked to comment on the assessment framework in terms of the suitability of the definitions, and how comprehensively it had addressed the issues associated with affordable and sustainable housing. Due to the fixed time of the discussion group, attention to each of the indicators and definitions was limited. However, valuable input was provided.

Overall, participants suggested that the assessment framework was a useful output inasmuch as it integrated components of environmental, economic and social sustainability housing as well as key aspects of affordability. Some participants noted that the framework could be further developed to become a useful assessment tool for industry.

While it was noted that indicators and metrics for the assessment of the environmental sustainability of housing are well developed, participants provided useful feedback on both conceptual and technical aspects of the assessment framework.

Specifically, there was substantial discussion on the need to decouple the indicators for energy efficiency and energy generation. In terms of materials, discussion regarding the sub-indicators resulted in the conclusion that a stronger emphasis is needed on durability and robustness, as well as issues of ongoing maintenance and occupants' health.

There was an interesting debate around innovations in construction materials and methods, in that some participants felt that structures in the industry, such as the Building Code of Australia, was limiting the pursuit of non-conventional materials and methods. Such regulation and structures potentially inhibit options that were affordable and environmentally sustainable. The example given was that in many places in the world, timber frame and clad buildings (which may be comparatively cheaper than steel framed buildings) are permissible at varying heights, an occurrence that is limited under the building code. While these views were not supported by all participants, some of whom highlighted the benefits of strong regulation in the industry, it nonetheless indicated that further research into the delivery of affordable and sustainable housing could consider the strengths and limitations of building regulation.

In terms of building adaptability, participants at the discussion group noted that Universal Design Principles address adaptability in a holistic manner and that these agreed standards should be the

benchmark in assessing the adaptability of housing. It was suggested that the Building Code of Australia potentially has a role to play in ensuring Universal Design Principles are included in new dwellings.

The following indicators were suggested for possible inclusion in the assessment criteria. Due to the timing of these findings, there was not scope in this project to comprehensively review literature and practice regarding these indicators. Rather, these four indicators should be the basis of future research should the affordability and assessment framework be further developed.

- **Safety.** This could include both physical features to facilitate passive surveillance, such as crime prevention through environmental design techniques, as well as residents' perception of safety in their neighbourhood.
- **Quality of life.** This indicator could assess the overall wellbeing and quality of life of occupants, reflecting issues such as time lost in travel and opportunities to develop social capital.
- **Quality of place.** This indicator could address design issues, both at a dwelling and neighbourhood scale. As later discussed, a strong theme of the discussion group was that successful affordable and sustainable housing outcomes may only be achievable through a high standard of design, and as such, strong design codes are needed.
- **Health.** The discussion group noted that the physical form of dwellings and neighbourhoods has considerable scope to facilitate physically and socially healthy communities. It was, for example, noted that walkability within a neighbourhood to basic services such as local schools and shops not only has health benefits but also contributes to the development of social capital.

### 5.2.2 Housing Affordability

Discussion group participants spent considerable time discussing housing affordability, the issues contributing to the problem, potential solutions and effective measures to adequately quantify housing affordability.

Participants were generally in agreement that simple income to housing cost ratios used to derive certain purchase and rental prices for housing poorly reflect the many issues that contribute to decreasing housing affordability. Similarly, there was agreement that it is impossible to consider housing affordability without an in-built transportation factor, considering the substantial impact transportation can have on households' living costs over a 25 year period. The example given was that while it may be affordable to purchase a home on the urban fringe for a relatively low cost, over a 25-year period, its occupants may spend the same value as the initial purchase price in excessive transportation costs. It was thus suggested that indicators of affordability must somehow consider the life cycle costs of living in the dwelling, in relation to transportation costs, not just affordability at the point of sale. This was linked to the discussion on developing a 'quality of life' indicator that looks at



the contribution of the family home to wealth creation, the development of social capital and overall wellbeing.

It was also noted that while the Ecocents project has specifically focussed on improving the affordability and sustainability of individual dwellings, there is a need to address the land cost issues because ultimately it is the spiralling land cost (rather than changes to housing construction costs) that has driven the current housing affordability crisis.

Discussion group participants reinforced the notion that any housing outcomes from the Ecocents project should be seeking to provide affordable housing across many different market segments, encompassing both subsidised housing as well as those struggling with home purchase and in the private rental market. This idea is well developed in the literature and has been a guiding principle for the entire project.

### **5.2.3 The importance of design**

Throughout the discussion around the many physical and social components of affordable and sustainable housing, it became apparent that good design can solve a myriad of issues, and that high quality design outcomes are particularly important when increasing building and population densities.

In terms of individual dwelling design, it was noted that internal design is important for overall wellbeing, health and in providing space for the development of social capital (by, for example, entertaining guests). It was in this context that participants discussed the roles of public and private open space, and how the design of public open space is increasingly important as dwelling and allotment sizes decrease. As one participant noted the success or otherwise of this style of development largely rests not with the design of residential buildings but with the effective design of the public realm.

There was also some discussion of the importance of the 'intermediate zone', that is, those areas which are neither public nor private space, but play an important role in developing social networks. Typically, these areas have been the front yards of houses, although different 'intermediate zones' may be required with more alternative housing forms at higher densities.

It was suggested that well considered, integrated design can make an important contribution to the social acceptability or otherwise of any given housing development.

### **5.2.4 Other comments**

Participants spent some time discussing the importance of community consultation, not only in the implementation of individual housing projects but in effectively assessing housing needs. It was acknowledged that while it is important to facilitate a wide range of housing choice in markets which

have not always provided diversity, the bigger issue is effectively understanding the needs and aspirations of current and future consumers. Some participants noted the important role played by builders and developers as “public educators” and the role played by sales consultants. Likewise, at the implementation end, it was noted that community “buy-in” and involvement is vital to the success of any project.

One participant noted that gender imbalance at the discussion group and used this to highlight how the construction industry is male oriented, and this has implications for the assessment of appropriate housing outcomes. This notion was well supported amongst other participants, some of whom highlighted that masculine and feminine approaches to design vary considerably. There is thus a need for equal gender representation in community consultation and needs analyses.

### 5.3 Implication of the discussion group for the Ecocents Living project

In summary, the diverse and collective expertise of participants at the discussion group provided valuable insight and input into the Ecocents project.

Specifically, while acknowledging the relevance and usefulness of the affordability and assessment framework, participants were able to suggest changes and additional indicators. Subtle changes have already been made to the assessment framework and more substantial changes will be considered in future research.

The discussion, however, was most useful when debating the conceptual challenges associated with the delivery of housing that is both affordable and sustainable in the broader sense of the term. Specifically, participants regularly pointed toward the land cost issue in discussing affordability, which in turn directed the conversation to discussions of appropriate densities for appropriate locations. Additionally, participants stressed the need to somehow consider transportation in the assessment framework, considering the potential impact transportation has on a household's living costs.

The other key outcome of the discussion group is the positioning of dwelling and neighbourhood ("urban") design at the forefront of possible models for affordable and sustainable housing. Importantly, the discussion group highlighted the needed for strong design guidelines to ensure that any housing models provide appropriate places for social interaction, especially in the absence of private open space and the 'intermediate zone' of interaction.

## Chapter 6: Possible models of affordable and sustainable housing

### 6.1 Introduction

The methodology of this research project was to triangulate information from a number of sources so that conceptual models of affordable and sustainable housing could be synthesised. The sources of information were as follows.

- Literature review
- Development of the indicators and assessment framework
- Study of a number of examples of affordable and sustainable housing
- Inputs from the Discussion Forum

During the course of the research, it became apparent that there was no universal solution to the design of affordable and sustainable accommodation. Different designs would be suitable for different circumstances such as the needs of the resident and the precise location for the dwellings. The latter was particularly relevant in the context of urban densification and its proposed adoption in city development plans including the 30 year Plan for Greater Adelaide (Government of South Australia, 2009). For these reasons, possible models were conceptualised at three densities being based on detached/semi-detached houses, row houses and apartments. These might also correspond to three locations, namely outer suburbs, middle-ring suburbs and city centre although it is recognised that the future construction of higher density transport oriented developments (TODs) in particular suburbs may have a place for all three types of model. It is emphasised that these models do not represent physical designs and do not preclude other possible solutions. What is important is that they cater for diversity in accommodation requirements.

## 6.2 Possible model 1 - Detached and semi-detached houses

- Semi-detached or detached housing at approximately 18 dwellings/hectare suitable for outer suburbs.
- The road layout is on a grid system with improved public transport accessibility. The grid layout promotes many intersections and places for pedestrian activity.
- Promotion of pedestrian usage over vehicular access with traffic calming and accessibility by foot to public transport corridors.
- Smaller private gardens and with public open spaces to encourage social interaction.
- Dwellings designed for adaptability as the needs of residents change. Consideration given to biodiversity needs particularly in the open spaces.
- Diversity in dwelling allotment sizes to ensure the developments are socially acceptable, desirable and thus sustainable. Such size diversity is particularly important in greenfields development which otherwise develop homogenously with negative social repercussions.

### *South Australian Application*

This model may be well suited to greenfields developments currently taking place on the urban fringe. The LMC is currently facilitating large residential developments at Seaford Heights in the south and Andrew's Farm in the north. The incorporation of affordable and sustainable housing in these locations would ensure that the traditional approach to improve affordability in new developments (smaller allotment and dwellings and cheap construction) does not impinge on the on-going running costs of these households, or the social sustainability of the development.



Figure 9: Conceptual model of affordable and sustainable outer suburban development.

## 6.2 Possible model 2 – Row houses

- Row housing at approximately 45 dwellings/hectare suitable for inner suburbs or part of transit oriented development.
- Focus on community facilities and usage of public transport.
- Small but well defined private space and good observation of streetscape for security (CPTED) purposes.
- Well defined public and shared communal space and severely restricted traffic speed.
- Some provision for adaptability in the design of dwellings as the needs of residents change.

### *South Australian Application*

This model may be well suited to middle-ring suburbs, the part of the city that is often forgotten by planners and policy makers. The row housing option is well suited to middle ring suburbs inasmuch as the higher land cost in these areas is counterbalanced through increased densities. Importantly, these low-rise buildings are relatively compatible with the existing suburban character and as such, are likely to be socially acceptable. Additionally, in terms of energy consumption, there is little change to the energy use compared with that of a detached or semi-detached dwelling, as lifts are not required for everyday access. This form of development is also able to facilitate the increase of housing supply and diversity in largely homogenous housing markets. Although a greenfields development in the UK, the Oxley Park development at Milton Keynes provides some guidance and indication of possible design outcomes for row housing.

Facilitating row housing in middle ring suburbs, in places such as Aberfoyle Park, would occur as these suburbs organically redevelop. As such, there is a greater need for flexible planning policy in development plans to facilitate this style of housing to ensure there are appropriate affordable and sustainable housing. There may also be a need to consider land assembly and site amalgamation in these middle ring suburbs, as high quality design outcomes which are affordable and socially, environmentally and economically sustainable may only result on larger allotments. Policy research to this end is needed.



Figure 10: Conceptual model of affordable and sustainable housing in a middle-ring suburb.



### 6.3 Possible model 3 – Apartments

- Apartments at approximately 150 dwellings/hectare suitable for inner city location or possibly transit oriented development.
- Increased population density with focal points for interaction such as a courtyard design of external common areas.
- Encouragement of community identity with social and meeting spaces along with public open space integrated within the development.
- Possible provision of community gardens.
- Strong emphasis on public transport usage and reduced provision for car parking..
- Accessible to residents requiring wheelchairs.
- Strong emphasis on a diversity of dwelling sizes and styles, and thus costs within each building to minimise adverse social outcomes.

#### *South Australian application*

This housing solution represents a marked difference from the existing character and is unusual in the Adelaide context. As such, it is only suited to a CBD location or an area which is seeking to develop a new and distinctly urban character, such as the Bowden Village north of Adelaide. Apartment development is the only urban form that is able to achieve substantial increases in densities, which facilitates affordability by maximising the use of land, the cost of which is premium in many inner-city locations. However, residential apartment development in Australian cities has not always been environmentally and socially sustainable, with high amounts of per capita energy consumption and undesirable social outcomes created by homogenous housing options within single buildings. As such, this model must create a diversity of housing options and consider how the development can have a reduced environmental impact. In terms of urban form, these apartments in bulk and scale could be as small as the Christie Walk development in Adelaide, although could be as large as the K2 development in Melbourne, which requires lifts.



Figure 11: Conceptual model of affordable and sustainable inner city development.

## 6.4 Common design features for environmental sustainability

All three conceptual models are likely to incorporate the following features:

### 6.4.1 Materials

- Low embodied energy materials
- Recycled and re-used materials
- Low toxicity materials
- Sustainably harvested timber

### 6.4.2 Passive design

- First principles of solar design for winter conditions maximising winter solar access
- Solar access to all living areas
- Avoid shading of adjacent buildings and existing developments
- First principles of solar design for summer conditions
- Shade living areas from summer extremes
- Additional shading for late summer temperatures
- Reduce proximity of hard landscaping materials to living areas
- Colours and materials to reduce solar gains through building fabric
- Internal thermal mass
- Double glazing
- Shading devices on north facing windows

### 6.4.3 Water conservation

- Rainwater harvesting
- Grey water re-use
- Low water consumption fittings
- Landscaping with indigenous shrubs and groundcover
- Some porous paving
- Bioswales to filter stormwater

### 6.4.4 Energy conservation

- Solar water heating
- Photovoltaic panels
- Maximum use of natural light

#### **6.4.5 Urban design**

- Public and shared communal spaces
- Reduced vehicular traffic or severely restricted
- Integration with surrounding streets and community
- Location near public transport and facilities
- Limited car parks

## 6.5 Delivery, policy and regulation

**Housing policy:** Affordable and sustainable housing may be developed in the first instance through a specific government-sponsored demonstration project. This may only occur as the result of department-level policy and ideological shifts that acknowledge the mutual benefits of a joint commitment to improve both affordability and sustainability.

**Structure planning:** Facilitating affordable and sustainable housing could play an important role in the structure planning of new development sites, whether greenfield or brownfield. Structure planning of new development sites can ensure that locations identified for the provision of affordable housing are well located to maximise the affordable housing's social sustainability, acceptability, desirability, and importantly, linkages with open space, transport, employment and other services.

**Development plans:** Development plans play an important role in facilitate affordable and sustainable housing options. Although mandating a minimum provision of affordable housing in new developments is commendable, development plans can also facilitate affordable housing by realistic densities and built forms, and thus, a diversity of housing options. This is particularly relevant in middle-ring suburbs, where affordable and sustainable housing is less likely to be provided as a result of a policy change or structure planning processes.

**Regulation:** The BCA and other building regulation should continue to play an active role in improving the environmental performance of all housing, including affordable housing. Doing so often results in small increased up-front costs, but long term benefits in comfort and running costs. Such benefits are particularly experienced by low and middle income households seeking affordable housing.

## Chapter 7: Conclusions and Recommendations

### 7.1 Conclusions

1. The Ecocents research project has provided a preliminary investigation of the issues concerned with affordability and sustainability in housing at a time when both areas are highly relevant in the Australian context. Despite the fact that these areas are quite complex in themselves, the project has bridged affordability and sustainability and provided a way forward to integrate the two in a logical manner. This has involved the consideration of both conceptual and practical matters.
2. The project has been based on an initial analysis of the concepts of affordability and sustainability in housing and it has been found that their objectives are similar in many ways and should be considered as mutually supporting. Furthermore, sustainability must be considered in a context that recognises the inter-dependence between economic, social and environmental sustainability. Housing affordability is thus an intrinsic component of sustainability.
3. Social acceptability is a key challenge that new housing innovations must address as sustainable housing techniques have had a remarkably low take up despite successful demonstration projects. This is especially relevant now that housing affordability challenges are being felt in sectors of the community that traditionally are not associated with disadvantage. There is the particular benefit of developing affordable environmentally sustainable housing because low-income households spend a larger portion of their income on utilities and transport.
4. The conceptual analysis resulted in the identification of key characteristics which were the basis of subsequent research into indicators of affordable and sustainable housing. Indicators were developed which, whilst preliminary in nature, spanned the spectrum of sustainability and included environmental, social and economic components. At this stage, 24 sub-indicators have been nominated.
5. It has been found that those indicators dealing with environmental sustainability are reasonably well defined in the research literature as are the levels of performance required for each sub-indicator. This is not the case with the indicators dealing with economic and especially social sustainability. These indicators require further definition and the methods for measuring performance are in need of considerable research to render the indicators useful when assessing affordable and sustainable housing.
6. The derivation of preliminary indicators has raised the question of weightings of sub-indicators and the subjectivity and complexity of assessment frameworks in general. This suggests that more research is needed in this area to determine a comprehensive and objective framework which provides a balanced assessment method of affordability and sustainability.

7. The main features of affordable and sustainable housing were also studied using nine existing developments with affordable and sustainable features selected from South Australia, interstate and overseas. This has enabled an initial testing of the assessment framework of indicators to take place and has highlighted different emphases on the three components of environmental, social and economic sustainability by the different developments. While our initial conclusions were based on an equal weighting of the economic, environmental and social components of housing, there is a need to empirically establish an appropriate weighting of the various components. The exercise also illustrated a range of solutions to the challenge of developing affordable and sustainable housing according to location and urban density.
8. A further mechanism to canvass issues and test the validity of the assessment framework of indicators was provided by the Discussion Group comprising a broad spectrum of interested parties. This reinforced the initial findings of the research and identified further issues which should be incorporated into research methodology. In summary, the issues are:
  - Durability, robustness and maintenance of dwellings.
  - Governance issues including restrictions caused by the Building Code of Australia, financial procurement and planning policy. Use of universal design principles to encourage adaptability.
  - Social factors i.e. safety, quality of life, quality of place and health.
  - Life cycle costs for households including transportation.
  - Importance of private and public spaces as well as intermediate zones.
  - Importance of community consultation.
9. Models for affordable and sustainable housing have been derived to summarise the concepts arising from the research. These are not intended as physical designs but are aimed at providing possible solutions to affordable and sustainable housing corresponding to different location and urban densities. They reflect the ideas generated by the research project particularly in terms of achieving successful neighbourhoods.
10. The success of affordable and sustainable housing projects can be confirmed post- construction when performance, as defined by indicators, can actually be measured. This suggests that monitoring of the performance of new and existing developments by means of post occupancy analysis should be considered in further research.

## 7.2 Recommendations

1. **Development and refinement of economic and social indicators. These are currently underdeveloped but are required to achieve a balanced approach to sustainability in housing developments.**
2. **Determination of weightings for sub-indicators so that relative importance can be assigned to the sustainability features of housing developments.**
3. **Maintain observation of new affordable and sustainable developments to ensure that the most recent knowledge is incorporated and to avoid duplicating research effort.**
4. **Include the suggestions of the Discussion Group in further research particularly with respect to:**
  - **governance issues eg Building Code of Australia, financial procurement and planning policy**
  - **universal design principles in both housing and neighbourhood environment to encourage adaptability and quality of place**
  - **life cycle approach to the performance of housing from a cost to household perspective.**
5. **Consider post occupancy analysis of new and existing affordable and sustainable housing projects as part of further research to test the validity of performance frameworks.**
6. **Incorporate all of these recommendations into a research project of national significance by means of an ARC Linkage grant with industry partners thus ensuring that the most recent research is channelled into new affordable and sustainable housing developments.**



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## Appendix A: Abstracts of Research Publications

### Peer-Reviewed Published Papers

Arman, M., Zuo, J., Wilson, L., Zillante, G., Pullen, S. (2009) Challenges of responding to sustainability with implications for affordable housing, *Ecological Economics* 68 (2009) 3034–3041.

**Abstract** - Sustainability is one of the most contested ideologies of our time because everyone acknowledges that it must occur but no one can agree on what needs to change in response. This is unsurprising, because objecting to the goal of sustainability is like objecting to other inherently good goals like peace or freedom. Responses to sustainability exist on a long continuum, with some interpreting sustainability to mean conservation-at-all-costs and reduced economic growth, while others suggest that the market will ensure sustainable outcomes eventually result. Further, sustainability can be easily manipulated to justify predetermined outcomes. There are, indeed, a multitude of conceptual and pragmatic challenges to operating on sustainability, particularly when the scale shifts from a global goal to local action. Using the application of sustainability to affordable housing in Australia as a case study, this article argues that rather than limiting sustainable outcomes, the existence of the sustainability debate which focuses on the many challenges is a positive indicator that sustainability may be attainable.

Zillante, G., Arman, M., Davidson, K., Wilson, L., Pullen, S., Zuo, J. (2009) The sustainable and affordable housing debate in Australia, *The CRIOCM 2009 International Symposium on “Advancement of Construction Management and Real Estate”*, 29th -31st October 2009, Nanjing, China.

**Abstract** - Improving the sustainability and affordability of housing tend to be parallel objectives among Australian policy makers. Whereas traditionally the objectives of housing affordability and housing sustainability were considered in isolation, policy responses are increasingly recognising the importance of both. However, any policy attempting to foster best practise in terms of affordability and sustainable housing must be able to link housing outcomes with the broader community; that is, affordable and sustainable housing must be socially sustainable. This paper considers social sustainability in terms of social acceptability, the minimisation of social exclusion and the fostering of social capital. Affordability is also analysed at a conceptual level before the concluding discussion attempts to overlay the two concepts in suggesting how social sustainability may be fostered in affordable and sustainable housing.

Arman, M., Wilson, L., Zuo, J., Zillante, G., Pullen, S. (2009) Conceptualising affordable and sustainable housing: Towards a working model to guide planning and construction, *Australasian Universities Building Educators Association (AUBEA) Conference 2009*, Adelaide, Australia.

**Abstract** - In Australia, sustainable housing has generally been constructed for the high end of the market while affordable housing has been synonymous with homes constructed of low-cost materials on the periphery of developments, suggesting a tension between the concept of affordable housing and sustainability. What is considered affordable and/or sustainable housing depends on how these terms are understood. This paper considers definitions of housing affordability, sustainability and sustainable housing, seeking a definition of affordable and sustainable housing that is flexible enough to meet the needs of diverse stakeholders and can be applied to differing markets and spatial locations. This definition is refined to a working model to guide planning and design that explicitly specifies what constitutes affordable and sustainable housing.

Zillante, G., Pullen, S., Wilson, L., Davidson, K., Chileshe, N., Zuo, J., Arman, M. (forthcoming) Integrating affordable housing and sustainable housing: bridging two merit goods in Australia, Chapter in Wallis, I., Bilan, L., Smith, M. and Kazi, A.S. (Ed.) Sustainable Construction: Industrialised, Integrated, Intelligent, I3CON handbook. Accepted for publication in 2010.

**Abstract** - Interest among planning and policy makers in environmentally sustainable housing has risen in recent years as a response to the global goal of attaining sustainable development. In Australia, there has long been concern that the market might under-provide affordable housing and, more recently, concerns have been raised over the capacity of the market to provide sustainable housing. Governments in Australia have intervened through subsidies, tax incentives and more direct forms of support for the provision of affordable and sustainable housing. Providing environmentally sustainable housing is thus perceived to be a “merit good” in Australia. That is, a good that has social merit but one that is underprovided by markets. Contemporary housing policy debate in Australia has emphasised the need to respond to a growing housing affordability challenge. Affordable housing might also be seen to be a merit good in Australia. Nevertheless there has been a reluctance to consider housing sustainability in the same context as housing affordability.

This chapter addresses the debate over affordable and sustainable housing in Australia by drawing on learnings from the Ecocents Living research project to suggest a conceptual basis to understand the issues at hand. Ecocents Living is a project that seeks to integrate the concepts of affordable and sustainable housing into a model to guide industrial implementation of sustainable and affordable housing. It is argued that the concepts of sustainable housing and affordable housing have synergies that warrant consideration and the further development of an embryonic model for integrating sustainable and affordable housing is offered in this chapter.

### **Papers under peer review**

Arman, M., Pullen, S., Zillante, G., Zuo, J. & Wilson, L. (2009) Affordable and Sustainable Housing: What can Australia learn from the UK? 4th Australasian Housing Researchers' Conference, Sydney, Australia.

**Abstract** - Improving housing affordability is a challenge for both the United Kingdom and Australia. Likewise, both countries are committed to sustainable development which inevitably means working the global goal into local policy responses. The two issues, however, need not be considered in isolation. Both countries need to develop housing that is both affordable and sustainable. This paper considers the history of affordable housing provision in the UK and compares this with the Australian experience. The paper then analyses recent affordability policy, developed at the same time as impressive sustainability policy that aims to see all new homes in the UK carbon neutral by 2016. The article looks at a practical application by summarising a new development at Milton Keynes. The concluding discussion considers what Australia could learn from the UK and what factors might inhibit an application of British policy and innovation to Australia's housing market.

Wilson, L., Arman, M., Zillante, G, Pullen, S. and Zuo, J. (2010) "National housing policy in Australia: are new initiatives in affordable housing sustainable?" submitted to "Critical Social Policy"

**Abstract-** Australians have traditionally enjoyed high rates of home ownership. However house price growth in Australia has outstripped income growth to the point where more than one million low and middle income households are now experiencing housing stress. Decreasing government involvement in the provision of housing and its replacement by a reliance on grants and market subsidies in accordance with neoliberal economic orthodoxy has recently been partially reversed by the Australian Commonwealth Government. New national programs have been established to build more social housing and improve private housing affordability. This paper critically reviews affordable housing provision in Australia and considers new initiatives such as the National Affordable Housing Agreements. We conclude that current initiatives remain constrained by hastily implemented policies, a 'rush to build' and a reluctance to provide an ongoing commitment to social housing with implications for Australia's capacity to provide traditional levels of affordable housing for its citizens.

## Appendix B: Assessment Tables for 9 Case Studies

### Case 1.0: Inspire at Noarlunga (middle-ring suburb), South Australia

No	Criteria for Comparison	Description
1	<b><u>Year of Development</u></b>	Currently being built
2	<b><u>Energy Efficiency</u></b>	<ul style="list-style-type: none"> <li>• 6.5 star rating</li> <li>• Incorporate energy efficient appliances               <ul style="list-style-type: none"> <li>• Gas connection provides to all houses with 5 star instantaneous gas hot water units</li> <li>• No high energy use lighting fixtures</li> <li>• Light fittings suitable for low energy use such as compact fluorescent lights</li> </ul> </li> <li>• The dimensions of the allotments were configured to facilitate the construction of homes based on passive design principles. These principles are possible to maximize the number of days of acceptable levels of thermal comfort without the expenses of operating artificial heating and cooling devices.               <ul style="list-style-type: none"> <li>• Effective insulation: R2.0 insulation to external walls; R3.0 insulation installed in ceilings</li> <li>• Orientation and location of living spaces to achieve good solar access to winter sun</li> <li>• A balance between minimizing the extent of east and west facing windows and the need for east and west facing windows for the purpose of providing surveillance from the house over activities in the street and for effective ventilation</li> <li>• Effective shading of windows during summer months</li> <li>• Zoning or closing off, of living spaces from the rest of the house to minimize the area of the house to be heated or cooled at the same time</li> <li>• An outdoor space located adjacent to a living area, which may be developed by the house owner as an outdoor living area.</li> </ul> </li> </ul>
3	<b><u>Water Efficiency</u></b>	<ul style="list-style-type: none"> <li>• Retain water individually</li> <li>• Water efficient appliances</li> <li>• All showerheads have 3 star WELS ratings</li> <li>• All tapware have 4 star WELS ratings</li> <li>• All toilet cisterns have 4 star WELS ratings</li> <li>• A 1000 litre rainwater tank plumbed to the toilet</li> <li>• Drip irrigation systems to the front yards</li> <li>• Water tolerant plants to the front yards</li> </ul>
4	<b><u>Construction Materials</u></b>	<ul style="list-style-type: none"> <li>• Design principles intend to produce a development which enhances the liveability of the housing whilst reducing wasted resources.</li> <li>• Meets HIA Greensmart requirements</li> <li>• Use low VOC paints</li> </ul>
5	<b><u>Construction Methods</u></b>	Intended to reduce waste and ensure that the environment is

		<p>not unduly affected. 95% of building waste is recycled.</p> <p>1. minimize the cut and fill</p> <ul style="list-style-type: none"> <li>• Stormwater management during construction</li> <li>• Stormwater diversion</li> <li>• Run-off control</li> <li>• Stockpile erosion protection</li> <li>• Site access control</li> <li>• Site stabilisation</li> <li>• Gross pollutant traps</li> </ul> <p>2. waste management (almost 100% of waste generated by project has been recycled)</p>
6	<b><u>Financial Procurement</u></b>	Developed by Housing SA using land owned since the 1970s. Development uses similar processes to other development agencies, such as the LMC. Individual procurement follows standard DFC procedures, with a strong emphasis on facilitating affordable purchase opportunities.
7	<b><u>Affordability (Cost of dwelling/rent)</u></b>	<p>The land was divided with great care to provide a range of small, well oriented and affordable allotments which maximize the usage of the land.</p> <p>A\$250,000 cap, affordability measure (construction price + land price)</p>
8	<b><u>Dwelling size/ appointment</u></b>	<ul style="list-style-type: none"> <li>• Approx. 155 metres of living area for 2 storey dwelling (not including carport and porch). No more than</li> <li>• Approx. 84 sq. metres of living space for single story dwelling.</li> <li>• Block sizes of 230 sq. metres</li> </ul>
9	<b><u>Outer/inner city suitability</u></b>	<ul style="list-style-type: none"> <li>• It is an outer city development but with block sizes smaller than in the inner city (230 sq. metres)</li> </ul>
10	<b><u>Adaptability (eg for people with disability):</u></b>	<p>The Adaptability features of all dwellings single storey dwellings and the ground floors of two storey dwellings included:</p> <ul style="list-style-type: none"> <li>• Stepless entry and sheltered porch.</li> <li>• Enhanced design of doorways with minimum 820mm doorleaf for all doors.</li> <li>• Wider circulation and offsets at doorways.</li> <li>• Power points, fixtures and door furniture located and set out at universally acceptable heights, generally 900 to 1100mm above floor level, wall power outlets 400 to 450mm above floor level.</li> <li>• Bathroom spatially set out and designed to accessibility criteria, including a stepless shower, toilet within the bathroom and reinforced wall construction so that grabrails can be fitted later as an adaptation.</li> <li>• Wider circulation between kitchen benches (1500mm).</li> <li>• Carport with widening at side and extended paving (not applicable to double carport/garage).</li> <li>• Minimum 1m wide external paving.</li> </ul>
11	<b><u>Social Acceptability</u></b>	<ul style="list-style-type: none"> <li>• The development is affordable housing characterised by small blocks and dwelling size but it is medium density housing. It is located at the “back of Bunnings” home depot</li> </ul>

		<p>at Noarlunga and is not in immediate proximity to many other dwellings. It is unlikely to attract objections to its development from surrounding communities.</p>
12	<b><u>Desirability</u></b>	<ul style="list-style-type: none"> <li>• The traditional approach in SA for increasing housing sustainability is by increasing housing density through the use of Community Title developments. The research found that many people are reluctant to live in housing which is governed by a community corporation and requires on-going payment to carry out the management and maintenance of the corporation. It also often results in each dwelling being significantly smaller than a dwelling on an individually titled allotment and often subject to more restrictions</li> <li>• One key element of this development is the creation of small individual Torrens titled allotments. Advantages of individually titled properties are: <ul style="list-style-type: none"> <li>○ Compact allotments which minimize the cost to purchasers through the efficient and effective use of land</li> <li>○ Each property has full control of the use of space within each allotment</li> <li>○ Ownership and control of the external space around the house</li> <li>○ Owners can make their own independent assessment and decisions on maintenance and improvements</li> <li>○ The timing of maintenance and improvements can be determined by the owner taking into account their financial situation</li> <li>○ There are no usual strata or community title corporation fees</li> </ul> </li> </ul>

## Case 2.0: Lochiel Park at Campbelltown (middle-ring suburb), South Australia

No	Criteria for Comparison	Description
1	<u>Year of Development</u>	Ongoing (Commenced in 2004)
2	<p><u>Energy Efficiency</u></p> <p><b>Miniature circuit breaker (MCB)</b></p> <p><b>Sustainability Goal:</b> increasing the use of renewable energy so that it comprises 15% of total electricity consumption within ten years (T3.10).</p>	<ul style="list-style-type: none"> <li>• 7.5 stars energy efficiency, Energy conservation achieved <b>through passive design techniques</b></li> <li>• Orientation: Each home's orientation and positioning on the site ensures the maximum possible benefit from passive solar gain.</li> <li>• Achieving daylight access into windows (for winter solar gain)</li> </ul>
3	<p><u>Water Efficiency</u></p> <p><b>Design Principles adopted:</b> The fit-for-purpose approach requiring the collection and use of rain water from individual house tanks for use in hot water systems and the use of treated storm water from community storage facilities.</p>	<ul style="list-style-type: none"> <li>• Use soil moisture detection devices to ensure plants are only watered when necessary.</li> <li>• Group plants with similar water needs together.</li> <li>• Collect and reuse water collected on site if possible.</li> <li>• Use mulch on garden beds, Use subsurface irrigation where irrigation is necessary</li> </ul>
4	<p><u>Construction Materials</u></p> <p>Only timbers that are supplied from sustainable plantation sources or locally sourced recycled timber. Ultimately, this would result in the creation of a healthy environment by minimising toxic out gassing (release of toxins as gas). Furthermore, the use of materials would take into consideration the greenhouse gas emissions and water use associated with their production</p>	<ul style="list-style-type: none"> <li>• Construction materials and products selected based on balancing the range of <b>environmental criteria</b> such as <b>low embodied energy</b> and highly <b>recyclable</b> content.</li> </ul> <p><b>Selection Criteria:</b></p> <ul style="list-style-type: none"> <li>• Eco-labelling and certification</li> <li>• High recyclable content or potential for recycling</li> <li>• Sustainable sourcing</li> <li>• Low embodied energy (the energy used in their manufacture).</li> <li>• Low pollution from manufacturing.</li> <li>• Low transport costs.</li> <li>• Minimal environmental impact</li> <li>• Durability and minimal maintenance</li> <li>• Non-hazardous</li> </ul>
5	<u>Construction Methods</u>	Straw-bale <b>construction</b> is a building <b>construction method</b>
6	<u>Financial Procurement</u>	<ul style="list-style-type: none"> <li>• The Land Management Corporation (LMC) under instruction from the Government. LMC purchased the surplus land for \$1.15m in 2002.</li> <li>• All consultants to date have been engaged using appropriate LMC procurement processes. The appointment of consultants reflects the three stages of the project, namely:</li> <li>• Stage 1 – Concept development and feasibility, and development approvals;</li> <li>• Stage 2 – Detailed design, documentation and Registration of Interest Process; and</li> <li>• Stage 3 – Contract management.</li> </ul>



7	<b><u>Affordability (Cost of dwelling/rent)</u></b>	<ul style="list-style-type: none"> <li>Part funded by the “Housing Affordability Fund”</li> </ul>
8	<b><u>Dwelling size/ appointment</u></b>	<ul style="list-style-type: none"> <li>When complete, Lochiel Park will comprise of 100 homes showcasing leading edge design principles.</li> <li>Only 4.25 hectares of the 15 hectare site allocated for the residential component with <b>81</b> dwellings</li> <li>Lots 1-5 (dwellings) will have a minimum area of 40m<sup>2</sup> and a minimum dimension of 4m. The remainder of the private open space would have a minimum dimension of 2.0m.</li> <li>Lots 24-28, 30-32, 34-66 and 72-76 and dwellings designated as “affordable housing” on Lots 1-5 with a ground floor level will (would) have a minimum area of 30m<sup>2</sup> of private open space, and the dwellings would have a minimum area of 24m<sup>2</sup> and a minimum dimension of 3m. The remainder of the private open space would have a minimum dimension of 2.0m.</li> <li>Mews dwellings on Lots 12, 24, 26, 29, 49 and 61 and any other dwellings without a ground floor level including dwellings designated as “affordable housing” on Lots 1-5 should have a balcony or roof patio with a minimum area of 8m<sup>2</sup> and a minimum dimension of 2.5m.</li> <li>Expected number of residents: around 40</li> </ul>
9	<b><u>Outer/inner city suitability</u></b>	<ul style="list-style-type: none"> <li>Incorporation of urban forest and other active and passive recreation within the Parkland areas.</li> </ul>
10	<b><u>Adaptability (handicapped):</u></b> (Difficulty walking, poor sights, impaired hearing, etc)	
11	<b><u>Social Acceptability</u></b>	<ul style="list-style-type: none"> <li>Community garden</li> <li>Private open space areas to be provided to meet the needs and overall size of the allotment (<b>to reduce the ecological footprint</b>); and to foster a sense of community.</li> </ul>
12	<b><u>Desirability</u></b> - <b>Transport</b> - <b>Fewer car parking spaces</b>	<ul style="list-style-type: none"> <li>Reduction of transport demand and provision of food production capability were part of the strategy for this project; and Provision of fewer (10) car parking spaces for 13 two and three bedroom dwellings</li> </ul>

### Case 3.0: Christie Walk, Adelaide, South Australia

No	Criteria for Comparison	Description
1	<u>Year of Development</u>	<ul style="list-style-type: none"> <li>Staged Completion (Stage 1- July 2002); (Stage 2 – December 2003); (Stage 3 – December 2004)</li> </ul>
2	<u>Energy Efficiency</u>	<ul style="list-style-type: none"> <li>Passive solar / climate responsive design. cooling and humidity control using breezes, sunlight and vegetation.</li> <li>Solar hot water; and Solar Energy; Power from photovoltaic's – panels to b installed on pergolas roof gardens.</li> </ul>
3	<u>Water Efficiency</u>	<ul style="list-style-type: none"> <li>Onsite storage of stormwater in underground tanks – water used on gardens (irrigation) and to flush toilets.</li> <li>Sewer mine to further reduce water wastage and irrigate the community landscape</li> </ul>
4	<u>Construction Materials</u>	<ul style="list-style-type: none"> <li>Recycled, non-toxic materials with low embodied energy.</li> <li>Carports and feature elements constructed from recycled materials including bricks, <b>stone, steel</b> and <b>timber</b> retrieved from demolition of the few pre-existing structures on the site.</li> </ul>
5	<u>Construction Methods</u>	<ul style="list-style-type: none"> <li>Variety of construction methods including load-bearing autoclaved aerated concrete, poured low-strength concrete (earthcrete), steel framing, and timber-framed straw bale.</li> </ul>
6	<u>Financial Procurement</u> <ul style="list-style-type: none"> <li>Source(s) of funds</li> </ul>	<ul style="list-style-type: none"> <li>Private investment and ethical borrowings from Bendigo Community Bank</li> <li>Participation in the design process was managed on the basis of individual consultation on dwelling layouts within an overall framework set by the architect for the site and approved by semi-formal processes internal to the developer organisation.</li> </ul>
7	<u>Affordability (Cost of dwelling/rent)</u>	<ul style="list-style-type: none"> <li>Cost: Stage 1: \$900,000; Stage 2: \$1,600,000</li> <li>Standard apartments ranged from \$280,000 to \$460,000 (in 2006) and included all community areas and facilities.</li> </ul>
8	<u>Dwelling size/ appointment</u>	<ul style="list-style-type: none"> <li>2000 square-metre</li> <li>Number: 27 dwellings in total</li> <li>Area: Apartments 1 to 9 are approximately 52m<sup>2</sup> excluding balconies.</li> </ul>
9	<u>Outer/inner city suitability</u> <ul style="list-style-type: none"> <li>Location wise</li> <li>Inner City</li> </ul>	<ul style="list-style-type: none"> <li>Reduced car dependency due to inner city context</li> <li>Healthy, people-friendly public spaces, easy walking distance of Adelaide's Central Markets, parks lands and CBD.</li> <li>Australia's <b>ONLY</b> example of a fully featured and integrated inner-city environmental housing development.</li> </ul>
10	<u>Adaptability (handicapped)</u>	<ul style="list-style-type: none"> <li>Designed to allow the expansion and contraction of households over time</li> </ul>
11	<u>Social Acceptability</u>	<ul style="list-style-type: none"> <li>Shared gardens including roof garden</li> <li>Local food production in onsite community food garden</li> <li></li> </ul>
12	<u>Desirability</u>	<ul style="list-style-type: none"> <li>Pedestrian friendly spaces; Healthy buildings</li> </ul>

## Case 4.0: Mawson Lakes (middle-ring suburb), South Australia

No	Criteria for Comparison	Description
1	<u>Year of Development</u>	Ongoing
2	<u>Energy Efficiency</u>	Homes designed for energy efficiency with solar orientation. 'Scorecard' system as encumbrance for each house development developed by UniSA including efficient appliances. Base power load demand believed to be lower than Adelaide average per dwelling but with high peak summer load due to reliance on air conditioning (Check POE by UniSA! ) Home Management Systems in homes - ability to control irrigation, air conditioning, security and energy usage. Mandatory Solar Hot Water. Solar street lighting around lake. Part of Solar Cities initiative by federal government.
3	<u>Water Efficiency</u>	Water recycling systems connected to aquifer storage for treated stormwater. Dry Creek Wetlands. Water management - connection to recycled water systems for toilet flushing and purple taps system for garden watering.
4	<u>Construction Materials</u>	Recycled materials used for roads – check this!
5	<u>Construction Methods</u>	Initially focussed on mainly 2 storey houses but later stages included low rise multi-storey apartments, townhouses and units.
6	<u>Financial Procurement</u>	Commercial development by Delfin Lend Lease with support from government (Land Management Corporation) for land acquisition. Originated as the Multi Function Polis (MFP) project. Objectives were profitability and world's best practice.
7	<u>Affordability (Cost of dwelling/rent)</u>	Market values for private dwellings. Supported accommodation to be checked.
8	<u>Dwelling size/ appointment</u>	Varies from large houses to more modest apartments/townhouses.
9	<u>Outer/inner city suitability</u>	Central to Adelaide's major growth region. Suitable as Greenfield development.
10	<u>Adaptability (handicapped)</u>	Not known
11	<u>Social Acceptability</u>	Housing diversity with higher density residential, aged care and student accommodation. Mawson Lakes school, Mawson Centre and Endeavour College. Transit interchange.
12	<u>Desirability</u>	Successful development with substantial marketing. Sustainable landscape projects with water sensitive vegetation. Green open spaces. Now has transport interchange linking to city centre. There are over 189 hectares of open space, 70 hectares of lakes and waterways and 26km of hike and bike trails,

## Case 5.0: Aldinga Arts Eco Village (Outer Suburb), South Australia

No	Criteria for Comparison	Description
1	<b><u>Year of Development</u></b>	Ongoing. Development secured 1999; Headworks 2002; First construction 2003.
2	<b><u>Energy Efficiency</u></b>	<ul style="list-style-type: none"> <li>• Entire development on a north-facing hill to maximise passive solar orientation</li> <li>• Minimum of 30% of total glassed area must face north</li> <li>• Key living areas must be located no more than 20 degrees off north</li> <li>• Internal thermal mass walls</li> <li>• Criteria regarding minimising excessive thermal mass on southern and western walls</li> <li>• Solar hot water and PV cells mandatory</li> <li>• Insulation: walls <math>\geq R2.5</math>; roof &amp; ceilings total <math>\geq R3.0</math></li> </ul>
3	<b><u>Water Efficiency</u></b>	<ul style="list-style-type: none"> <li>• Minimum 10,000L rainwater tank</li> <li>• Main used only occasionally (max draw 1000L per download from two external connections)</li> <li>• Small-scale biologically-based wastewater treatment plant to re-use effluent from village to on-site agricultural uses</li> <li>• 'Soft engineering' – eg permeable surfaces, rip-rap drainage, 9 fenced detention basins</li> </ul>
4	<b><u>Construction Materials</u></b>	<ul style="list-style-type: none"> <li>• Underground services use High Density PolyEthylene (non PVC)</li> <li>• The use of recycled timber and bricks is encouraged</li> <li>• Corrugated iron and rammed-earth materials feature regularly</li> <li>• Variety of non-traditional materials, including straw, mud bricks</li> <li>• Locally sourced limestone and slate</li> </ul>
5	<b><u>Construction Methods</u></b>	<ul style="list-style-type: none"> <li>• Variety of non-traditional methods, eg straw-bale, reverse brick veneer, semi-underground rooms</li> <li>• Many homes are fully or partially self-built</li> </ul>
6	<b><u>Financial Procurement</u></b>	<ul style="list-style-type: none"> <li>• 15 years of planning</li> <li>• Community title; Community corporation, internal by-laws</li> <li>• Two mini-developments within the village; remainder are owner-builders</li> </ul>
7	<b><u>Affordability (Cost of dwelling/rent)</u></b>	<ul style="list-style-type: none"> <li>• CoBUILT Affordable Homes – 2 bedroom cottages – from \$184 500</li> <li>• 'The Terraces' Townhouse – in August 2009, a 2-bedroom townhouse was on the market for \$320,000-\$325,000</li> <li>• In August 2009, a 2-bedroom architecturally designed home was on the market for \$395,000 - \$410,000</li> </ul>
8	<b><u>Dwelling size/ appointment</u></b>	<ul style="list-style-type: none"> <li>• Dependent on individual builders.</li> <li>• Co-built affordable cottages are 2 bedroom with a floor area of 76 sqm.</li> <li>• 'The Terraces' have 4 townhouse sizes, ranging from 1-3 bedrooms, with floor areas from 83sqm <math>\rightarrow</math> 138sqm</li> </ul>

9	<b>Outer/inner city suitability</b>	<ul style="list-style-type: none"> <li>• Well suited for outer-city greenfields development</li> <li>• Site-specific design – principles need adapting to local context</li> </ul>
10	<b><u>Adaptability</u></b>	<ul style="list-style-type: none"> <li>• Co-built homes?</li> <li>• One of 'The terraces' designs are single storey</li> <li>• Potential to develop individual adaptable housing dwellings</li> <li>• Village designed to be pedestrian oriented but some roads/track may be too steep for wheelchairs</li> </ul>
11	<b><u>Social Acceptability</u></b>	<ul style="list-style-type: none"> <li>• Perception of alternative lifestyle</li> <li>• Non conventional building materials and methods</li> <li>• Village levies in addition to annual rates</li> <li>• Large amount of open space</li> <li>• Low amounts of traffic</li> </ul>
12	<b><u>Desirability</u></b>	<ul style="list-style-type: none"> <li>• Many community features – e.g. events, participation in day-to-day running of village</li> <li>• Open space (40%) and food production</li> <li>• Maximum 2 neighbours</li> <li>• No solid fencing</li> <li>• Good linkages with Willunga Creek and Port Willunga beach</li> </ul>

## Case 6.0: Landcom NSW Designs

No	Criteria for Comparison	Description
1	<u>Year of Development</u>	30 year history and originally set up to offer affordable houses on Sydney's fringe
2	<u>Energy Efficiency</u>	This is Landcom's project indicator #8 and up until 2008, the objective was to achieve a 40% reduction in greenhouse gas emissions over five years. This included heating/cooling, water heating and appliances. Now, all Landcom residential projects must achieve minimum of 40% score for BASIX energy index. There is also an indicator 10 which concerns renewable/sustainable energy supply. All dwellings are to be fitted with gas boosted solar water heaters sufficient to meet 60% of annual hot water requirements with exceptions.
3	<u>Water Efficiency</u>	This is Landcom's project indicator #1 and is in 4 parts. 100% of projects to have project-specific WSUD strategies. Combination of water efficiency and reuse options – achieve 40% score for BASIX water index. Public domain irrigation must be from non-potable sources and designed with water efficiency in mind.
4	<u>Construction Materials</u>	This is Landcom's project indicator #7. Achieve 95% recovery of total construction and demolition waste materials generated from sum of civil works contracts completed in that year. Achieve 76% recovery of total construction and demolition waste materials generated from sum of building projects delivered in that year.
5	<u>Construction Methods</u>	No specific targets for this performance indicator.
6	<u>Financial Procurement</u>	As a Government agency, Landcom are responsible to the community but as a commercial enterprise, they operate like any other business. The challenge is to balance community good with commercial gain and Landcom make sure that the Government's urban design and environment policy is delivered. They also partner with the private sector to create new communities.
7	<u>Affordability (Cost of dwelling/rent)</u>	For example, Koala Bay/Tanilba Bay, House & Land package from \$275,500. 7.5% of Landcom's total product is moderate income housing. Moderate income housing is delivered where commercially viable consistent with existing Landcom Moderate Income Housing Policy.
8	<u>Dwelling size/ appointment</u>	Varies. Units, townhouses and houses depending on project and location.
9	<u>Outer/inner city suitability</u>	Outer suburban and inner city projects. Design adapts to location. 100% of projects to have design guidelines to control the siting of dwelling, garages and fencing and incorporate appropriate building elements which contribute to the streetscape quality and promote casual surveillance. All design guidelines produced by Landcom must include minimum solar access zones (generally indicates where private open space should be located) in accordance with SEDA's Solar Access for Lots Guidelines for residential subdivision in NSW.
10	<u>Adaptability (handicapped)</u>	Landcom has a well developed policy on adaptable housing

11	<b><u>Social Acceptability</u></b>	100% of projects have Community Consultation Plans developed and implemented in accordance with Landcom's "Stakeholder Consultation workbook".
12	<b><u>Desirability</u></b>	No net loss for high conservation value vegetation. Riparian corridor management (net loss or gain). 100% of significant heritage items and places conserved (unless where there is safety or contamination issues).

## Case 7.0: K2 (inner suburb), Melbourne, Victoria

No	Criteria for Comparison	Description
1	<u>Year of Development</u>	<ul style="list-style-type: none"> <li>Completed February 2007</li> </ul>
2	<u>Energy Efficiency</u>	<ul style="list-style-type: none"> <li>Designed and positioned to receive maximum light (northern orientation)</li> <li>Internal thermal mass</li> <li>high levels of insulation</li> <li>Sealed construction</li> <li>double glazing,</li> <li>Central gas heating</li> <li>It has been estimated than apartments will require 55 per cent less mains electricity , 46 per cent less gas from the mains supply than standard apartment due PV cells (10% of total load), solar hot water and central gas heating</li> </ul>
3	<u>Water Efficiency</u>	<ul style="list-style-type: none"> <li>Rainwater harvesting</li> <li>Grey water re-use</li> <li>Central rain water tanks supplements with hot water systems</li> <li>Water efficient (AAA) fixtures and features</li> <li>Landscape treatments naturally filter stormwater (WSUD)</li> <li>It has been estimated that apparent will use 53 per cent less mains water (including irrigation) than standard apartment</li> </ul>
4	<u>Construction Materials</u>	<ul style="list-style-type: none"> <li>Carefully chosen materials, considering embodied energy, recyclability, robustness, and to avoid excess waste or toxic chemicals.</li> <li>Only recycled and sustainably-managed plantation timber is used for external screens, window frames and for internal stud wall framing.</li> <li>Class 1 durability timbers have been left to age naturally and most surfaces have been left with their natural finishes.</li> <li>Low maintenance materials</li> <li>PVC products avoided</li> <li>Low volatile organic compound paints used</li> </ul>
5	<u>Construction Methods</u>	Unknown
6	<u>Financial Procurement</u>	<ul style="list-style-type: none"> <li>Development by Office of Housing, Government of Victoria. The office for housing provides “subsidised housing for eligible low-income Victorians who cannot access the private rental or home ownership markets”.</li> </ul>
7	<u>Affordability (Cost of dwelling/rent)</u>	<ul style="list-style-type: none"> <li>Public housing development and rents would therefore be set below market rents.</li> </ul>
8	<u>Dwelling size/ appointment</u>	<ul style="list-style-type: none"> <li>Unknown.</li> </ul>
9	<u>Outer/inner city suitability</u>	<ul style="list-style-type: none"> <li>Well suited for inner city medium density location.</li> </ul>
	<ul style="list-style-type: none"> <li>Location wise</li> </ul>	



10	<b><u>Adaptability</u></b>	<ul style="list-style-type: none"> <li>• Strong emphasis on adaptable housing, with 49 out of 96 homes built with a focus on people with a disability.</li> </ul>
11	<b><u>Social Acceptability</u></b>	<ul style="list-style-type: none"> <li>• Substantial green space linking buildings.</li> <li>• Architecturally interesting facade, unlike historical public housing developments</li> <li>• Appears that the development is entirely for public housing tenants - no private sales.</li> </ul>
12	<b><u>Desirability</u></b>	<ul style="list-style-type: none"> <li>• Designed for indoor air quality, natural ventilation and stable internal temperatures</li> <li>• Variety of community spaces – public and private courtyard areas</li> <li>• Good access to public transportation</li> <li>• Tenant information kit: information on air quality, accessing transport, tips re grey water, water usage, natural and mechanical ventilation, energy and lighting, cleaning and finishes.</li> </ul>

## Case Study 8.0: BedZED (inner suburb), London, U.K

No	Criteria for Comparison	Description
1	<u>Year of Development</u>	<ul style="list-style-type: none"> <li>2002</li> </ul>
2	<u>Energy Efficiency</u>  <b>33% reduction compared to the UK average of 4 kWh per person per day. (BRE 2002, Domestic energy consumption by final use).</b>  90% reduction compared to the UK average of 140 kWh/ m2/ year.	<ul style="list-style-type: none"> <li>100% renewable energy use</li> <li>Low embodied energy materials</li> <li>Passive solar heating</li> <li>Zero heating homes</li> <li>energy saving appliances and light bulbs as standard</li> </ul>
3	<u>Water Efficiency</u>  Hot Water Consumption in the Home  <b>Aim: 33% reduction compared to the UK average of 14.1 kWh per household per day.</b>	<ul style="list-style-type: none"> <li>91 litres / day (vs. 140 litres/day in typical UK lifestyle)</li> <li>50% reduced portable water</li> <li>On-site ecological water treatment</li> </ul>
4	<u>Construction Materials</u>	(Reclaimed Materials) <ul style="list-style-type: none"> <li>Renewable</li> <li>Recycled (<b>timber</b>)</li> <li>Reused (<b>structural steel</b>)</li> </ul>
	<u>Waste &amp; Recycling</u>  60% recycling rate by weight of waste. (includes composting)	
5	<u>Construction Methods</u>	<ul style="list-style-type: none"> <li>ZED House types fits into Housing Corporation "Modern Methods of Construction" Category. It includes "<b>Off Site Manufacture</b>" sub assemblies and components.</li> </ul>
6	<u>Financial Procurement</u>  <ul style="list-style-type: none"> <li>Source(s) of funds</li> </ul>	<ul style="list-style-type: none"> <li>Government-led Procurement</li> </ul>
7	<u>Affordability (Cost of dwelling/rent)</u>	<ul style="list-style-type: none"> <li>Building a 6 plot terrace to a ZED specification costs a predicted extra £571,208 or £34/ft<sup>2</sup>, compared with a conventional development built to 2000 Building Regulations. However, for each terrace, the ZED planning gain tool allows a developer to generate an extra £208,800 in extra profit.</li> <li>The prices range from £150,000 (1 Bed) to £350,000 (4 Bed Semi)</li> </ul>
8	<u>Dwelling size/ appointment</u>	<ul style="list-style-type: none"> <li>This mixed-tenure, mixed-use development (16,544 sq.m) with approximately 50 dwellings per hectare) on a former sewage works site provides 82 new homes (1, 2, 3 &amp; 4 bed houses and flats), commercial work space (1,695 sq.m), and 18 live/work units. Other on-site facilities include medical centre, nursery, café/bar, sports pitch (4,336 sq.m) with clubhouse and village green (538</li> </ul>

		sq.m).
9	<p><b><u>Outer/inner city suitability</u></b></p> <ul style="list-style-type: none"> <li>• Location wise</li> </ul>	<ul style="list-style-type: none"> <li>• Location wise: The site is in a suburban area of Hackbridge within the planning authority of the London Borough of Sutton.</li> </ul>
10	<p><b><u>Adaptability (handicapped)</u></b></p> <ul style="list-style-type: none"> <li>• Difficulty walking, poor sights, impaired hearing, etc</li> <li>• Mobility Issues</li> </ul>	<ul style="list-style-type: none"> <li>• Drop kerbs for prams and wheelchairs</li> </ul>
11	<p><b><u>Social Acceptability</u></b></p>	<ul style="list-style-type: none"> <li>• Mixed tenure, home type and occupiers</li> <li>• Private open space for homes</li> <li>• Community internet</li> </ul>
12	<p><b><u>Desirability</u></b></p> <p><b>Private Car Mileage</b></p> <p>To reduce private fossil fuel car mileage to 50% of what would have been expected on a 'conventional' build on the same site, The local average is 6,000 miles per person per year.</p>	<ul style="list-style-type: none"> <li>• Proximity to wider community critical mass</li> <li>• Living and working community activity</li> <li>• Air quality and comfort</li> </ul>

## Case 9.0: Oxley Park, (outer suburb), Milton Keynes, UK

No	Criteria for Comparison	Oxley Park, (outer suburb), Milton Keynes
1	<b><u>Year of Development</u></b>	<ul style="list-style-type: none"> <li>• Construction commenced 2006</li> <li>• Expected completion December 2010</li> </ul>
2	<b><u>Energy Efficiency</u></b>	<ul style="list-style-type: none"> <li>• Eco-hats heat exchange system and water heating</li> <li>• Airtight construction</li> <li>• 120mm paper (recycled telephone directory) insulation</li> <li>• Rubber membrane roofing with 90mm foam insulation</li> <li>• Low emission boilers, energy efficient white goods</li> </ul>
3	<b><u>Water Efficiency</u></b>	<ul style="list-style-type: none"> <li>• On-site rainwater collection</li> <li>• Water efficient toilets</li> </ul>
4	<b><u>Construction Materials</u></b>	<ul style="list-style-type: none"> <li>• Strong emphasis on embodied energy – materials carefully selected – eg no ceramic tiles</li> <li>• ‘Flat pack’ prefabricated panels, timber and steel frames</li> <li>• Foam insulation and rubber membrane – high thermal performance, low embodied energy</li> </ul>
5	<b><u>Construction Methods</u></b>	<ul style="list-style-type: none"> <li>• Prefabricated ‘flat-pack’ homes – theoretical construction time of 31 days</li> <li>• Basic crane/hoist used to assemble on site</li> <li>• Concrete footings and two/three courses of concrete blocks</li> </ul>
6	<b><u>Financial Procurement</u></b>	<ul style="list-style-type: none"> <li>• Public private partnership</li> <li>• Developed by George Wimpey – leading house builder</li> <li>• Product of central government initiative to catalyse innovation – the ‘Design for Manufacture Competition’</li> </ul>
7	<b><u>Affordability (Cost of dwelling/rent)</u></b>	<ul style="list-style-type: none"> <li>• 56 dwellings built at a construction cost of £60,000</li> <li>• Many of these were sold to housing associations and/or sold via affordable housing schemes</li> <li>• In 2009, market prices for homes in the development started at £230,000</li> </ul>
8	<b><u>Dwelling size/ appointment</u></b>	<ul style="list-style-type: none"> <li>• Vary.</li> <li>• Smallest, cheapest homes are 2 bedroom; 76.5sqm</li> </ul>
9	<b><u>Outer/inner city suitability</u></b>	<ul style="list-style-type: none"> <li>• Greenfield development</li> <li>• Achieved density of 35-45 d.p.h. which may be suitable for inner city location in an Australian context</li> </ul>
10	<b><u>Adaptability (handicapped)</u></b>  (Difficulty walking, poor sights, impaired hearing, etc)	<ul style="list-style-type: none"> <li>• Problematic.</li> <li>• All dwellings are two storey; bedrooms upstairs</li> <li>• Limited internal movement space.</li> </ul>
11	<b><u>Social Acceptability</u></b>	<ul style="list-style-type: none"> <li>• Non-conventional architectural style and building materials</li> </ul>
12	<b><u>Desirability</u></b>	<ul style="list-style-type: none"> <li>• High amounts of natural light</li> <li>• Good ventilation</li> <li>• Well insulated</li> <li>• 50mm gap between homes to serve as sound insulation</li> </ul>