How Green is my subdivision? 'Green' Marketed Subdivisions: the nexus between sustainable urban planning and energy efficient housing.

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ABSTRACT

This PhD research examines, in particular, the inclusion of sustainability features into 'green' marketed subdivisions currently available in the Perth housing market. The data collected will help to understand how, and how well sustainability is being implemented in niche subdivisions, the houses built in them and the lifestyles of the householders. It will also provide an understanding of the current gaps in implementation, barriers to implementation, and the areas where improved government policy is required. The type and form of residential subdivisions and housing is having an important impact on the state of the environment. In Australia, there has been an escalating level of residential energy use per person and the factors influencing this include the increasing average size of dwellings despite the decreasing number of people per dwelling, changes in consumer preferences for housing design, increases in consumption patterns more generally and changing expectations about personal comfort. Using an Holistic approach embedded in an environmental axiology, the research involved examining indicators of sustainability from four case study subdivisions in the Perth area that are currently being marketed as 'green', 'eco' or 'sustainable' or similar. The criteria for which the case studies have been examined come from widely agreed sustainability and energy efficiency outcomes to be expected from 'green', 'eco' or 'sustainable' houses and subdivisions as found in the literature. It is clear from the data and review of the literature that there is a considerable gap in the way in which the subdivision has been designed and the energy efficiency of the houses; and the recent media attention regarding the efficacy of the energy efficiency ratings tools would appear to support this research finding. There is a need to increase the energy efficiency of houses as energy costs continue to increase.

BACKGROUND TO THE RESEARCH

The context and aspirations of sustainability in the residential sector focuses on energy efficiency and creating settlements where people drive less, housing is affordable, residents can connect meaningfully with their neighbours, children can play safely in parks, work and services are close by and the surrounding natural environment is an important part of the community (Crabtree and Hes 2009; Marshall 2010; Mapes and Wolch 2010). In Australia the residential sector is responsible for producing more than 63 Mt/a CO2-e of greenhouse gases each year, which is about 20% of Australia's total emissions (Australian Bureau of Statistics 2006, 2010). For each household in Australia that amounts to nearly 9t/a CO2 –e of emissions, and the embodied energy alone from the more than 120, 000 new houses added to the Australian housing stock each year adds another 6 Mt CO2-e of emissions (Grace 2007). The Australian Government has highlighted the need to reduce greenhouse gas emissions in the residential and building sectors through the recent introduction of the National Partnership Agreement of Energy Efficiency, and reducing the energy demand from residential houses is one way of achieving that goal (Council of Australian Governments 2009, 2010).

There are a number of motivations for this thesis research, primary among them is the understanding that Australia's residential sector will face much of the brunt of impacts and adaptation from climate change and the belief that governments have a social and ethical imperative to help them to do so (Gardiner 2004; Marden and Mercer 2005; Vucetich and Nelson 2010). As elected community representatives governments have a responsibility to create the best possible opportunities to enable the reduction of carbon and other greenhouse gases in the atmosphere (World Commission on Environment and Development 1987; Australian State of the Environment Committee 2001; Garnaut 2008; Australian Government 2010; Council of Australian Governments 2010). Whilst many levels and sectors in industry and the community will be, (and are), affected differently by climate change, for the individual the impacts and costs of such changes will likely be felt most within the home. This thesis examines the capacity of developers to incorporate sustainability principles and practices into 'green' marketed housing subdivisions (housing estates) that are now available in the marketplace and seeks to bridge the research gap in understanding the question of how to create sustainable subdivisions, from urban design through to housing and sustainable lifestyles. The research began with two questions:

1. What do developers of 'green' marketed subdivisions mean by 'green' (or other terms such as 'eco' or 'sustainable') when labelling such subdivisions, and to what extent is this achieved?

2. Do such criteria and definitions of 'green' match common definitions of environmental/sustainability indicators and how do 'green' marketed subdivisions rate as far as these more common definitions of environmental and/or sustainability indicators are concerned?

LITERATURE REVIEW: URBANISATION IN A CHANGING WORLD

More than half of the world's population are living in cities, and they have become the defining life experience for the majority of people (Register 2006; Wiland, Bell, and D'Agnese 2006; Frey and Yaneske 2007; Farr 2008; Newman, Beatley, and Boyer 2009). Any examination of subdivisions must therefore

explore the origins of human settlements, to enable an understanding of some of the motivations and drivers for the current expression of modern settlement (Mumford 1961). Human creativity and intelligence have created cities with unprecedented opportunities in technology, trade and culture; and cities have become a key source of economic expansion and development (Mumford 1961; Newman and Jennings 2008; Newman, Beatley, and Boyer 2009). Our cities and how they have developed express our collective identity:

> Cities are the summation and densest expressions of infrastructure, or more accurately a set of infrastructures, working sometimes in harmony, sometimes with frustrating discord, to provide us with shelter, contact, energy, water and means to meet other human needs. The infrastructure is a reflection of our social and historical evolution. It is a symbol of what we are collectively, and its forms and functions sharpen our understanding of the similarities and differences among regions, groups and cultures. The physical infrastructure consists of various structures, buildings, pipes, roads, rails, bridges, tunnels and wires. Equally important and subject to change is the 'software' for the physical infrastructure, all the formal and informal rules for the operation of the systems (Ausubel and Herman 1988:1).

Unfortunately they have also had 'the greatest destructive impact on nature of any human activity' (Register 2006:1). The environmental damage that our planet is experiencing, due in part to the imbalanced and over consumption of scarce resources, serves to emphasise the need for houses and housing subdivisions that work with the Earth and its services rather than against it (Low et al. 2005; Stern 2007; Garnaut 2008).

The Drivers for Unsustainable Settlements

Australia's State of the Environment Report, for 2001 and 2006, clearly highlights that headline indicators of resource use continue to be at unsustainable levels, and are currently at the equivalent of three-to-four planets worth of consumption (Australian State of the Environment Committee 2001, 2006; Garnaut 2008; Newton 2008). To some extent these patterns are embedded and encouraged by planning and development paradigms, that rely on the premise that land, energy and materials are abundant, infinite and cheap, and the structure of families hasn't changed since the 1950s (which is also prevalent in North America) (Gonzalez 2005; Ehrenfeld 2008; Garnaut 2008; Productivity Commission of Australia 2005; Newton 2008). Newton (2008) suggests that "cities were built using technologies which assumed that abundant and cheap energy and land would always be available. Communities therefore grew quickly and inefficiently, and became dependant on lengthy distribution systems. Cheap energy influenced the construction of our spacious homes and buildings, fostered our addiction to the automobile and increased the separation of our workplaces from our homes". Consequent to this phenomenon global economic demand has escalated as a result of sprawling urban communities, most especially since World War II, increasing the demand for commodities such as land, fuel, energy, automobiles and household appliances (Gonzalez 2005). The unintended consequence of this global demand and urban sprawl is climate change and irreversible environmental damage to the planet, predicated on large undervalued, inexpensive inputs of energy from fossil fuels (Newman, Beatley, and Boyer 2009; Frey et al. 2009; Falk 2009b; Beard 2009; Speth 2008; Garnaut 2008; Newton 2008). The costs to our society, economy and our environment of the types of urban forms that currently exist in our cities are significant, however these costs are hidden in the apparent economic benefits of the way in which urban form as we now know it has been planned and developed (Gonzalez 2005; Productivity Commission of Australia 2005; Ehrenfeld 2008; Garnaut 2008; Newton 2008).

The economic boom that Australia, and particularly Western Australia, experienced in the period up to 2009 saw a dramatic increase in median household and individual income and a significant change in consumer patterns and expectations of comfort (Australian Bureau of Statistics 2006, 2010). According to the 2006 Australian Social Trends report (which was based on ABS research conducted across a number of capital cities) Australia's per capita consumption of space, energy and water are amongst the highest in the world and is continuing to increase (Australian Bureau of Statistics 2006). The current national headline indicators are showing that Australia's household environmental impacts and related costs are significant, and are far from sustainable (Australian State of the Environment Committee 2006; Australian Bureau of Statistics 2001, 2006; Garnaut 2008; Australian Bureau of Statistics 2010). In Australia per capita energy use was at 266 GJ/year in 2003/04 with a forecast energy use increase of 2.2% per year to 2019; per capita waste generation is over 1 tonne/year; in 2000/01 per capita water use at 115KL/year (a 3.2% per year increase over 1996/7 levels); increases in per capita mobility by car of 8000km/year (vehicle km in capital cities are forecast to be one-third higher by 2020 than in 2002); an increase of per capita CO_2 generation of 27.5 tonnes/year; and a 2.2% increase in the floor area of new buildings between 1993/94 and 2003/04 (Australian Bureau of Statistics 2001; Australian State of the Environment Committee 2001; Australian Bureau of Statistics 2006; Australian State of the Environment Committee 2006; Australian Bureau of Statistics 2010). Whilst it is apparent that these unsustainable consumption patterns are in some ways 'built-in' to our cities, through energy inefficient building/infrastructure design and the use of undervalued, inexpensive inputs, there is still a significant proportion that is attributable to the consumption behaviour and lifestyles of households (Newman and Kenworthy 1999; Australian Bureau of Statistics 2001; Australian State of the Environment Committee 2001; BTRE 2002; Australian Bureau of Agricultural and Resource Economics 2003; Productivity Commission of Australia 2005; Australian Bureau of Statistics 2006; Australian State of the Environment Committee 2006; Newton 2008; Garnaut 2008; Australian Bureau of Statistics

2010). In 2003/04, Australian households used 420 petajoules (PJ) of energy or 13% of the final energy consumed in Australia; and between 1983/84 and 2003/04, energy use in the residential sector grew by 52% or an average of 2.2% per year (Australian Bureau of Statistics 2006, 2010). Increased household energy use is influenced by a range of factors some of which include the increasing size of dwellings, the decreasing number of people per dwelling (between 1995 and 2004 the average number of people per household decreased from 2.7 to 2.5 the average bedrooms increased from 2.9 to 3.0), changes in consumer preferences for housing design, increases in consumption patterns more generally and the changing expectations about personal comfort (Australian Bureau of Statistics 2006, 2007, 2010). Moreover, changes in population and average energy use are expected to continue to increase residential energy consumption in the future (Australian Bureau of Agricultural and Resource Economics 2003; Australian Bureau of Statistics 2010).

The context of urbanisation

To understand both the context of urbanisation as we now experience it and the reasons for why the modern urban form has develop the way it has, a review of the history of urbanisation is necessary. Friedman (2007), Hall (2002) and Mumford (1961) in particular refer to two movements as influential in the development of the 'suburban ideal' in the late 1800s, particularly in North America, Howard's Garden City Movement and the City Beautiful Movement. The 'place making' ethos that was at the centre of these movements proved seductive to the more affluent citizens who could move 'out to the suburbs' and away from the overcrowded and dirty inner city, and what started as seasonally used homes became permanent dwellings with the advent of passenger transit (trams and trains) and commuting became commonplace (Mumford 1961; Holcomb and Beauregard 1981; Friedman 2007). By the early 20th Century the increasing affordability and prevalence of the automobile allowed the 'growing middle class to follow its more affluent counterparts to the suburbs' (Friedman 2007:38). Unsustainable planning and living patterns have gradually taken hold through the separation of city and suburbs: work and home; single-use zoning; automobile dependency; the desire to live in low-density, single family homes; and the popular notion of the suburb as the best place to raise a family (Gillham 2002; Mumford 1961; Garreau 1991; Hall 2002; Gonzalez 2005; Ehrenfeld 2008; Falk 2009a; Frey et al. 2009). The advent of affordable automobiles in the middle of the 20th century underpinned the demise of many public transit systems through underinvestment and poor planning, and has had an enormous influence on the way in which cities and their suburbs have been planned and envisioned since (Newman and Kenworthy 1999; Ambrose, Mead, and Miller 2006; Sheurer 2007; Farr 2008; Frey et al. 2009; Newman, Beatley, and Boyer 2009; Bert 2009; Berry 2009; Beard 2009). Rethinking these planning and living patterns represents one of the greatest challenges for twenty-first-century sustainable community design (Friedman 2007:44).

What is a sustainable subdivision and house?

In Australia's five main capital cities between 1991 and 2001 1.24 million people were added to their respective suburbs (equating to 94% of the total population change), and although inner city suburbs in Australia experienced population loss until the 1990s they are still growing at a much slower rate than the suburbs (Newton 2008) ABS 2001, 2006 2010). Whilst there is a widespread acknowledgement by researchers and governments that there is much to be done to our city's urban forms to improve sustainability outcomes (see (Barton 1998; Wiland, Bell, and D'Agnese 2006; Mander, Brebbia, and Tiezzi 2006; Frey and Yaneske 2007; Stern 2007; Friedman 2007; Speth 2008; Siracusa; et al. 2008; Newton 2008; Marsden 2008; Keilar 2008; Hopkins 2008; Hahn 2008; Farr 2008; Garnaut 2008; Ehrenfeld 2008; Birch and Wachter 2008; Ambrose 2008b; Falk 2009a, 2009b) there is still considerable debate on how to achieve such a goal and very few examples of real success stories (Barton 1998; Hollick and Connelly 1998; Siracusa; et al. 2008; Keilar 2008).

In the built environment literature there is some difficulty in defining exactly what a 'green' or 'sustainable' house or subdivision might look like in practice. Friedman (2007:12) describes a sustainable community or development as one in which there is a clear integration of people, land and buildings; an incorporation of different people from differing cultures, living comfortably with the natural features of the land in buildings that harmonise with existing older structures and the environment they dwell in. By contrast, Ambrose, Mead and Miller (2006) describe sustainable communities or, in particular subdivision developments, as those that take into consideration the overall impact on the environment and its inhabitants by considering environmental degradation, waste and pollutants, construction methods and materials, developer and consumer energy consumption and water use. Ambrose, Mead and Miller (2006) have discussed the difficulties associated with developing more sustainable suburbs in Australia, and suggest that the current focus of the new energy efficiency regulations of the BCA are on construction rather than subdivision design (and current research is suggesting that even this focus hasn't been successful see (Thomas 2010b, 2010d, 2010a; Williamson, Soebarto, and Radford 2010)). The authors do however concede that with tighter Energy Efficiency Rating (EER) standards allotment size and orientation will become increasingly more important, but this again assumes that the EER tools used to assess house design are effective in the first place, which it is becoming clear is not the case (Ambrose, Mead, and Miller 2006; Thomas 2010c; Williamson, Soebarto, and Radford 2010). Ambrose, Mead and Miller (2006) highlighted a number of barriers to developing more sustainable subdivisions and they include: regulatory barriers that inhibit the use of more sustainable

subdivisions, by not rewarding the implementation of sustainability principles within developments, and in some cases local government planning authorities finding it difficult to approve such developments under their current planning frameworks; market barriers that do not allow for the true valuation of more sustainable homes and subdivisions, which has a considerable impact on financiers being able to fund such developments. Much of these issues are beginning to be addressed now that Western Australia in particular has upgraded its EER standards to 6 Stars, however recent research is suggesting the there is still some way to go before all mainstream houses are energy efficient in practice (Thomas 2010b, 2010a, 2010d, 2010c; Australian Bureau of Statistics 2010; Williamson, Soebarto, and Radford 2010).

There is sufficient research and knowledge already available on what constitutes a sustainable subdivision and a sustainable house, albeit with ongoing debate about what constitutes the social and economic aspects of sustainability (Girling and Kellett 2005; Friedman 2007; Frey and Yaneske 2007; Zetter and Watson 2006; Mander, Brebbia, and Tiezzi 2006). In particular Wiland, Bell and D'Agnese (2006) describe criteria as a measure of a subdivision's or suburb's more obvious sustainability. They include the provision of urban forestry, open space and public parks, watershed management, environmentally conscious waste disposal and recycling, green buildings and mass transit/transport management promoting accessibility instead of mobility (access to a range of modes over the mobility of the private vehicle). Using such an integrated response means that new suburbs and subdivisions can emulate the natural processes that occur in ecosystems such as minimising waste, reducing latent heat, capturing and retaining water, reducing pollution, and reusing and recycling everything they can (Wiland, Bell, and D'Agnese 2006). It is commonly accepted in the literature that ecologically or environmentally sustainable development (ESD) principles in housing design, building components and urban planning and development are vital components for long term sustainability (Low et al. 2005; Horne 2006; Miller, Ambrose, and Ball 2006; Ambrose 2008a). There are a number of criteria for what could be called a sustainable house and Low, et al. (2005) describe a sustainable subdivision as one in which the houses exhibit the qualities described above, where there is a mix of activities and house types and where services, employment and recreation are within walking distance. Low et al. (2005), and Friedman (2007) have used a range of criteria that constitute a house that is sensitive to its environment, and they include being designed for the local climate and prevailing breezes; orientated so that main windows face north (south in the northern hemisphere); makes good use of thermal mass; provides high insulation; designed for good ventilation but minimising leakage of air or heat; manages water wisely; limited or no need for extra heating and cooling. Additionally, Horne (2006) and Friedman (2007) suggest that a sustainable house, developed along basic ESD principles, will function well in conserving water and energy and utilise low-impact materials compared to the typical four-bedroom, two-bathroom suburban house. In practice what this research implies is that a house with a dark roof, limited or no eaves, limited or no shading on the west and north sides, living areas not in the northern section of the house, limited or low insulation values in the walls (especially on the west and north sides), an inefficiently orientated house with limited breeze capture etc, and insufficient thermal mass in the walls will not be energy efficient and will require heating and cooling supplementation via air conditioning and heating (Pham and Hargreaves 2001; Low et al. 2005; Productivity Commission of Australia 2005; Horne 2006; Miller, Ambrose, and Ball 2006; Friedman 2007; The Brisbane Institute 2007; Ambrose 2008a; Farr 2008; Hahn 2008; Newton 2008; Welsh 2008; Crabtree and Hes 2009; Williamson, Soebarto, and Radford 2010).

Whilst there is certainly continued debate about what sustainability even means in the context of urban design and the built environment, a broad definition must include the environmental, economic and socio-cultural aspects of subdivisions and to a lesser extent the houses that are built therein. The literature is certainly clear that a subdivision that has good community shared space that includes access to nature, safe paths to walk along, is legible to the pedestrian, is accessible to the pedestrian first, allows for a mix of types of houses and sizes of houses, builds in the potential for home based or small businesses within the subdivision, allows good access to public transport, encourages residents to be active outdoors, and ensures that the houses that are built there are energy efficient and affordable to a range of home buyers has the potential to be sustainable. Unfortunately until the complementary policy and political decisions within the built environment, and land use and transport sectors actually support subdivisions and houses to be sustainable they remain as potentials rather than actualised.

The Public Sector Responses to Sustainable Housing and Subdivisions

In Australia, governments are beginning to make the policy and practice changes that are required to make the housing stock more energy-efficient and the subdivisions they exist within (Ambrose 2008a). In recent years, the Building Code of Australia (BCA) has been amended to include mandatory energy efficiency rating and performance criteria for new housing (Australian Building Code Board 2007). There have been numerous changes in government and industry policy to accommodate these changes in the intent of the building code including the New South Wales Building Sustainability Index (BASIX) initiative (although technically this is a n alternative solution to the BCA), Victoria's 'First Rate', Western Australia's 5-Star Plus (now supercede by the BCA going to 6Stars), the Housing Industry Association's 'Green Smart' program, and the Australian Green Building Council's 'Green-Star' Accreditation program, and a vast array of local government initiatives across Australia that attempt to encourage more sustainable buildings and developments (Department of Housing and Works 2007; Low et al. 2005; Randolph, Kam, and Graham 2007; Beatley and Newman 2009).

However, while more sustainable housing options remain outside the volume project home industry, the capacity of the majority of first home buyers to buy more sustainable homes remains limited (Randolph, Kam, and Graham 2007). According to Randolph et al. (2007), the introduction of mandatory Building Sustainability Index (BASIX) (in NSW) energy and water efficiency measures has seen the introduction of 'better practice models for more environmentally sustainable project homes'; and this large scale implementation of such measures has the potential to make new homes far more affordable and sustainable (Randolph, Kam, and Graham 2007). Unfortunately more recent research on the efficacy of the current suite of national residential housing energy efficiency software tools suggests that there are considerable flaws in the way that data is processed and is even logical in practice (Thomas 2010d, 2010a, 2010b, 2010c; Williamson, Soebarto, and Radford 2010). As this research has found for the development of subdivisions, at least in Perth, the introduction of the State Government's Liveable Neighbourhoods Policy (adopted as policy in 2008) has influenced the creation of subdivisions that have far greater potential to be more sustainable (Beatley and Newman 2009; WA Department of Planning 2009). Even though there is some debate about whether Liveable Neighbourhoods has had any positive influence on transport dependence in particular, the New Urbanist ideals that underpin the policy appear to have gone some way to making subdivisions more liveable (as evidenced by this research) (Australian Council for New Urbanism 2006; Falconer, Newman, and Giles-Corti 2009; Falk 2009b, 2009a; Beatley and Newman 2009).

Private Sector Responses to Sustainable Housing and Subdivisions

One of the private sector's market responses has seen the development of 'green' marketed housing subdivisions (such as subdivisions like Harvest Lakes and Evermore Heights). Competitive and government policy pressure has increased the prevalence of 'green' products in the Australian market and 'green' marketed housing subdivisions are no exception. More and more builders are also beginning to offer house designs that are marketed as more 'sustainable', 'eco-friendly' and 'environmentally sound' options, than mainstream house designs (see Dale Alcock, Ross North Homes and Impressions the Home Builders). However, there currently exists no compulsory, mandated, commonly agreed upon benchmark for what is actually an energy efficient, sustainable house or subdivision. Whilst the BCA mandates a minimum level of energy efficiency required for compliance, as recent research and media attention has highlighted, there is significant debate about the efficacy of the software tools designed to provide energy efficiency ratings for house designs and whether the standards are actually getting energy efficiency outcomes in the first place (Thomas 2010d, 2010a, 2010b; Williamson, Soebarto, and Radford 2010). Much of the knowledge and technology requisite for sustainable building design is already available, however the implementation of these principles and practices by developers, designers, builders and consumers is yet to happen on a widespread scale (Ambrose and Miller 2005).

METHODOLOGY AND RESEARCH DESIGN

The research involved examining the environmental outcomes from four case study subdivisions in the Perth area that are currently being marketed as 'green', 'eco' or 'sustainable'. The criteria for which the case studies have been examined come from widely agreed environmental and energy efficiency outcomes to be expected from 'green', 'eco' or 'sustainable' houses and subdivisions as found in the literature. A number of methods of collecting and analysing the data were chosen in this research, both as a reflection of the multi-disciplinary nature of the topic which necessitated the use of the 'Mixed-Methods' research technique, and as a method of triangulation to get data from many different sources to enhance efficacy. Primarily this research utilised case study methodology with the addition of document analysis, site observation and analysis of the features of each estate. Semi-structured interviews and surveys of developers were also conducted as well as online surveys of residents of each case study estate, an analysis of the technical features of the estates and buildings as compared to benchmarked standards. These techniques enabled the examination of each case study's planning, development, energy, transport and water use data analysis, and analyse the marketing and habitation data results to determine actual environmental outcomes. Case study methodology was chosen because the 'case' is a *'…*spatially delimited phenomenon (a unit) observed at a single point in time or over some period of time. It comprises the type of phenomenon that an inference attempts to explain'; the case study is seen to be an intrinsic part of the whole, that both informs the research and the analysis of the phenomenon of how developers are measuring the 'green-ness' of their 'green' or 'sustainable' marketed subdivisions and whether they are performing as they are marketed (Gerring 2007:36). The case study method was chosen as the best way to examine a range of sites, and their data, that have been identified in the real estate market as purpose built sustainable or green estates; so that their respective environmental and sustainability performance could be measured.

Other research techniques that have been used include semi-structured interviews, online surveying of residents in the case study subdivisions, and online surveying of all people who have built a house in the last 5 years. Qualitative interviews have been widely used in the social sciences as a way of gaining knowledge and data for a long time and is an important research technique for collecting knowledge of the social world; particularly as a listening approach that seeks thoroughly tested knowledge; it is a structured and purposeful conversation and a research technique that is ideally suited to knowledge that requires unearthing in the context of this research (Kvale 2007). Interviews of developers of 'green' marketed subdivisions (from the four case study subdivisions) were conducted to explore what the industry believes to be criteria that entail a

'green or sustainable' estate, and determine the industry views on perceived or actual barriers to more environmentally sensitive or sustainable housing developments being created. Kvale's (2007:21) 'Miners' (or a more post-modernist) approach is used in this research; one that sees 'interviews as a site of data collection separated from the later data analysis, where knowledge is seen to be already there waiting to be 'found''. The interview technique was used to enable the personal perceptions, opinions and impressions of housing development industry members to be explored; and was most pertinent to this research because the various participants' 'lived' experience within their specific sector is necessary knowledge in building up the story of 'green' marketed housing subdivisions in Perth.

Through the use of the online 'Survey Monkey' website an online survey was developed to enable residents of the case study estates to be surveyed, to enable members of the Urban Developers Institute of Australia (UDIA) Environment Committee to be surveyed for their views on the development of more sustainable subdivisions and to allow the surveying of anybody who had built a house in the last 5 years in Australia. This research used online surveys as a cost and time effective method of gaining an understanding of residents' reasons for buying into an estate, to understand their lived experience of living in a 'green' marketed subdivisions, and to be able to collect more quantitative data about their lifestyle as it relates to their housing choices without having to go to the expense and time of physically surveying them or posting hard copy surveys. This research mixed the techniques of interviews and questionnaires as a way of obtaining different answers to similar research questions (Kvale 2007). Although the use of mixed methodologies has attracted some controversy in research circles, for this research it is used as an important technique for getting a range of data, both qualitative and quantitative, by asking similar questions through different techniques (Kvale 2007).

A specific field data observation tool was developed as a way of assessing the basic energy efficiency outcomes from houses built in each subdivision and the subdivision design itself. The case study site observation matrix tested a random selection of houses for a range of energy efficiency criteria that were found to be consistently agreed upon in the literature, including: the presence of water tanks, solar hot water, solar panels, native gardens, water wise design, solar orientation, insulation, grey water system, east/west shading, high thermal mass in the building envelope, large surrounding eaves, and a light coloured roof, that could be sighted from the street (features such as insulation and energy efficient hot water heating features are mandated in the BCA) (Horne 2006; Low et al. 2005; Friedman 2007). Each subdivision was analysed for its performance against a set of criteria that were also widely agreed upon in the literature to be what constitutes a more sustainable and resource efficient subdivision design, including: walking/cycling access, preserved bushland/wetlands, discourages car use, mix use developments, services within walking/cycling distance 400m/800m, native vegetation, water reuse for irrigation, close to public transport, a mix of house types, local employment potential, emphasis on 'place making', recycling programs, community space, affordable housing, and eyes on the street (Ambrose, Mead, and Miller 2006; Ambrose 2008a; Miller, Ambrose, and Ball 2006).

FINDINGS AND DISCUSSION

The data from the site observation matrix, whilst basic and an approximation, supports a significant issue that has recently become obvious in the mainstream media; namely that the energy efficiency rating tools used by builders to ensure their designs are compliant to the energy efficiency requirements of the BCA, and any additional State Government requirements, are seriously and fundamentally flawed (Thomas 2010d, 2010a, 2010b, 2010c; Williamson, Soebarto, and Radford 2010). The most serious issues that appear in the data are the lack of sufficient eaves and the existence of dark roofing materials on houses in these 'green' marketed subdivisions. Throughout the literature these two criteria, in particular, were seen as vital to ensuring a house is cool in summer and warm in winter – in other words energy efficient (Low et al. 2005; Miller, Ambrose, and Ball 2006; Wiland, Bell, and D'Agnese 2006; Department of Housing and Works 2007; Friedman 2007; Ambrose 2008a; Farr 2008; Hahn 2008; Newton 2008). Yet a large majority of houses in 3 of the case study subdivisions exhibited both of these energy inefficient design features (Subdivision 2 is still in its infancy as far as finished buildings are concerned). In addition, in each subdivision the developer has established legally binding building guidelines or covenants that prohibit the use of dark coloured roofs or limited or no eaves on houses in the subdivision, yet as can be seen in Table 1 of a random selection of streets the number of houses that had installed dark coloured roofs or limited eaves, despite the covenants, was in the order of more than 50% in some cases.

Table 1: Case Study Site Observation Matrix - Houses

Houses:	Criteria	Subdivision 1	Subdivision 2	Subdivision 3	Subdivision 4
	Water tanks	n/a	Yes	n/a	n/a
	Solar hot water	Yes	Yes	Unknown	20%
	Solar panels (Not Mandatory)	No	Yes	n/a	1
	Water wise gardens	Yes	Yes	Yes	Yes
	Nth/Sth Solar orientation	50%	n/a	70%	50%
	Insulation	Roof/ceiling	Roof/ceiling	Roof/ceiling	Roof/ceiling
	Grey water system	n/a	n/a	n/a	n/a

	East/West shading	No	n/a	30%	No
	Use of thermal mass	Double brick cavity	Double brick cavity	Double brick cavity	Double brick cavity
	Large Eaves	No	No	No	No
	Light Roof	50%	TBA	50%	50%

What has become obvious in the fieldwork of this research is that each developer and builder has very different ideas of what makes a subdivision or house sustainable. Data collected from the online survey of the UDIA's Environment Committee and interviews of each case study subdivision developer's project manager, highlighted that developers were more likely to nominate a small number of criteria that they felt made their subdivision more sustainable than the mainstream, rather than the full suite of sustainability criteria in the site observation matrix. For developers the predominant sustainability features they concentrated on was water wise urban design and retainment of natural/original vegetation. Whilst these features are arguably very important, and according to the most recent ABS research have had a significant positive effect on reduced water use (see (Australian Bureau of Statistics 2010), on their own they don't make a subdivision more sustainable. However by virtue of the influence of the Department of Planning's Liveable Neighbourhood Policy, much of the sustainability features agreed upon in the literature as important, are now mandatory, such as encouraging active transport over motor transport, public transport access within an 800m radius, emphasis on place making, community spaces, mixed housing types and mixed use land uses, and 'eyes on the street' to design out crime potential (WA Department of Planning 2009).

Table 2: Case Study Site Observation Matrix - Subdivisions

Subdivisions:	Walking/cycling access	Yes	Yes	Yes	Yes
	Preserved bushland/wetlands	Yes	Yes	Yes	Some
	Discourages car use	Yes	Unknown yet	Yes	No
	Mix use developments	No	not yet…	not yet…	not yet
	Services within walking/cycling distance 400m/800m	No	not yet	not yet	in development
	Native vegetation	Yes	Yes	Yes	Yes
	Water reuse for irrigation	Yes	Yes	Yes	Yes
	Close to PT	within 5kms of Sth Rail Line	Yes	Yes	Close to bus network
	Mix of house types	Yes	Yes	Yes	Yes
	Local employment potential	close to major employment hub	Yes	Yes	Yes
	Emphasis on 'place making'	Yes	Yes	Yes	Yes
	Recycling program	Yes	Yes	Yes	Yes
	Community space	Yes	Yes	Yes	Yes
	Affordable housing	No	No	No	No
	Eyes on the Street	Yes	Yes	Yes	Yes

The survey of residents found that they felt that sustainability and environmental actions were important but were unwilling to implement energy efficiency features or design in their houses because of the perceived costs; they weren't necessarily aware that the subdivision that they had built in was marketed and had been awarded for its environmental aspects; and some were unwilling to take up the incentives that developers provided to encourage people to include energy efficient design and features into their house. In very few cases did residents of the case study subdivisions admit to buying into their particular subdivision for it's marketed or awarded environmental or sustainability aspects.

As far as the four case study subdivisions are concerned, the developers would like buyers to make the connection between 'green', 'eco', 'sustainable', 'back to nature', 'live naturally' and other similar phrases used in their marketing, and sustainability and environmental awareness as the literature would define it. The sustainability indicator tool, and the interview of the project managers of the four case study subdivisions, found that the developers of the four case study subdivisions have concentrated on marketing more generally those sustainability features that are easiest to do, quantifiable to a certain extent and most obvious – namely: water sensitive design, prioritising for solar orientation, retaining remnant trees and creating a sense of 'place' and 'community'. Of course it's also easy to find the general meaning of sustainability or environmental awareness implied in such vague terms as 'A Sustainable Community', 'Change your world', 'WA's first GreenSmart Village', "Back to Nature", and "Live for Today and Tomorrow" or terms such as 'green', 'eco', 'sustainable', 'back to nature', 'live naturally'.

As to whether the implied sustainability/environmental awareness in the marketing is actually achieved, is a little more difficult to determine with certainty. Each subdivision is embedded within a much larger planning framework, and their ability to influence wider infrastructure decisions to be more sustainable is limited. However, the research did identify that the case studies were all walkable and with greater access to public transit systems they could provide residents with a viable alternative to the private car; and once essential services are in place this will be much more possible. Unfortunately, each subdivision is influenced by the capacity of the residents to change their behaviour towards living a more sustainable lifestyle and the complementary policy enacted through local and state government in which each subdivision is embedded, which is not something developers can control. The research clearly identified that the houses that residents

of the case study subdivisions had built, and were designs offered by the builders in these case studies, did not reflect the sustainability marketing or ethos of the 'green' marketed subdivisions.

Table 3: Case Study Developers Subdivision Features Matrix

Subdivisions	Developer	Building guidelines	Age of Development	Size of Development	Location	Green' Incentives Provided by Developer	Marketed as 'Green' or equivalent	Green' Industry Awards
Subdivision 1	Landcorp/ Satterleys	• Window shade awning to front of dwelling & eaves overhang to front of dwelling. • Minimum of 2m wide veranda to front of dwelling. • Tuscan themes, porticos and dwellings with no eaves to the primary street frontage are not permitted. • Minimise west / east facing windows and adequate summer shading (e.g. awnings, eaves, pergolas) or use of energy efficient glazing (e.g. solar performance film, tinting, toned)	5 years	160 hectares, 4200 people	Atwell - south central	unavailable	HIA GreenSmart/Liveable neighbourhoods	UDIA 2008 Awards for Environmental Excellence
Subdivision 4	Cedar Woods	*provide adequate eaves and pergolas on all sides; *Lighter roofs preferred and black roofs are prohibited; *deciduous trees along northern boundary for summer shading;	5 years	400 lots approx	Baldivis - South Coastal	Unavailable	HIA GreenSmart	UDIA 'Water Sensitive Urban Development Award'
Subdivision 3	Stocklan d	Land purchasers will be actively encouraged to build a home incorporating elements that represent best practice in sustainability including passive solar design, Waterwise and energy efficient initiatives and the use of sustainable building materials.	5 years	500 lots approx	Forrestdale Sth East-foothills	Unavailable	HIA GreenSmart	UDIA 2008 Awards for Environmental Excellence
Subdivision 2	Satterleys/ Landcorp	*maximise solar orientation, minimise glazing to minimise heat in summer but allow winter sun; * 450mm eaves to entire home; *allow favourable cross ventilation in summer & draught proofing for winter; *light coloured roof material;	1 years old	379 lots	Baldivis - South Coastal	1kw PV unit; 3000ltr rainwater tank plumbed to the toilet and cold water laundry; third-pipe reticulation of groundwater to all domestic gardens; front and rear Waterwise landscaping; Telstra Smart Community package.	Sustainable Community	UDIA 2009 Awards for Excellence - Urban Water

CONCLUSIONS

The difficulty with making an outright analysis between what has been marketed and what is in practice is that all of these subdivisions are still in development, with essential services still to be incorporated. Moreover, because these subdivisions are embedded within a much larger planning framework, their ability to influence wider infrastructure decisions to be more sustainable is limited. However, the research did identify that the case studies were all walkable and with greater access to public transit systems they could provide residents with a viable alternative to the private car; and once essential services are in place this will be much more possible. However, each subdivision is influenced by the capacity of the residents to change their behaviour towards living a more sustainable lifestyle and the complementary policy enacted through local and state government in which each subdivision is embedded, which is not something developers can control.

The data and review of the literature suggests that there is a considerable gap in the overall design of the subdivision, which in all the case studies could be said to have the potential of being sustainable, and the design of the houses in relation to energy efficiency. In addition the recent research and media attention regarding the efficacy of the energy efficiency ratings tools and the most recent research from Williamson, Soebarto, and Radford (2010), would appear to back up this research finding, in other words the rating tools used to ultimately operationalise the energy efficiency requirements of the BCA don't appear to be enabling energy efficiency outcomes in the urban built form. What the research of Williamson, Soebarto, and Radford (2010) highlights is that the baseline assumption made by the national energy efficiency rating tools, used to assess the performance of a house design, is that every house will supplement the heating and cooling of the space with artificial air-conditioning. Which would appear to counteract the stated goals of the BCA to reduce household carbon emissions through energy efficient design, as houses are being designed to be artificially air-conditioned rather than as a passive solar house.

For the Perth metropolitan area, the situation is made even more complex because of the brick industry monopoly on building materials, to such an extent that it is known anecdotally that building with double brick is cheaper than with single brick (although it was difficult to find research on this issue). Despite the assertions of the brick industry in Perth (see www.thinkbrick.com.au) uninsulated double brick cavity, when used with limited or no eaves and no summer shading, black roofs, high roof insulation and limited cross ventilation creates an oven affect in houses, and there is currently a proliferation of such houses in the Perth metropolitan area (McGee, Mosher, and Clarke 2008; Reardon and Clarke 2008; Reardon and Downton 2008; Reardon, McGee, and Milne 2008; Reardon, Mosher, and Clarke 2008). These houses will need to be mechanically air-condition to be habitable in the height of a summer heat wave, such as has been experienced in the recent 2011 summer in Perth. Given that the Federal and WA Government is keen for

people to reduce their residential energy use, particularly during the afternoon 'peak', this would seem an unfeasible goal if such houses continue to be built in Perth.

Therefore, as much as developers of the case study 'green' marketed subdivisions are able to they have created subdivisions that: are walkable; have a strong sense of community through shared spaces, activities and news sharing; are connected to nature through the retainment of remnant vegetation; are water wise through using water wise plantings and using innovative storm water vegetation drains and 'raingardens'; are attempting to encourage excellence in energy efficient house design through orientating blocks along the north/south axis and through building guidelines that attempt to inhibit energy inefficient design features. Once services and improved public transport connections become a priority of local and state governments, these case study subdivisions could provide residents with viable alternatives to the use of the private car for every trip. Yet, because any subdivision is ultimately embedded within local policy and regulation environments, and is limited in its capacity to either influence or change government policy there is only so much that a developer has control over. Given the limited influence that developers or governments appear to have in preventing the use of dark coloured roof materials and the use of no or limited eaves and summer shading, aspects that the research made clear inhibited energy efficiency of a house, it is debatable that the current EER tools or use of building guidelines is actually creating energy efficient houses. Unfortunately, through exploring the research and collecting data to answer the two research questions, it has become apparent that in the context of 'green' marketed subdivisions, the two sectors that currently exhibit a considerable barrier to increasing sustainability in subdivisions are the building and consumer sectors. The overall conclusions from the data collected and review of the literature is suggesting very clearly that there is a considerable gap in the overall design of 'green' marketed subdivisions, which in all the case studies could be said to have the potential of being sustainable, and the design of the houses in them in relation to energy efficiency and sustainability.

According to Ehrenfeld (2008) the search to find the solution to our currently 'unsustainable' lifestyles has predominantly led researchers, politicians and policy makers to seek what are ultimately 'band-aid solutions' to attempt to fix complex fundamental problems. For Ehrenfeld (2008) 'almost everything being done in the name of sustainable development addresses and attempts to reduce unsustainability yet reducing unsustainability, although critical, does not and will not create sustainability' because it fails to address overconsumption and the current inability to price environmental damage (Ehrenfeld 2008:7). Sustainable development is, according to many researchers (see (Edwards 2005; Filho 2005; Meadows, Meadows, and Randers 2005; Lovelock 2006; Hawken 2007; Suzuki, McConnell, and Mason 2007; Ehrenfeld 2008; Patton 2008; Speth 2008)) premised on the assumption that the current status quo of 'progress' is successful (in other words that the economic growth that the world experiences over time is successful despite the environmental, social and financial cost). Perhaps even more importantly for the wider perspective of sustainability in the residential sector, if Governments continue to allow new subdivisions to be built further and further from services and public transport networks, (and in the absence of a level playing field for renewable energy sources and more sustainable development generally), the people that can least afford to manage the impacts of climate change and peak oil will be hit the hardest (Trubka, Newman, and Bilsborough 2010). These clearly misguided commercial and policy decisions are yet to be really challenged by governments, although if the current Federal Government succeeds in introducing a price on carbon such decisions may no longer be viable. So perhaps 'green' subdivisions, given the necessary support from government, and with educated and engaged consumers, can actually be a more sustainable residential alternative.

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