FUTURE POLICY DIRECTIONS FROM ZERO EMISSION HOUSING IN AUSTRALIA: IMPLICATIONS FROM AN INTERNATIONAL REVIEW AND COMPARISON

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Several advanced economies are in the process of a transition towards zero emission housing by 2020. Such transitions require a radical shift beyond existing limited building envelope and energy efficiency improvements. The Zero Emission Housing (ZEH) concept indicates such a radical shift, implying as it does home energy consumption within limits set by the home itself, and renewable energy technology as standard. This paper analyses current new housing energy performance policies from Australia, the EU and USA against a set of socio-technical transitions principles presented within a zero emission housing framework. Key trends, present knowledge and implementation gaps are identified. Initiatives are proposed to enable a transition to zero emission housing. These include longer term policy goals, links to higher level policies (such as climate change emission reduction targets) and mandatory requirements for renewable energy generation. Without these initiatives, Australian housing energy performance policy risks falling further behind in the shift towards a low carbon future. The paper concludes by highlighting the implications of different policy elements of a ZEH transition in Australia, particularly for environmental, economic and social outcomes.

1. INTRODUCTION

It is well documented that current housing energy provision is unsustainable (Boardman, 2007; Horne & Hayles, 2008). In Australia, increasing floor size of new houses, decreasing average occupant numbers and the increasing proliferation of appliances has placed an upward trend on absolute and per capita residential energy consumption (Newton & Tucker, 2009; Pitt & Sherry, 2010). For countries like Australia who rely on fossil fuel energy generation, this increase in energy consumption translates to an increase in greenhouse gas emissions.

Policy approaches to address energy consumption in housing in advanced economies has typically targeted improving heating and cooling energy requirements in new housing. However this approach has significant limitations in that it only addresses up to 50% of household energy consumption (DEWHA, 2008). Depending upon local climate and household demographics, the portion of energy use ascribed to household appliances, electronics, lighting and other non-space heating and cooling services is significant. In recognition, several jurisdictions have implemented a more holistic policy approach. These policy innovation developments also include a more balanced policy approach which values environmental, economic and social elements as well as wider household energy consumption (Cato, 2011; Scorse, 2010). Countries such as the UK have developed pathways to achieve zero emission housing (ZEH) standards based upon these wider considerations (DCLG, 2006). While a paradigm shift is underway internationally, housing energy performance policy innovation in Australia remains limited (Horne & Hayles, 2008).

Policy innovation includes attempts to intervene in the broader institutional system of housing supply, energy supply, and use. Drawing on the concept of *transitions management* (Geels, 2010; Kemp & van Lente, 2011; Loorbach, 2010) in this paper we apply a socio-technical transitions (STT) framework to selected current housing energy performance policy approaches in Australia and international case study jurisdictions, in order to identify potential policy 'gaps' inhibiting ZEH in Australia.

1.1. Characteristics of ZEH systems

For the purposes of this paper, ZEH is housing which is able to generate net energy consumed in the dwelling across a year (Marszal et al., 2011). While adding a large renewable energy system onto existing standard housing is one way to achieve this outcome, it is not always the most economical solution to achieve a zero emissions outcome (Moore, 2010). It has been argued elsewhere that zero emission housing must come firstly from energy efficiency improvements to the building envelope to reduce demand for energy, and then once these options are exhausted, the addition of renewable energy technologies (Vale & Vale, 2000; Zhu, Hurt, Correa, & Boehm, 2009).

Technical requirements to build a ZEH are well established (Vale & Vale, 2000). These elements include dwelling design, correct orientation, improved insulation for floor, walls and ceilings, double glazed windows, external blinds, eves and renewable energy systems (Morrissey, Moore, & Horne, 2011; Vale & Vale, 2000; Zhu, et al., 2009). Houses are not always built with full consideration of these elements, leading to suboptimal energy consumption for heating and cooling purposes (Peterkin, 2009).

1.2. Characteristics of socio-technical transitions

STT theory has emerged over the past decade as a method for moving beyond short term, technology focused policy development (Rip & Kemp, 1998). Authors such as Kemp et al (2007) argue that the inclusion of social aspects is critical for emerging technologies and practices to achieve sustainable development. Historical case studies have shown how STT can work in theory, and attempts have been made to apply it to contemporary policy approaches, in particular in the Netherlands (Geels, 2005; Verbong & Geels, 2010).

A number of key elements have been identified in these case studies. These include long term policy setting, scenario development, reflexive governance and transitions experiments to achieve visions (Geels & Schot, 2007; Rotmans, Kemp, & Van Asselt, 2001; Vergragt, 2003). It is argued that a transition is partly a function of wider landscape factors including national and international policy contexts and policy commitments such as addressing climate change (Foxon, Hammond, Pearson, Burgess, & Hargreaves, 2009).

Within this framework, wider considerations of social elements are critical. For example, relationships, behaviours, norms, networks and social expectations of key actors and society in general are an important focus of STT (Smith, Voß, & Grin, 2010). Pricing and fiscal reform are also important considerations (Foxon, et al., 2009).

So far there has been a limited application of STT to a sustainable housing transition (Bergman, Whitmarsh, Köhler, Haxeltine, & Schilperoord, 2007; Smith, 2007; Tambach, Hasselaar, & Itard, 2010). Housing STT research to date has focussed on both existing and new housing, often combined together for the transition analysis (Smith, 2006). The danger with combining analysis is that addressing energy performance of new and existing housing has typically involved significantly different approaches (Hoppe, Bressers, & Lulofs, 2011; Míguez et al., 2006). As yet a STT approach has not been applied in the Australian housing context for either new or existing dwellings.

2. METHODOLOGY

A systematic review of relevant housing energy performance policies across three case study jurisdictions is presented. Set criteria were developed and applied to analysed policies, based upon a socio-technical zero emissions housing framework. A comparative matrix was developed to facilitate clear comparisons of trends and gaps between policies and across jurisdictions. The framework for analysis was based upon both social and technical elements and criteria were developed based upon previous research, case studies and demonstration projects (Bergman, et al., 2007; CSIRO, 2009; Edwards & Turrent, 2000; Geels, 2002; Moore, 2010; Smith, 2006; Vale & Vale, 2000; Zhu, et al., 2009). The criteria include (Table 1):

Table 1: Technical and social criteria for framework analysis

Technical criteria	Social criteria
Energy efficiency of building envelope	Long term policy and vision setting
Reduction of overall emissions	Scenarios (pathways)
Energy generation/ infrastructure	International best practice
House as part of larger system	Link to wider policy goals
Smart technology	Reflexive governance
Through life costs and benefits	Wider social aspects
Occupancy patterns	Research and development
Appliances	Financial sector
	Institutional structure reform

Three case study jurisdictions were selected to enable appropriate comparison across state and federal levels of Government, as presented in Table 2. Current housing energy performance policy documents were selected by investigating housing and energy regulators across jurisdictions. In Australia, these included the Australian Building Codes Board and the Department of Climate Change and Energy Efficiency. Reports such as (Halverson, Shui, & Evans, 2009; Shui, Evans, & Somasundaram, 2009; SOGEE, 2010; Williams, 2008) also helped to identify relevant policies.

Table 2: Case study jurisdictions and current housing energy performance policies selected for analysis

Case Study	*Federal level entity*	*Policy document*	*State level entity*	*Policy document*
1	European Union	Directive 2010/31/EU on the energy performance of buildings (recast)	United Kingdom	Code for Sustainable Homes
		Directive 2009/28/EC on the promotion of the use of energy from renewable sources (and other similar EU energy policies)		
2	United States of America	2009 International Residential Code	California	CALGreen
		International Energy Conservation Code 2009		
		National Green Building Standard ICC 700-2008		Assembly Bill 212 Zero net energy buildings
		LEED for homes 2008		
		Building Energy Code initiative - Building America		
3	Australia	Building Code of Australia 2011	Victoria	Building Code of Australia 2011
		Report of the Prime Minister's Task Group on Energy Efficiency		
		COAG National Strategy on Energy Efficiency July 2009		

Five key policy documents and position statements are reviewed at the federal level in the USA (Fig. 1). The International Residential Code (IRC) is the national minimum building code standard in the USA with the energy elements informed by the International Energy Conservation Code 2009 (ICC, 2009a, 2009b). Whilst the IRC is a national standard, implementation is at the discretion of State level decision makers. The majority of USA states use the 2006 version of the standard (ICC, 2011) at the time of the research (2011). The USA has a voluntary National Green Building Standard (NGBS) which builds upon the IRC and includes wider environmental sustainability principles (NAHB, 2008). The separate but competing LEED for Homes rating system also exceeds minimum standards set by the IRC (U.S. Green Building Council, 2011). The Building America program has a stated objective of achieving ZEH by 2020. Meanwhile, California has recently become the first state in the USA to mandate NGBS (known as CALGreen).

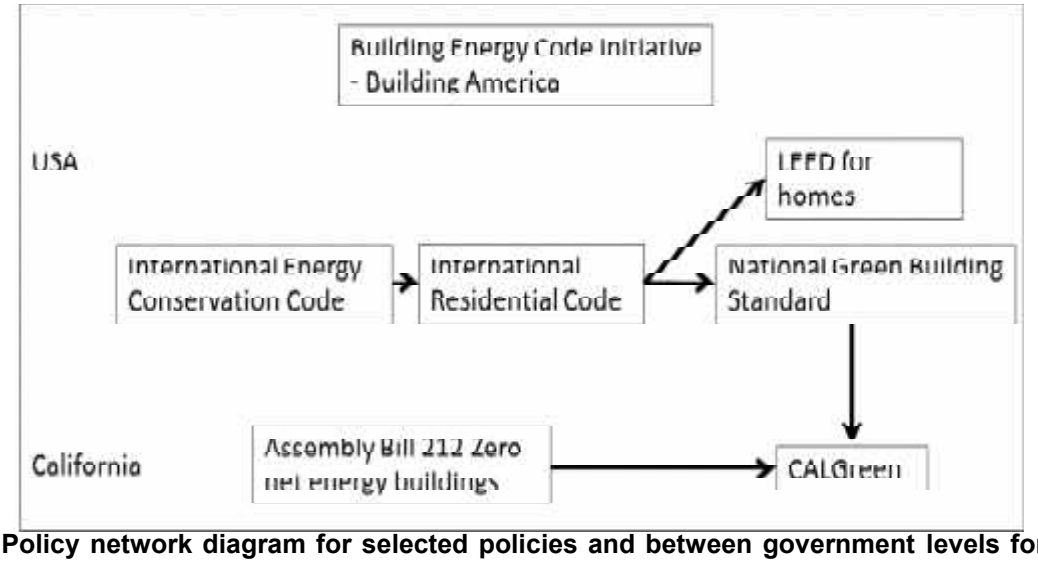

Figure 1: Policy network diagram for selected policies and between government levels for analysis from USA and Californian context.

In the EU, the main policy document analysed in this study is Directive 2010/31/EU on the energy performance of buildings (European Commission, 2010). While no separate sustainable housing policy exists at the EU level, Directive 2010/31/EU sets out requirements for member states to develop pathways to build ZEH by 2020 (Fig. 2) and is informed by wider energy directives (Directive 2009/28/EC). Within this context, in the UK a minimum regulatory requirement has been developed for new housing to be ZEH by

2016, known as the Code for Sustainable Homes (CSH). The CSH was launched as a voluntary code in December 2006 and became mandatory for all new dwellings in May 2008 (DCLG, 2006, 2010).

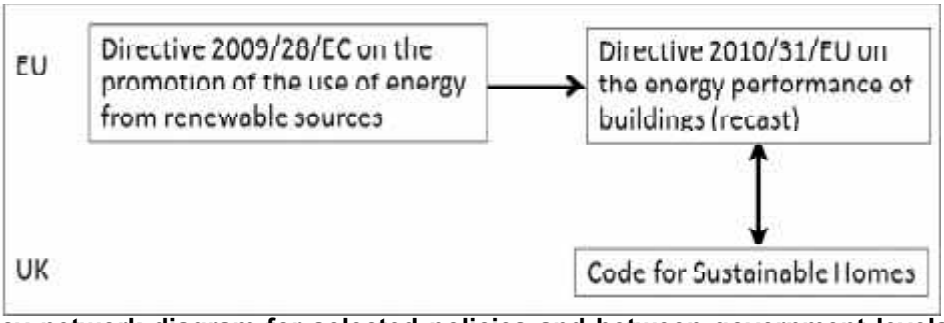

Figure 2: Policy network diagram for selected policies and between government levels for analysis from Australia and Victorian context.

The Building Code of Australia (BCA) 2011 sets standards for the housing industry in Australia (ABCB, 2011). Changes to the BCA minimum performance levels are informed by the direction of COAG (Council of Australian Governments). Plans for future housing energy performance regulation are included within the National Strategy on Energy Efficiency (COAG, 2009). In addition, the 2010 Prime Minister's Task Group on Energy Efficiency (TGEE) (Australian Government, 2010) explores future requirements for housing in terms of energy performance. Building regulation, however, is undertaken at state level. Therefore, alongside the aforementioned documents, the state version of the BCA 2011 in Victoria was included in analysis. Fig. 3 presents the links between the policy documents and levels of government.

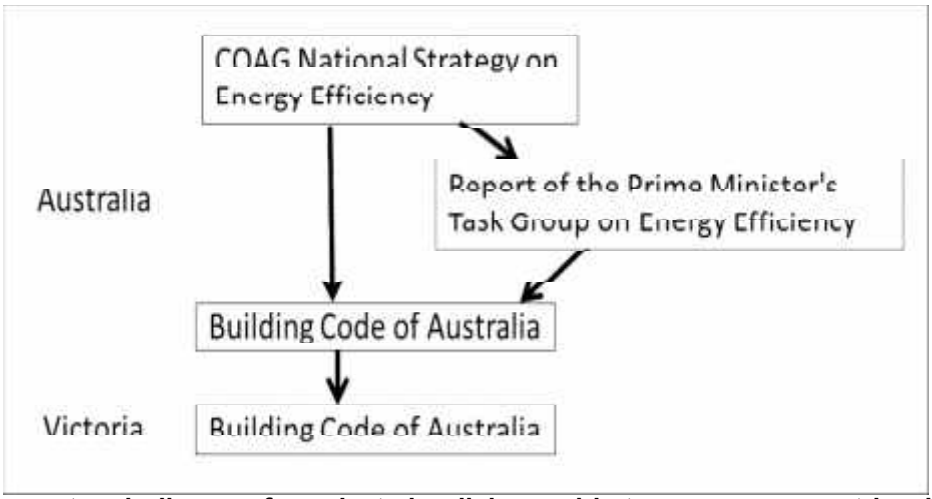

Figure 3: Policy network diagram for selected policies and between government levels for analysis from Australia and Victorian context.

3. RESULTS AND DISCUSSION

Over 70 specific questions were assessed against the policy documents across the various key ZEH and STT criteria discussed above. Table 3 presents headline criteria from the analysis, and documents were coded as follows:

- Y – Included in policy and mandatory,
- R – Included in policy but not a mandatory requirement,
- P – Included but only partially addressed,
- N – Discussed in policy but not included,
- U – Unclear,
- Blank - Not mentioned at all, and
- f – Included as mandatory in future tightening of regulations.

Table 3: Summary of ZEH and STT assessment against the various policies

		USA					California		EU	UK	Australia			Victoria
	Selected criteria questions	2009 International Residential Code	International Energy Conservation Code 2009	National Green Building Standard ICC 700-2008	LEED for homes 2008	Building Energy Code initiative Building America	CALGreen	Assembly Bill 2112 Zero net energy buildings	Directive 2010/31/EU	Code for Sustainable Homes	Building Code of Australia 2011	Task Group on Energy Efficiency	National Strategy on Energy Efficiency July 2009	Code Building of Australia 2011
ZEH criteria	Is there a requirement for renewable energy technologies?	N		R		Y	R/Yf	Y	R	R/Yf	N		U	R
	Is there a requirement for 'smart' technologies as part of minimum building standards?			R			R	R	R	R	U			
	Does the document present the through life economic costs & benefits?						P	Y	Y	Y	Y	U	U	
	Is targeting the behaviour of householders addressed as part of the minimum building standards?	N		N			P	P	N	R	N		Y	
STT criteria	Is ZEH a policy goal?	N	N	N		Y	N/Yf	Y	Y	Y	N	U	N	
	Is there evidence of a medium term (5-14 years) housing performance policy?	N		N		Y	Y	Y	Y	Y	N	N	N	
	Are any scenarios generated to achieve longer term policy objectives?			N		U	Y	Y	Y	Y	N	U	N	
	Is there a link between housing performance policy & greenhouse gas emissions reduction targets?			U		Y	Y	Y	Y	Y		U	P	
	Is there a link between housing performance policy & renewable energy targets?			U		Y	Y	Y	Y	Y		U	U	
	Are multiple social aspects considered?	N	N	Y	U	Y	P	Y	P	Y	N	P	U	N
	Is there support provided for demonstration ZEH projects or technology development?					Y		U	P	Y	P	P	P	
	Is there a requirement to reduce increased upfront costs (if there are any)?								Y	U		P		

The paper will now discuss each case study and explore the analysis with a particular focus on those criteria with critical importance for the development of policy pathways, appropriate for a ZEH transition.

3.1. United States of America/California

Through the Building America program, the USA has announced a ZEH standard for all new housing to be implemented by 2020. Whilst the practicalities of achieving this goal are not well developed in the policy at present, the program provides funding and support for research, demonstration projects and targeted programs to help move the building industry and regulations towards this goal, which is recognised by STT as important for encouraging innovation (DOE, 2010; Loorbach, 2007). This policy direction places significant emphasis on the inclusion of renewable energy technology. The program is strongly linked to wider climate change emission reduction targets and renewable energy generation targets. However it is not yet linked to the IRC and NGBS.

The IRC is limited to improving heating and cooling energy efficiencies. There are no requirements for aspects of renewable energy or wider 'smart' technologies to be included. Further the standard is not linked to wider government policy development. In its current form it will not lead to a ZEH transition in the USA.
The NGBS does link into the wider environmental policies and recognises them as the key drivers of the policy. Critical ZEH elements such as the use of renewable energy technologies and improving indoor air quality are included in the standard; however the standard does not specifically target ZEH as a goal. In addition to technical components, a number of social elements are addressed in the standard, such as improving occupant health. LEED for homes 2008 is a similar rating system to NGBS and has many of the same elements (NAHBRC, 2008). As long both standards remain voluntary they are unlikely to achieve a significant paradigm shift.

At the state level California has mandated new ZEH by 2020 (Californian Government, 2008; CPUC, 2008). The switch from the IRC to CALGreen for minimum housing standards at the star of 2011 was an early step along the pathway to achieve these goals. The Californian Government has developed a pathway with interim targets through back casting to enable tracking to the target goal (CPUC, 2008). While design interventions including building orientation are addressed, critical elements required for ZEH such as renewable energy technologies are not currently mandatory.

3.2. European Union/United Kingdom

In 2010 the EU through Directive 2010/31/EU set out a requirement for all member states to enable zero emissions housing standards for all new housing by 2020, with interim goals for 2015. The Directive provides a list of areas suggested for inclusion, including renewable energy technologies. There is a strong link between the requirement for renewable energy technologies and wider EU renewable energy and greenhouse gas reduction targets. A requirement is included for Member States to report on current and proposed financial instruments to help achieve ZEH outcomes.

In the UK, the CSH includes low and zero carbon technologies, the environmental impact of materials, adaptable homes and the requirement for home user manuals. It also specifically mentions wider social issues such as occupant health, housing affordability and fuel poverty, which are significant departures from 'technology only' policies. For example to help address upfront affordability concerns, a stamp duty reduction was offered to houses achieving code level 6 before 2012 (Financial secretary to the treasury, 2007).

Within a STT context, the UK approach is relatively promising as a starting point. Notwithstanding, the expected uptake of renewable energy technologies requires tracking alongside changing institutional and social structures (industry, trades people, households, etc).

3.3. Australia/Victoria

In contrast to the UK approach, the inclusion of renewable energy technologies and wider social elements are missing or rather not integrated into housing regulation improvements in Australia. In Victoria, there is a requirement for onsite solar hot water or a rainwater tank. However, there is a lack of systemic policy consideration and 'joining up' of policy domains relating to a ZEH 'transition'. For example, whilst rebates are provided by the government to induce higher demand for renewable energy technologies, there is no strategy to integrate this with new housing regulations (Macintosh & Wilkinson, 2011).

Wider considerations such as occupant health, housing affordability, fuel poverty and 'sustainable housing industry' development are not explicitly linked to or considered in policy approaches to improving housing environmental performance, despite some existing research indicating such links as important (Newton & Tucker, 2009; Pitt & Sherry, 2010).

Apart from the National Strategy on Energy Efficiency, there is no long term housing energy performance policy development strategy in Australia, and no ZEH policy goal. The TGEE does recognise international best practice (USA and EU) towards ZEH by 2020, but fails to address mechanisms of achieving ZEH in Australia.

3.4. Comparisons across jurisdictions and lessons for Australia

The analysis has shown that there are a number of similarities and differences between the policy approaches taken across the case study jurisdictions with regards to ZEH when analysed against a set of STT criteria. The previous sections have highlighted a number of strengths and gaps in the policies from the selected case study areas. Based upon the analysis, both the USA and EU are more advanced in terms of a

STT towards ZEH than Australia. Results of STT criteria analysis will now be explored to develop lessons for the Australian context, particularly with a view to identifying lessons for future Australian policy.

Importantly, ZEH is a long term overarching policy goal in the USA and EU but not currently in Australia, where there are limited medium or longer term policy goals. The lack of long term goals is a significant barrier to achieving ZEH (Berkhout, Smith, & Stirling, 2004; Eames, Mcdowall, Hodson, & Marvin, 2006). The development of longer term goals and pathways is important for the emergence and stability of bi-partisan shifts, informing and improving 'decisions that must be made while the future remains uncertain or undecided' (Hughes & Strachan, 2010, p. 6056). Furthermore, investment vehicles for new technology research and development invariably rely on planned or foreseeable change over a decade or more, and such time is also needed in preparing affected actors for future policy changes (Eames, et al., 2006; Hughes & Strachan, 2010). As there are no long term policy plans in Australia, the future development for sustainable technologies is uncertain.

Longer term policy goals for ZEH in the USA and EU are linked to climate change emission reduction and renewable energy targets. This provides justification for changes to minimum housing energy performance standards over the long term. The UK in particular has set significant greenhouse gas emission reduction targets of 80% of 1990 levels by 2050. The setting of such clear and strong targets has meant that every greenhouse emitting sector will have to make substantial greenhouse gas reductions, including housing. Therefore in the UK, policy makers have determined that new housing can contribute to these targets by building to a ZEH standard and that this can be achieved by 2016. Australia has announced similar greenhouse emission reduction targets by 2050 but is yet to integrate this target this into wider policies or targets.

Both EU and USA approaches include renewable energy generation in ZEH policy pathways, and both acknowledged that a current lack of mandatory renewable energy requirements is a limitation (DOE, 2010; European Commission, 2010). Such requirements are planned for mandating by 2016 in the UK and by 2020 for the EU and USA.

As introduced above, STT approaches also invariably include non-technical systemic considerations in attempts to improve the potential for a successful transition (Geels, 2002; Rip & Kemp, 1998). Notwithstanding occasional references to human health (indoor air quality) and affordability elements such considerations are generally lacking, except in the EU and UK, where they have been used to support a move to higher housing standards.

A further significant identified barrier to the uptake of improved housing performance is the associated higher upfront costs (CIE, 2010; MBAV, 2008). This implies a need for long term fiscal responses intended to provide price signals appropriate to a transition. Reframing the cost argument to include through life costs can help to move the debate away from upfront costs. While cost benefit analysis steers debate away from 'uncosted' issues, it can also be reframed to promote ZEH. Indeed, it also provides a standard 'way of seeing' that mediates against ambit claims against regulatory changes made by vested interest groups (Crabtree & Hes, 2009).

4. CONCLUSION

Using a STT framework, our analysis of 3 case study regions indicates relative gaps in current Australian housing energy performance policy. While all jurisdictions demonstrated some gaps, the international case study jurisdictions generally indicated a more ambitious and long term commitment to future housing energy performance pathways compared to Australia. Key criteria missing from Australia's ZEH approach include:

- No long term housing energy policy, with a clear vision of ZEH as a policy goal,
- A lack of policy linkage and integration between wider government policies,
- Limited mandatory requirements for key ZEH technologies such as renewable energy technologies
- Insufficient integration of social aspects such as health, wellbeing and domestic social practices, and
- Limited consideration of the financial factors involved with ZEH.

It is too early to tell if the EU or USA policy approaches will be successful, or if STT theory operationalized through *transition management* can work in the context of ZEH, either in Australia or elsewhere. However, steady progress towards ZEH is reported in the UK (DCLG, 2010; Osmani & O'Reilly, 2009), where redefining affordability from upfront costs to through life costs has helped the policy become more accepted by the building industry and consumers. While there is ongoing discussion on the finer details of the 2016 targets, these are more about the split of onsite/offsite renewable energy generation requirements rather than the overarching principles and requirements for ZEH. The debate has moved on.

In Australia, to address the gaps, the following recommendations are proposed:

- Longer term housing performance goals and ZEH standards are needed, including renewable energy generation with a preference for onsite energy generation where possible. This should be developed in conjunction with improving current minimum thermal performance standards. The current cost-optimal star rating combined with renewable energy technologies is 8 stars with approximately 3.5kW of solar photovoltaics and solar hot water system (Moore, 2010).

- More reflexive policy approaches are needed, with independent monitoring and evaluation of change towards long term goals. A review should be undertaken no longer than every three years.

- Strong links are needed to wider policies such as climate change emission reduction targets, renewable energy generation targets and key social policies such as improving health and reducing fuel poverty. These links should be interlocking and mutually reinforcing.

- A deeper understanding of the complexity and diversity of changing social and cultural practices is urgently needed, including (a) as they relate to both technologies in domestic spaces and in turn to energy demand and (b) how onsite renewable energy technologies change the relationship between supply and demand and thus influence energy demand.

- The investment costs of achieving ZEH need to be addressed through fiscal measures as well as through redefining affordability (to include through life costs and benefits) and long term mechanisms to improve cost efficiencies of building materials and sustainability technologies.

REFERENCES

ABCB. (2011). BCA 2011. Building Code of Australia. Class 1 and Class 10 buildings. Housing provisions volume two. Canberra: Australian Building Codes Board,.

Australian Government. (2010). *Report of the Prime Minister's task group on energy efficiency*. Canberra: Australian Building Codes Board,.

Bergman, N., Whitmarsh, L., Köhler, J., Haxeltine, A., & Schilperoord, M. (2007). *Assessing transitions to sustainable housing and communities in the UK*. Paper presented at the International conference on whole life urban sustainability and its assessment, Glasgow.

Berkhout, F., Smith, A., & Stirling, A. (2004). 3. Socio-technological regimes and transition contexts. *System innovation and the transition to sustainability: theory, evidence and policy*, 48.

Boardman, B. (2007). Examining the carbon agenda via the 40% House scenario. *Building Research and Information, 35*(4), 363-378.

Californian Government. (2008). Assembly Bill No. 2112 Energy: building standards. California: Californian Government.

Cato, M. (2011). *Environment and economy*. London; New York: Routledge.

CIE. (2010). Energy-efficiency: building code star-ratings. What's optimal, what's not. Canberra: The Centre of International Economics on behalf of Master Builders Australia.

COAG. (2009). National Strategy on Energy Efficiency. Retrieved 06/09/2009, from Council of Australian Governments http://www.coag.gov.au/coag_meeting_outcomes/2009-07-02/docs/Energy_efficiency_measures_table.pdf

CPUC. (2008). California long term energy efficiency strategic plan: Achieving maximum energy savings in california for 2009 and beyond: California Public Utilities Commission.

Crabtree, L., & Hes, D. (2009). Sustainability uptake on housing in metropolitan Australia: An instiutional problem, not a technological one. *Housing Studies, 24*(2), 203-224.

CSIRO. (2009, 16/09/2009). Australian Zero Emission House, from http://www.auszeh.org.au/

DCLG. (2006). Code for Sustainable Homes A step-change in sustainable home building practice. London: Department for Communities and Local Government.

DCLG. (2010). Code for Sustainable Homes. Technical guide. (Vol. November 2010). London: Department for Communities and Local Government.

DEWHA. (2008). *Energy use in the Australian residential sector 1986-2020*. Canberra: Department of the Environment Water Heritage and the Arts,.

DOE. (2010). About Building America Retrieved 03/03/2011, 2011, from http://www1.eere.energy.gov/buildings/building_america/about.html

Eames, M., Mcdowall, W., Hodson, M., & Marvin, S. (2006). Negotiating contested visions and place-specific expectations of the hydrogen economy. *Technology Analysis & Strategic Management, 18*(3), 361 - 374.

Edwards, B., & Turrent, D. (2000). *Sustainable housing: Principles & practice*. Oxon: E & FN Spon.

European Commission. (2010). *Directive 2010/31/EU on the energy performance of buildings (recast)*. European Parliment Retrieved from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF.

Financial secretary to the treasury. (2007). *Budget 2007: Regulatory Impact Assessments Chapter 9: Stamp duty land tax relief for new zero-carbon homes*. London: Retrieved from http://www.hmrc.gov.uk/ria/9-zero-carbon-homes.pdf.

Foxon, T., Hammond, G., Pearson, P., Burgess, J., & Hargreaves, T. (2009, 4-5 June). *Transition pathways for a UK low carbon energy system: exploring different governance patterns.* Paper presented at the 1st European Conference on Sustainability Transitions: "Dynamics and Governance of Transitions to Sustainability", Amsterdam, The Netherlands.

Geels. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research policy, 31*(8-9), 1257-1274.

Geels. (2005). The dynamics of transitions in socio-technical systems: A multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930). *Technology Analysis & Strategic Management, 17*(4), 445-476.

Geels. (2010). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. *Research policy, 39*(4), 495-510.

Geels, & Schot. (2007). Typology of sociotechnical transition pathways. *Research policy, 36*(3), 399-417.

Halverson, M. A., Shui, B., & Evans, M. (2009). Country Report on Building Energy Codes in the United States: Pacific Northwest National Laboratory (PNNL), Richland, WA (US).

Hoppe, T., Bressers, J. T. A., & Lulofs, K. R. D. (2011). Local government influence on energy conservation ambitions in existing housing sites--Plucking the low-hanging fruit? *Energy Policy, 39*(2), 916-925. doi: 10.1016/j.enpol.2010.11.016

Horne, R., & Hayles, C. (2008). Towards global benchmarking for sustainable homes: an international comparison of the energy performance of housing. *Journal of Housing and the Built Environment, 23*(2), 119-130.

Hughes, N., & Strachan, N. (2010). Methodological review of UK and international low carbon scenarios. [doi: DOI: 10.1016/j.enpol.2010.05.061]. *Energy Policy, 38*(10), 6056-6065.

ICC. (2009a). International Energy Conservation Code. USA: International Code Council Inc.

ICC. (2009b). International Residential Code for one - and two-family dwellings 2009 (2009 ed.). USA: International Code Council Inc.

ICC. (2011). International codes - Adoption by State (updated 01-28-2011). USA: International Code Council Inc.

Kemp, R., Rotmans, J., & Loorbach, D. (2007). Assessing the Dutch energy transition policy: how does it deal with dilemmas of managing transitions? *Journal of Environmental Policy & Planning, 9*(3), 315-331.

Kemp, R., & van Lente, H. (2011). The dual challenge of sustainability transitions. *Environmental Innovation and Societal Transitions, 1*(1), 121-124. doi: 10.1016/j.eist.2011.04.001

Loorbach, D. (2007). Transition management: new mode of governance for sustainable development.

Loorbach, D. (2010). Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework. *Governance, 23*(1), 161-183.

Macintosh, & Wilkinson. (2011). Searching for public benefits in solar subsidies: A case study on the Australian government's residential photovoltaic rebate program. *Energy Policy, 39*(6), 3199-3209. doi: DOI: 10.1016/j.enpol.2011.03.007

Marszal, A. J., Heiselberg, P., Bourrelle, J. S., Musall, E., Voss, K., Sartori, I., & Napolitano, A. (2011). Zero Energy Building - A Review of definitions and calculation methodologies. *Energy and Buildings, 43*(4), 971-979. doi: DOI: 10.1016/j.enbuild.2010.12.022

MBAV. (2008). Submission to the Liveability Inquiry. Victorian Competition and Efficiency Commission. February 2008. Melbourne: Master Builders Association of Victoria.

Míguez, J. L., Porteiro, J., López-González, L. M., Vicuña, J. E., Murillo, S., Morán, J. C., & Granada, E. (2006). Review of the energy rating of dwellings in the European Union as a mechanism for sustainable energy. *Renewable and Sustainable Energy Reviews, 10*(1), 24-45. doi: DOI: 10.1016/j.rser.2004.08.003

Moore, T. (2010). The costs and benefits of zero emission housing; modelling of single detached houses in Melbourne. Working paper. Melbourne: Centre for Design, RMIT University.

Morrissey, J., Moore, T., & Horne, R. E. (2011). Affordable passive solar design in a temperate climate: An experiment in residential building orientation. *Renewable Energy, 36*(2), 568-577. doi: 10.1016/j.renene.2010.08.013

NAHB. (2008). National Green Building Standard ICC 700-2008. USA: National Association of Home Builders.

NAHBRC. (2008). Green home building rating systems - A simple comparison. USA: National Association of Home Builders Research Centre Inc.

Newton, P., & Tucker, S. (2009). Hybrid Buildings: Pathways for greenhouse gas mitigation in the housing sector. Melbourne: Institute for Social Research, Swinburne University of Technology.
Osmani, M., & O'Reilly, A. (2009). Feasibility of zero carbon homes in England by 2016: A house builder's perspective. *Building and Environment, 44*(9), 1917-1924.
Peterkin, N. (2009). Rewards for passive solar design in the Building Code of Australia. *Renewable Energy, 34*(2), 440-443. doi: DOI: 10.1016/j.renene.2008.05.017
Pitt & Sherry. (2010). The pathway to 2020 for Low-Energy, Low-Carbon Buildings in Australia: Indicative Stringency Study. Melbourne: Prepared by Pitt & Sherry on behalf of Department of Climate Change and Energy Efficiency.
Rip, A., & Kemp, R. (1998). Technological change. *Human choice and climate change, 2*, 327-399.
Rotmans, J., Kemp, R., & Van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *Foresight-The journal of future studies, strategic thinking and policy, 3*(1), 15-31.
Scorse, J. (2010). *What Environmentalists Need to Know about Economics*: Palgrave MacMillan.
Shui, B., Evans, M., & Somasundaram, S. (2009). Country Report on Building Energy Codes in Australia: Pacific Northwest National Laboratory (PNNL), Richland, WA (US).
Smith, A. (2006). Governance lessons from green niches: the case of eco-housing. *Governing Technology for Sustainability*, 89–109.
Smith, A. (2007). Translating Sustainabilities between Green Niches and Socio-Technical Regimes. *Technology Analysis & Strategic Management, 19*(4), 427 - 450.
Smith, A., Voß, J.-P., & Grin, J. (2010). Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. [doi: DOI: 10.1016/j.respol.2010.01.023]. *Research policy, 39*(4), 435-448.
SOGEE. (2010). *National Building Energy Standard-Setting, Assessment and Rating Framework*. Senior Officials Group on Energy Efficiency, Commonwealth of Australia,.
Tambach, M., Hasselaar, E., & Itard, L. (2010). Assessment of current Dutch energy transition policy instruments for the existing housing stock. [doi: DOI: 10.1016/j.enpol.2009.10.050]. *Energy Policy, 38*(2), 981-996.
U.S. Green Building Council. (2011). LEED for homes Retrieved 06/06/2011, from http://www.usgbc.org/DisplayPage.aspx?CMSPageID=147
Vale, B., & Vale, R. (2000). *The new autonomous house : design and planning for sustainability*. London: Thames & Hudson.
Verbong, G. P. J., & Geels, F. W. (2010). Exploring sustainability transitions in the electricity sector with socio-technical pathways. [doi: DOI: 10.1016/j.techfore.2010.04.008]. *Technological Forecasting and Social Change, In Press, Corrected Proof*.
Vergragt, P. (2003). Back-casting for environmental sustainability: from STD and SusHouse towards implementation. *Towards Environmental Innovation Systems*, 301-318.
Williams, J. (2008). Green Houses for the Growth Region. *Journal of Environmental Planning and Management, 51*(1), 107 - 140.
Zhu, L., Hurt, R., Correa, D., & Boehm, R. (2009). Comprehensive energy and economic analyses on a zero energy house versus a conventional house. *Energy, 34*(9), 1043-1053.