Zero emissions **housing:**

a review of key policy regulations, technical issues and design challenges facing Australia's pursuit of zero emissions housing

Caroline Pidcock

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Caroline Pidcock was awarded the Byera Hadley Travelling Scholarship in 2009.
Cover image: Zero Emissions Houses at the BRE (Building research Establishment) Innovation Park in Watford, UK.
Photo by Caroline Pidcock

A review of key approaches to zero emissions housing in Europe across three broad areas: policy and regulations, technical issues, and design challenges.

This aim of this research was to better understand key drivers of Europe's success in lowering carbon emissions from the built environment sectors, to inform an Australian architecture of zero emissions housing

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Introduction

The Australian Institute of Architects' "Call to Action at Copenhagen 2009" states:

"The world faces a pressing challenge: maintaining and indeed improving standards of living and economic growth rates while reducing greenhouse gas emissions and other negative environmental impacts. The architecture and built environment professions have a crucial role to play... We believe it's the responsibility of the profession to make this call for action."

United Kingdom and Europe have been very proactive in approaching this issue. Regulations have been put in place that require new houses to achieve zero emissions from 2016 and 2019 respectively. I was impressed. If this can be undertaken in places with much more difficult climates than ours, surely in Australia, we could – or really should – do the same?

Having been awarded the Byera Hadley Travelling Scholarship in 2009, I developed this research project to look at the architecture of zero emissions housing, by firstly reviewing international approaches to this topic, in order to better understand the following key drivers:

1. Policy and regulations that have been developed in various countries around the world;
2. Technical issues relevant to achieving net zero emissions housing; and
3. Design challenges that must be addressed by architects to achieve zero emissions housing.

This report presents a summary of the major issues and recommendations for how we should address those drivers in Australia.

R Recommendations

R.1 Overview

Broadly speaking, net zero emissions housing aims to result in zero net energy consumption and zero carbon emissions annually. The definitions discussed in 1.1, mainly vary around the boundaries of what is included in the calculations.

Can and should Australia look towards the idea of net zero emissions housing? And if so, what are the major issues particular to Australia that should be considered?

Being awarded one of the 2009 Byera Hadley Travelling Scholarships has enabled me to review what is happening in a number of countries that are leading in this area. The places and people I visited were also chosen for reasons of excellence in their own right and relevance to Australia with regards to climate and culture.

My key motivation was to develop a broad understanding of the regulatory, technical and design aspects of the architecture of net zero emissions housing occurring in various parts of the world, and see if they might be appropriate for Australia.

The research was undertaken by way of connections with people and institutions I know in Australia; a trip to Europe in December 2009 – January 2010; a trip to Cascadia (north-west America and Vancouver) in September/October 2010; and from the privacy of my own lap top and many books prior to, during and subsequent to travelling. I have also had the benefit of information that is being developed by various groups in Australia over the last year.

During my research it was pointed out that I should change the title of my research to the Architecture of ***Net*** Zero Emissions Housing. This focuses on the outcome of annual energy use, recognising that most houses are part of larger systems to which they sometimes contribute, and at other times take from. During the course of my investigations, I became convinced that achieving ***net*** zero emissions over the year is a more sustainable and achievable objective in the urban world in which most of us live.

Even while I undertook the research, the situations in various countries were changing and will continue to adapt to their diverse environmental, economic and political situations. There are also many countries that I was not able to visit in the time I had. This report is therefore not a complete compendium on the subject, but does give a strong flavour of what is happening in a number of key areas in the world, relevant to Australia.

The generosity and intelligence of the people I met with on the trips and here in Australia have been critical to the research and development of ideas. It also renewed my faith in the human race as being strong and selfless enough to find creative ways to make necessary changes to deliver a positive future for us all. I would like to thank everyone who was involved. Most of all I would like to thank my partner John McInerney, who has been my companion on both overseas trips, intelligent sounding board for the development of my thinking, assistant editor for this report and great friend.

R.2 Recommendations generally

R.2.1 Is net zero emissions housing appropriate for Australia?

I am convinced that Australia is very well placed to be able to achieve net zero emissions for its housing.

This will be essential in the provision of affordable, comfortable housing in a low carbon future; a well trained workforce with exportable skills; a building industry able to compete in a global economy; and the development of effective renewable energy systems. As documented in the report on my studies, this is supported by the:

- delight of occupants of net zero emissions housing and their affordable lifestyles
- evidence of business success of those businesses engaging and competing in this area
- the uptake of practices and knowledge of a wide range of participants

R.2.2 Regulations

I believe that we will need to regulate to achieve net zero emissions housing. This regulation should contain:

- A 10 year time frame with a stepped introduction of increasingly stringent targets before net zero emissions for all new housing at its conclusion.
- An appropriate approach and timeframe for existing housing, that accounts for the various types of construction and climate issues around Australia.
- Targets to simultaneously and effectively reduce:
    - Overall energy consumption
    - CO2 emissions
    - Peak loads
- A strategy for how the mandatory disclosure certificates that are to be introduced in Australia can simply and effectively demonstrate energy consumption on a number of levels – for each household, person and per square metre.
- An overarching framework that integrates energy efficient building measures with other sustainability metrics, so each can be regulated in appropriate but separate ways. The UK Code for Sustainable Housing is an excellent example of how this might be achieved.
- A framework that is strong and clear in its overall aims and objectives, but flexible in its implementation so that local communities can modify specific aspects to reflect their own concerns and needs.
- A requirement that renewable energy (to cover the energy used) should be provided on-site. The definition of what constitutes on-site should be expansive enough to encourage local near-site community energy production, but not off-sourcing the production to other places. See 1.2.5 below.
- Provision for an independent organisation to proactively engage with industry, government and the general public to review the impact of the regulation as it is introduced, and to anticipate potential problems, with the aim of avoiding unintended consequences – similar to The Carbon Hub in the UK.

R.2.3 Which emissions should be counted?

The overarching framework for regulation should be designed to equitably account for the collective impact of the emissions over the life of a building resulting from:

- The operational energy of buildings, including:
    - heating and cooling
    - hot water
    - lighting
    - appliances
- The embodied energy of the materials and construction systems (both from any existing buildings as well as new work); and
- The travel emissions arising from the selection of the site.

The range of regulatory mechanisms required to do this should be coordinated and calibrated in a framework designed to steer housing outcomes to the most efficient possible for each building typology. While an overall score might result which will allow for some balancing across the different areas (as in GreenStar), there should be minimum achievements required for each emissions area.

R.2.4 Incorporating renewable energy

In order to achieve net zero emissions, renewable energy needs to be provided for the energy use that cannot be avoided. This should be required to be provided on-site or near-site, to help prioritise energy efficient construction.

Regulations need to encourage and enable the successful installation of renewable options such as:

- solar hot water heating
- photovoltaics mounted on the roof or other part of the site
- integrated photovoltaics – included as part of the roof or wall envelope
- wind turbines – separate to or attached to the building
- district heating systems that make the most of otherwise waste heat from such processes as electricity production or sewerage output
- geothermal heat sources

The many planning regulations that do not allow visible solar hot water heating and/or photovoltaics need to be rewritten to ensure that well designed installations are allowed on any north-facing roof – including heritage buildings (unless there is an outstanding reason why not). As demonstrated throughout Europe, buildings need to adapt and contribute to the future so they can be a useful part of it.

R.2.5 Is this really affordable?

It is critical that the solutions for zero emissions are applicable at all levels of the housing supply chain – most particularly for those on lower incomes.

When considering what “affordable” means, we need to include all the costs that contribute to the weekly bills. If not, we will continue the bias against building better houses in more appropriate locations with suitable services – which puts families into lifestyle poverty because of their overall unaffordability.

Calculations of affordability need to account for **all** the costs that make up the weekly bills – mortgage / rent; energy; water; transport; and food. As the decisions we make on how we plan and shape our cities will impact on these wider costs of living, we need to account for their impacts when these decisions are made – state, metropolitan and city planning agencies need their regulatory impact statements to extend the range of indices considered to do this. Approaches to be considered include:

Size	This major impact on the cost of building dwellings is rarely discussed – other than being larger is promoted as better. The best way of reducing the cost of the initial build – and the ongoing operation – is to reduce the size of the house. With good design, this does not have to have a negative impact of the livability.
Energy	Net zero emissions housing reduces the costs for energy over the year to zero, allowing this usually significant portion of the family budget to be spent in other areas. Planning regulation needs to be strongly guided by consideration for how the most energy efficient buildings and renewable energy generation can be achieved. Good orientation, efficient building forms and protection for solar collectors need to be properly supported in these instruments.
Water	Similar to energy, houses can be designed to assist their occupants to use water efficiently. While water is relatively inexpensive at the moment, in a dry, arid country we cannot assume this will continue. This is another portion of the family budget that can be better invested.

	We need to plan for cities and homes that can better harvest, store and use the water available to us, with consideration for individual and collective measures.
Transport	A car costs approximately $10,000 per year to keep on the road – this is money that can be much better spent. Sadly, many of our new suburbs have been built with no option other than for the residents to drive to work, school, play and every other aspect of their lives, requiring several cars per family.
	We must seriously address how our cities are planned so that more people are able to easily access and use public transport and non-motorised methods of transport. We need to carefully consider how we incorporate greater densities and infrastructure into our cities to enable this to happen. High levels of consultation and good design will be required.
Food	Food costs are rising and security is diminishing. Housing and neighbourhoods can be designed with appropriate space allocated for growing food for the occupants. While this might not provide the bulk of the food required for their populations, it can provide basic elements of people's diets for virtually no cost, while providing great community building opportunities.
	Planning that encourages sunny garden areas for occupants, along with street and community gardens, is required. Additionally, how and where we plan growth in our cities needs to ensure protection of valuable food producing land near where people live.

R.2.6 People and desirable design

The success of net zero emissions housing is ultimately down to the people who occupy them. People need to ***choose*** to live in more efficient houses and be ***willing*** and ***able*** to operate them in their most optimal way.

Architects need to design and develop desirable homes, that are spatially and thermally efficient, and that are intuitive and clear in their operation. Good design seems to be the most important investment to be made in order to create a sustainable future, and the requirement for it needs to be embedded in all regulation to do with the built environment.

We also need to develop conversations in the public realm where the wonderful opportunities of sustainable living – particularly net zero homes – can be discussed, and the details for what is required for both the buildings and the occupants to achieve this are made available.

Affordability – as mentioned in 1.2.4 – is essential to opening this up to as many people as possible.

R.3 Recommendations for architecture

The outcomes of the research and discussions with key individuals raised a number of ideas that have prompted me to think about and refine how we practice architecture. The following areas capture the main ideas I have been exploring.

- Architectural practice

R.3.1 Collaborating with clients

A project is only as good as the brief that drives it, behind which is the client. We need to work with our clients to create the best possible brief. We are working on the following ideas to improve this interaction.

- A design charette with our clients at the outset is allowing us to create a strong platform to better understand each other and develop a mutually understood language about the design process. Through this, we are finding it easier to align the requirements of the brief and sustainability agenda with the site opportunities and council constraints, and for the client to be really engaged in the refinement and realization of the outcome.
- We then use an ESD options list that provides a framework for discussions around options that might be appropriate for their project. Additionally, we are preparing a questionnaire to help identify

the “stuff” in their life that consumes energy. We hope that this will help illuminate the impact of their actions and lifestyles, and how these will impact on the aim of net zero emissions.

- So that our clients can be easily reminded of how the house works best at different times of the day and year, we will be preparing a handbook, clearly setting out ways of making it comfortable without additional heating or cooling. While the design might be “passive”, the occupation is not! We will also be conducting post-occupancy evaluations to check what is working and what can be improved.

R.3.2 Team building

Critical to successful sustainable design solutions is the involvement of all people involved in the project. Through this research and my own experience, I have found that traditional methods of practicing architecture do not always capture the skills and experience of all the people who can and should be involved to achieve sustainable outcomes. We are evolving our ways of working to address this more successfully in our practice.

We are recommending the early identification and appointment of the project team who are then involved in the documentation and building phases. By bringing this team together (builder and relevant consultants) at a time that they can contribute their experience and knowledge, we can help create a more responsive design that also addresses issues of buildability and budget. This process also aims to build ownership of the design and detailing by all the participants.

- Architectural design

R.3.3 Thermal modeling

As many management gurus note, if you can’t measure it, you can’t manage it. To develop seriously energy efficient housing that will enable the achievement of net zero emissions over the year, it is clear that we need to use well designed scientific modeling to fine-tune the details of our passive designs, including the location, amount and type of:

- thermal mass
- insulation
- glazing

We are currently asking our clients to invest in thermal modeling earlier in the design process than normal, so we can use it to help shape the design. This enables us to identify what needs to be done to achieve optimal outcomes when the options to how this might be achieved are open. We find this preferable to investing heavily in a design, only to belatedly find out it requires changes to achieve the desired energy efficiency goals.

There are questions about the veracity of thermal modeling tools (such as Accurate) and how accurately they can predict energy use (particularly in more humid climates). While they can be helpful when used with experience and understanding to give confidence to decisions on how to improve the potential performance of the house, a lot more work needs to be undertaken to improve these tools. We also need to allow tools proven in their capacity overseas to be adapted for Australia and recognised more easily by our codes.

It is also important to remember the major factor in the difference between predicted and actual energy use in residences is the actions of the occupants. A good occupant can occupy a poor building very efficiently, while occupants who don’t really care can incur high energy bills in a well-designed house. We are trying to work with our clients to help them understand the implications of how they live, and work with them to show how they can optimally operate the house we design for them. This is discussed further in R.3.7.

R.3.4 Heating/cooling options

Due to the extremely cold conditions faced over many years, Europeans and North-west Americans have evolved very efficient heating systems. They have developed well sealed building envelopes that minimize the amount of heating required to provide comfort, and efficient heat recovery systems to provide fresh air in an energy efficient way.

Here in Australia, we are often confused about how benign our climate is, and whether we require heating or cooling. Counter to most people's perception, in Sydney we need more heating than cooling. This often results in uncomfortable conditions, relieved in severe times by the most expedient measure available – usually the least sustainable, most inefficient and most costly in the long term.

After developing a true understanding of the potential thermal comfort from thermal modeling, we need to work out the best ways of supplementing this when required. There is much scope for the development of really efficient devices that can heat, cool and also assist with humidity.

R.3.5 Windows/doors

Many people in Australia like their houses to easily connect from inside to outside, and have tended to use large areas of glazing to help achieve this. The reality is that the glazed elements (windows and doors) of the building envelope will always be the weakest links in the system – at least 8 times worse than a solid wall.

Architects need to take a far more strategic approach to the number, location and type of windows and doors in houses. They need to be able to open up fully when the weather is conducive to comfort, and close down completely when the weather is either too hot or too cold. We also need to ensure the budget allocated to windows and doors enables the investment in quality materials and construction, and for external protection that improves performance when the weather is too warm and/or wet.

Convincing clients that less windows and doors is good can be difficult, especially when a view is to be enjoyed. However, we need to work with them to understand the critical link of a considered approach to their design with a comfortable and energy efficient home.

An increased demand for improved windows and doors would result from regulation. This should provide the market needed to help local manufacturers to develop a better, more affordable range of products than is currently available.

R.3.6 Ventilation

Most Australian's desire good natural ventilation – a strong part of our desire to connect with the environment. However, it seems we do not differentiate well between controllable ventilation and leaky buildings.

A critical part of an energy efficient building that will be able to achieve net zero emissions, is the ability to control and manage ventilation. Leaky building envelopes are a prime source of inadvertent ventilation, and are prevalent in Australia. Not only did our building codes for many years require such things as open vents in our external walls (for health reasons), but standard building practices have not concentrated on sealing up the connections between building elements such as windows and walls or walls and floors.

We need to focus on ensuring that we can deliver a very tightly sealed building envelope, with high performance windows and doors so that occupants can choose the appropriate ventilation option for the weather conditions. We then need to find appropriate and efficient ways of achieving the desirable amount of air changes when it is either too hot and/or humid, or too cold outside.

R.3.7 Design approach

While many people love a design aesthetic that clearly speaks of the sustainability issues addressed, there are many who find this confronting and unfamiliar in their homes. I believe there needs to be a broad church approach to what our designs might look like – I believe they can look like whatever they want, as long as they are sustainable.

The main messages that I believe we need to take on with regards to our design approach include:

- Energy efficient design can be more easily achieved when dwellings share part of their building envelope – such as walls, floors and/or ceilings – as this reduces the area exposed to the external environment. Terrace houses, semis and smaller apartment blocks are good examples of this approach. We need to develop a wide range of contemporary versions of these housing types that respond to our own cultural requirements.

- The most important aspect of successful dense housing is good design. This should consider:
    - Orientation and good solar design
    - Passive design approaches to thermal mass and insulation
    - Privacy, overshadowing and noise.
    - How to borrow space from outside to make smaller rooms seem more spacious
    - Use of materials that will last, do their job, impact minimally on the environment and have visual appeal
- As insulating external walls is of great benefit in most climates, we need to develop a range of cladding solutions for highly insulated light weight walls that can help deliver the low maintenance qualities of face brickwork.
- In a country with many places that experience high levels of solar radiation and torrential rainstorms, we need to continue to develop innovative solutions for protecting windows, doors and walls.
- We need to continue to develop a good understanding of the needs of people, so we can deliver housing solutions that work for them, and can be easily adapted as their lifestyles change.
- Most homeowners are unlikely to invest the time to learn how to operate complex climate control systems in their own homes. Intuitive and simple methods for how a house should work and be operated are the best way of ensuring it will work through its lifetime.
- Training of people we work with is critical to help develop an overall understanding of what we are doing while increasing the opportunities that we can explore.
- We need to develop good post-occupancy evaluations so we can understand what really does work and why, and what needs to be adapted in the future so we can improve what we do.

R.4 Conclusions

As a result of my research, I believe Australia should move towards making our housing net zero emissions. In order to achieve this, we will need to:

- Develop appropriate policy and regulation for both new and existing housing, that is placed within a broader sustainability framework that can be adapted to accommodate local concerns
- Improve our technical approaches to all aspects of our housing to deliver simple solutions that are climatically and culturally appropriate to help achieve energy efficiency
- Align our design thinking and practice to support diverse and desirable housing that can easily enable occupants to achieve net zero emissions

By moving in such a direction I believe we will achieve:

- Better and more comfortable housing
- Improved resilience to high energy costs in the future
- An industry able to compete in a global economy, including:
    - Skilled professionals and industry workers able to export their skills and knowledge
    - Materials and products able to be used internationally
- Exciting opportunities to innovate and improve.

1 Policy / Regulations

This is an area I was particularly interested in, having sat as Industry Representative on the Australian Building Codes Board for the last eight years. In this time I witnessed the difficulty of getting even modest improvements to energy efficiency into the Code, with the focus on estimates of increased costs of building always at the forefront. I was intrigued to see how other countries – presumably with similar building and development lobbies – had managed to make the case for such seemingly dramatic regulation.

Bill McDonough[1] notes that regulation is a signal of design failure. Regulators in Australia say it should only be used if there is market failure. With a history of both with regards to voluntary energy efficiency measures and a building industry that is not fond of change, it would seem we might be ready for regulation in this area.

1.1 A discussion on definitions

The clearest and simplest definition for zero carbon homes I found was in England.

From DEFINITION OF ZERO CARBON HOMES AND NON-DOMESTIC BUILDINGS Consultation DECEMBER 2008[2]

What does a zero carbon home mean?

Building A Greener Future (July 2007) set out that all new homes are to be built from 2016 in such a way that, after taking account of:

- *emissions from space heating, ventilation, hot water and fixed lighting*
- *expected energy use from appliances*
- *exports and imports of energy from the development (and directly connected energy installations) to and from centralised energy networks, the building will have net zero carbon emissions over the course of a year.*

The present consultation retains the approach of looking at net emissions (including from appliances) over the course of a year. It proposes that, to meet the zero carbon homes standard, homes should:

- *be built with high levels of energy efficiency*
- *achieve at least a minimum level of carbon reductions through a combination of energy efficiency, onsite energy supply and/or (where relevant) directly connected low carbon or renewable heat; and*
- *choose from a range of (mainly offsite) solutions for tackling the remaining emissions.*

The definition does not address the issues of:

- *embodied energy expended in the construction of the home, the manufacture and transportation of the materials used and the demolition and recycling of materials. The EU is currently exploring new harmonised standards in this area and as a result the Government is not seeking to develop national standards in this area while that work is under way.*
- *transport emissions associated with new development. Such impacts are addressed through other policies, such as spatial planning.*

More broadly, Government recognises that the large majority of emissions from buildings in 2050 will be from buildings that have already been built. Those buildings are, on average, less energy efficient than buildings constructed to today's Building Regulations. Government is committed also to addressing those emissions, and will consult on how to do so separately.

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[1] Bill McDounough – Architect and Co-author of "Cradle to Cradle"

[2] DEFINITION OF ZERO CARBON HOMES AND NON-DOMESTIC BUILDINGS, Consultation Paper, DECEMBER 2008 for the UK Communities and Local Government,

From broader discussions and investigations, considerations for the definition of zero emissions include:

- Should zero carbon be measured at the unit level, development or community level? The Australian Department of Energy Efficiency and Climate Change is preparing a discussion paper for mandatory disclosure for houses. They have discovered each of these approaches will reward some households while penalising others. A framework is expected to be ready this year.
- Should the zero carbon definition allow offsite abatement? The requirement for on-site generation encourages design teams to focus more on the energy efficiency of the building envelope, as it reduces the amount of on-site renewable energy generation needed in the most cost effective way. However, this approach is much more difficult for denser residential designs.
- Should it include embodied energy? Not including embodied energy in the calculations could impact negatively on the retention of existing buildings, when their embodied energy is not "counted" but their energy efficiency problems will be. This could skew us towards highly engineered buildings that have low operational energy but high embodied energy, rather than simpler low-tech buildings that are not quite as efficient.
- Should it include travel energy? Comparisons need to be made between low energy houses in places requiring lots of driving ("hybrid hummer houses") and dwellings in mixed use locations where travel energy can be substantially reduced. This particular issue seemed to be more relevant in north-west America which is highly car dependent and travel consumes approximately 50 - 60% of overall energy usage.

Many cities and states in Europe are using the ***Passivhaus*** standards in place of energy efficiency requirements, to deliver the high performing buildings required to achieve net zero emissions over a year. The term Passivhaus refers to the rigorous, voluntary, standard for highly energy efficient buildings. A similar standard, MINERGIE-P is used in Switzerland. For a house to be deemed Passivhaus it must achieve the following:

- **Maximum Heating or Cooling Energy:** 15 kWh/m2 per year
- **Maximum Total Source Energy:** 120 kWh/m2 per year ("Source Energy" includes the energy required to produce and deliver the energy to the site.)
- **Maximum Air Leakage**: 0.6 air changes per hour at 50 Pascals

Many architects involved in Passivhaus design are talking about positive energy buildings as a natural progression from zero emissions.

What outcomes are preferred? What are we looking for a reduction in?

- ***energy consumption*** – this will result in a focus on energy efficient building technologies and appliances, without necessarily considering the energy (and its emissions) being used, nor when it is used
- ***CO2 emissions*** – this can align with overall targets for the country that need to be achieved for international agreements, but can cause skews towards low emission energy sources rather than efficient systems
- ***peak loads*** – this can help to address the fact that base load systems are designed to accommodate peak loads, often resulting in wasted energy at non peak times

Should a framework for regulation be expanded to include other sustainability metrics (such as water, materials, embodied energy etc)? The benefit of considering more issues is that a more accurate picture of the impact of the house and lifestyle can emerge. The downside is that greater complexity can be more difficult to get right, and how do we compare such disparate elements, especially when they come into conflict?

Should regulations be uniform across the country (a mandate driving the Australian Building Codes Board)? I was surprised to see how much variation there was in regulations of all places in our travels. These occur not only in the different countries, but also at every level of state/region and city, both in Europe and north-west America. Such variation allows for local issues and concerns to be easily addressed, and greater ownership of the ideas from the people who have to implement and live with them. While there might be inconsistencies for businesses practicing across regions, it seems to work better for the locals. There must be a framework approach with room for local adaptation that can be explored for Australia.

1.2 What were the drivers for introduction of zero emissions regulations?

In the UK, under a bold and courageous initiative of the Blair Government's housing minister Yvette Cooper, the regulation was debated, refined and then implemented, requiring escalated levels of improvement with a given timetable for achievement. I understand that the government was motivated to make dramatic change so they could redress the fact that the UK was well behind most European countries in this area, and that small changes would not give industry the incentive they needed to progress. In order to give their industry and built environment professionals a future, they needed to provide a regulatory environment that would encourage the development of long term business plans to address energy efficiency.

A group with representation from industry and government was set up to identify and address potential problems that might arise. This has given certainty to all stakeholders involved about what will be required and a definite market for innovations to flourish in. Rather than wasting time debating the merits of energy efficiency, people's efforts are being channeled into actions leading towards this inevitable future.

In a happy display of bipartisan support, this initiative has survived the change of government in the UK.

In Europe, the specific motivations in this diverse continent were less clear. However, it is clear that with very cold and long winters, and fast dwindling sources of cheap energy, many Europeans have been motivated for a long time to develop homes (and buildings) that will give them cost effective shelter from the environment. This seems to have lead inevitably to net zero emissions homes, with the understanding that this is the most effective way forward.

I thought that similar conditions would have driven the Canadians. However, I was surprised to learn the people who live in BC consider their climate to be rather benign. While surprising to me, it probably is when compared to the middle of Canada. Their move towards zero emissions seems more linked with the directions being pursued in California and other advanced areas of the world.

California took major steps to address energy efficiency after the oil scares of the 1970s. They quickly saw the benefits of regulation (such as the reduction in double glazing prices as this became the standard rather than single glazing) and have continued to lead the USA in this area. While we were there, the state was concerned that a referendum to remove fundamental environmental safeguards at the upcoming elections would force the state to take a step backwards. Fortunately, the scare campaign, pushed by vested interests involved in the petrol and related fossil fuel groups, was unsuccessful.

Portland, Oregon, is a town that was very lucky to have a progressive mayor in the 1970's. By turning a federal grant for a highway into a light rail system for the city, the town took a direction that led to it being the public transport mecca of the USA. Along with this, came an understanding of the importance of the many and varied aspects of a sustainable city, including energy efficient buildings. As leaders in LEED and other aspects of good design, Portland has been a major source of knowledge about green buildings in the USA.

Boulder, Colorado, was another wonderful oasis of sustainability. As home to a university and numerous research institutions, the people of this town have ensured some of the most stringent energy efficient requirements in the country. With professionals and builders well trained, they are happily using this knowledge to their own advantage as well as exporting it further afield.

1.3 Should we regulate?

Nearly everyone we spoke to in Europe said that regulation was the key to bringing zero emissions buildings forward. It gives certainty to the market and focus on the real aim of the game – how to make this happen. I saw this as better than wasting time, energy and resources on endless debate.

Silke Krawitz, based in Rome but originally from Germany, argues that regulation is required for zero emissions achievements, as is political will and true pricing for energy.

Sarah Sturrock from Communities and Local Government UK believes regulation is necessary but not sufficient. It can be a blunt stick and does not necessarily deal with behavioural issues. Sarah believes whatever you do, there will always be those who will work out how to work around the standards – fortunately this is usually a minority.

There were mixed messages coming from north-west America where many believe in small government and no regulation. However, it was very clear that where there was regulation, there were high levels of achievement across the industry.

Should there be consistent regulation across the country? Should local governments (often closer to their constituents) be allowed to implement their own agendas? An important English court case - The "Merton" case – resulted in the support of a London council, which wanted to instigate more stringent requirements than the code required.

It was clear that in every city and state in both European countries and North-west America, there was a different approach that reflected the particular concerns of their communities.

Australia has been firmly pursuing the line that there should be consistent building codes and regulation across the country. If one considers the difficulties of large businesses, which operate across many states, the efficiencies of such an approach is easy to appreciate. However, the ability for smaller areas of government to be able to respond quickly and efficiently to the needs of the people they represent can also be appreciated. I suspect that a well-designed framework within which individual choices can be made will deliver the best outcome in the Australian context.

1.4 What do the various zero emissions regulations look like?

In all the places we visited, the ways of measuring and rating differ, as do the units used. It makes comparison very complicated. Following is my summary of relevant international regulations followed by an attempt to bring some relativity to compare what is happening in Australia.

UNITED KINGDOM

By 2016, each new house will be required to have net zero carbon emissions with respect to:

- emissions from space heating, ventilation, hot water + fixed lighting
- expected energy use from appliances
- exports and imports of energy from the development (and directly connected energy installations) to and from centralised energy networks

This was part of a 10 year plan with incremental increases to the EE of the 2006 codes involving:

- 22% improvements by 2010; and
- 44% by 2013

This "escalator" path was put in place to help build up to this challenging target. The very clear guidelines around energy efficiency align with sections in the Code for Sustainable Housing. This document considers a wider range of sustainability principles and metrics in a coherent, connected way.

EUROPE

In 2002, the EU adopted the Energy Performance of Buildings Directive (EPBD), which set minimum efficiency standards for both residential and commercial buildings[3].

This was described in a Eurativ article as follows: [4]

Member states were obliged to implement the provisions of the directive in 2006, but most decided to delay transposition until January 2009 due to a lack of qualified independent experts. The directive provided a

[3] 4.1.2003 EN Official Journal of the European Communities L 1/65 - L 1/71
[4] http://www.euractiv.com/en/energy-efficiency/energy-performance-buildings-directive/article-187130

common methodology for calculating the energy performance of buildings and obliged member states to draw up minimum standards. These were to be applied to all new buildings and to existing buildings with a usable floor area above 1,000m² when they undergo a major renovation.

The legislation stopped short of imposing EU-wide minimum efficiency standards in favour of a flexible approach, requiring member states to lay down concrete requirements, while accounting for local climate conditions and building traditions.

To promote greater public awareness and debate on energy savings in buildings, the directive introduced an energy performance certificate, which has to be made available each time a house is built, sold or rented out.

Problems that arose and needed to be addressed include:

- *lack of experts to issue certificates and carry out inspections*
- *by limiting application to existing buildings over 1,000m2 it excluded 72% of stock*

In order to rectify these shortcomings, the Commission proposed a revamp of the 2002 directive as part of its Second Strategic Energy Review in November 2008. This included:

- *the extension of the scope of the directive to all existing buildings undergoing major renovations*
- *alternative energy systems would have to be considered for all new buildings*
- *a methodology to calculate the "cost-optimal" level of standards, against which member states would have to compare their actual requirements*
- *clarification of the language of energy-performance certificates, in order to turn them into "real, active energy labels of houses" to be included in sales and rental documents as well as in all advertisements.*

The European Parliament adopted a strict stance on the recast amending the proposal by adding a condition that new buildings constructed as of 2019 would have to be zero-energy. All new buildings would consequently produce their own energy using renewable energies like solar panels while minimising energy-loss with better insulation, double-glazing and similar measures.

As for existing buildings, MEPs [Members of the European Parliament] urged member states to set percentages for a minimum share of existing buildings to become energy-neutral in 2015 and 2020.

At the beginning of 2010, this definition was amended to say all new buildings must be ***nearly zero*** energy buildings by 2020 and Member States shall set intermediate targets for 2015. A *nearly zero* energy building is one that is highly energy efficient, using a very significant amount of energy from renewable sources.

European countries are demonstrating varying achievements in addressing these issues, as follows[5]:

Austria	*Planned: social housing subsidies only for passive buildings as of 2015*
Denmark	*By 2020 all new buildings use 75% less energy than currently enshrined in code for new buildings.*
	Interim steps: 50% less by 2015, 25% less by 2010 (base year=2006)
Finland	*30–40% better than standard buildings by 2010; passive house standards by 2015*
France	*By 2012 all new buildings are low-energy buildings;*
	By 2020 new buildings to be energy positive
Germany	*By 2020 buildings should be operating without fossil fuel*
Hungary	*New buildings to be zero-emissions buildings by 2020, and for large investments by 2012*
Ireland	*60% less energy than current standards by 2010; net zero energy buildings by 2013*

[5] *European Commission, Low energy buildings in Europe: Current state of play, definitions and best practice, Brussels, 25 September 2009, www.ec.europa.eu/energy/effciency/doc/buildings/info_note.pdf.*

Netherlands	*25% less energy than current standards by 2010*
	50% less energy than current standards by 2015
	Energy neutral by 2020

CANADA

We visited Vancouver and Victoria in British Columbia, Canada. There is much work being done in other parts of Canada (such as Ottawa), but the approaches in the "benign" climate of the places I visited were more relevant to Australia.

To understand the issues that Vancouver is addressing for a more sustainable future, it is useful to consider the motion the Vancouver council adopted in 2008:

3. Greenhouse Gas (GHG) Emission Targets (VanRIMS No. 11-2000-14)

MOVED by Councillor Peter Ladner

SECONDED by Councillor

WHEREAS:

1. the World Mayors Council on Climate Change in Kyoto, Feb. 2007, adopted GHG reduction targets of 30% by 2020 and an 80% reduction by 2050;

2. the Inter-Governmental Panel on Climate Change has called for a 50% reduction in CO2 emissions by 2050 worldwide, putting an expectation on developed countries to do better than 50%;

3. the UK government has introduced a bill to enforce a legally binding target of a 60 percent reduction in carbon dioxide emissions below 1990 levels by 2050;

4. the B.C. government has committed to reducing GHG emissions by 33% current levels by 2020, which will place emissions 10% under 1990 levels;

5. Vancouver has a goal of being the most sustainable city in the world and is already pursuing reduced global warming emissions based on a target of reductions to 20 per cent below 1990 levels by 2012, and has initiated a major EcoDensity initiative to address land use and density in achieving these goals;

6. Council has passed a motion directing staff "to begin planning a significant reduction target beyond 2012, in partnership with provincial greenhouse gas emission reduction targets, and considering the eventual goal of a carbon- neutral city";

7. Vancouver's current strategy lacks a long-term target and a process for community involvement in achieving that target;

8. Edward Mazria of Architecture 2030 demonstrated the importance of targets when he recently spoke in Vancouver as part of the city's EcoDensity initiative, advocating carbon neutrality in new buildings by 2030;

9. major infrastructure planning occurs over decades, not years, requiring an immediate goal for the long-term future to adequately plan infrastructure investments today;

10. GHG reduction also addresses reducing our dependence on oil, given concerns about peak oil and the rising cost of oil.

THEREFORE BE IT RESOLVED:

1. THAT Vancouver set a target of a city-wide reduction of 33 per cent of current GHG emissions by 2020 and an 80 per cent reduction by 2050, with carbon neutrality for all new buildings by 2030.

2. AND THAT as part of the upcoming report on the status of Vancouver's Corporate and Community Climate Change Action Plans, staff comment on how those existing plans will move Vancouver towards

these longer range targets, and on what the next steps should be.

There are many similarities between Australia and Canada in culture, community, urban form and both building and transport efficiency. The direction of the Vancouver Council provides a model for similar Australian capital cities.

UNITED STATES OF AMERICA

The USA has a supposed overarching approach to energy efficiency, but it is implemented differently by each of its states and local governments. Following are excerpts from the US Department of Energy missives[6].

Building Regulatory Programs

1. Executive Summary

…The Building Energy Codes Program uses a holistic view of new buildings, including installed equipment, to develop model codes and improve overall energy efficiency. By combining these programs under a single organization, they can take a strategic focus on high opportunity technologies, including accelerating the speed and increasing the breadth and savings opportunities of codes and standards improvements…

Building Energy Codes

Building codes are promulgated and enforced by the states and local governments, except for manufactured housing standards, which have been the responsibility of the Department of Housing and Urban Development (HUD). State codes are generally based on the model energy codes, except for a few states such as California. Enforcement is generally a local responsibility, except in a few states where codes for some commercial building types such as schools are enforced by the state. Since the 1970's, DOE has been supporting the development and implementation of more stringent building energy codes…..

For residential buildings, the most recent model energy code is the 2009 edition of the International Energy Conservation Code (IECC), which was published in February 5, 2009 and requires residential low rise buildings to be 5 to 8 percent more efficient that those built to the 2006 edition. The 2012 edition will be published in October 2011, and is expected to require residential buildings to be about 30 percent more efficient that those built to the 2006 edition….

In California, which has a strong history of energy saving regulation, has a much more stringent approach. The "Integrated Energy Policy Report 2007 Energy Efficiency"[7] sets out how the state should move forward in a number of different energy related areas.

Energy Efficiency

The Energy Commission strongly supports capturing all cost-effective efficiency savings potential and recommends that this agency:

- *Adopt statewide energy efficiency targets for 2016 equal to 100 percent of economic potential, to be achieved by a combination of state and local standards, utility programs, and other strategies.*
- *Enlist publicly owned utilities in a collaborative relationship to further their efforts in aggressively ramping up energy efficiency programs. Publicly owned utilities can use their knowledge of local conditions and customers to craft new program ideas.*
- *Pursue legislation that would require energy audits and a cost-effective level of efficiency improvements at the time of sale of a building.*
- *Initiate a rulemaking, involving the CPUC and California ISO, to pursue the adoption of load management standards under the Energy Commission's existing authority.*
- *Enact appliance standards to improve the efficiency of appliances sold in California, including standards to increase the efficacy of general service lighting.*
- *Increase the efficiency standards for buildings so that, when combined with on-site generation,*

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[6] U.S. Department of Energy, Multi-Year Program Plan, Building Regulatory Programs, Energy Efficiency and Renewable Energy, Building Technologies Program, October 2010 , pp 7, 11, 16

[7] California Energy Commission, Arnold Schwarzenegger Governor, Integrated Energy Policy Report 2007 Summary

newly constructed buildings can be net zero energy by 2020 for residences and by 2030 for commercial buildings.

- *Investigate market-based approaches to energy efficiency, such as "white tags" or "white certificates" (also known as energy efficiency certificates or credits), the companion to renewable energy credits.*

1.5 How does Australia compare?

So what does regulation in Europe and the UK look like in comparison to what we have in place in Australia?

I have put together the following table that looks at three cities and their relative building regulations, that attempts to show which areas are currently being regulated. The information is based on data from the Zero Carbon Compendium [8]

CLIMATE *From Zero Carbon Hub Compendium*	**BERLIN** Temperate Ave temp 9.3˚ C Humidity 73% Sun hours 1,632 Rainfall 584mm		**LONDON** Warm Temperate Ave temp 10.4˚ C Humidity 79% Sun hours 1,579 Rainfall 543mm		**SYDNEY** Warm Temperate Ave temp 17.9˚ C Humidity 67% Sun hours 2,038 Rainfall 1044mm	
STANDARD	Passivhaus standards		UK new-build common practice – Building Regulations Part L1A (2006)		BASIX	
	U value	R value	U value	R value	U value	R value
Wall and ceiling components	0.15 W/m2K	10 m2K/W	0.25 – 0.35 W/m2K	2.85 – 4 m2K/W	Varies	Varies
Windows and doors	0.80 W/m2K	1.25 m2K/W	1.8 – 2.2 W/m2K	0.45 – 0.55 m2K/W	Varies 5.71 – 3.7	Varies Min 1.25
Building envelope air tightness	< 0.6 x house volume		7 – 10 m2/hr/m3 (nearly 10 times worse that Passivhaus)		BCA has basic construction requirements, not rates	
Energy saving household appliances	No requirements but all are deemed indispensable for a Passivhaus		Dedicated low energy lights required in some rooms. Appliances NOT included at the moment, but will be in the future.		Considers lighting, hot water heating, pool equipment, clothes drying, fridge ventilation, cooking, space heating/cooling equipment	
TOTAL ENERGY DEMAND FOR SPACE HEATING AND COOLING	< 15kWh/m2/yr		Approx 55 kWh/m2/yr *moving to* *42 kWh/m2/yr in 2010*		20 – 24kWh/m2/yr	

As only NSW uses BASIX in its assessments, I thought it would be useful to look at the energy outcomes of the star rating system that has been adopted by all the other states. Following is a review of the Nationwide House Energy Rating Scheme star criteria energy loads from the Protocol for House Energy Rating Software

[8] Zero Carbon Compendium – Who's doing what in housing worldwide, NHBC Foundation 2009

2006.1 [9]. They show the predicted in MJ/m2 conditioned floor area/annum from 5 and 6 star ratings, and what ratings would be required to achieve Passivhaus standards.

	5 STAR		6 STAR		PASSIVHAUS EQUIVALENT
	Mj/m2/yr	kWh/m2/yr	Mj/m2/yr	kWh/m2/yr	
Darwin	413	114.72	349	96.94	> 10 star
Brisbane	55	15.28	43	11.94	5 star
Sydney East	50	13.89	39	10.83	5 star
Canberra	216	60.00	165	45.83	8.5 star
Melbourne	149	41.39	114	31.67	8 star
Hobart	202	56.11	155	43.06	8.5 star
Adelaide	125	34.72	96	36.31	8 star
Perth	89	24.73	70	19.45	7 star
Cabramurra	454	126.11	352	97.78	9.5 star

This comparison shows the effects that the agreed weightings have for the different climate zones on the potential energy consumption required for heating and cooling. I have to admit that I was surprised at the range of these outcomes, and I believe a number of issues are raised by this analysis with regards to the differential weightings for different climate zones.

- Is it appropriate to have different weightings for each climate zone for achieving the same ‘rating’?
- Or should we have the same energy outcome for each climate?
- How should these differences be decided?
- Should there be some flexibility in achieving these outcomes, or should there be prescribed levels of performance for particular building elements?
- Should buildings in more benign climates (such as Sydney) work harder to move beyond net zero emissions and become energy positive?

Clearly there is much to discuss in finding nationwide agreement in the details of moving forward towards net zero emissions housing.

Whilst complex, I think that consistent and specific emissions outcomes tied to a national target are required, with either financial or low emissions energy assistance given in climates where the achievement of this is difficult.

[9] ABCB Protocol for House Energy Rating Software, Australian Building Codes Board Version 2006.1

1.5 Support mechanisms

It is apparent that if the implementation of regulations is to be successful, a range of support mechanisms is required. These can vary from incentives to push for initial uptake, to support groups to mediate between government and industry to help identify and deal with unintended consequences.

Stakeholder recommendations to the UK Government at the start of their process covered a range of policy responses:

- regulation (a more stringent Building Code);
- fiscal incentives which reduce the payback period for lower carbon measures;
- involvement of buildings in carbon or energy efficiency trading markets;
- and Government leadership by example.

Another major recommendation was for the finance sector. Innovative financing measures are needed to incentivise investment in lower carbon buildings. This could include subsidising capital costs (in the form of energy performance contracting), green mortgages and preferential lending rates for lower carbon buildings.

Martin Townsend from BRE, UK, has a similar list of ideas:

- Fiscal incentives – to help things happen
- Education league tables – to show how you are placed against others in the area
- Exemplars – to inspire you to what is possible
- Regulation – to make sure the desired outcomes happen at the lowest levels

He believes there definitely needs to be a strong connection between mandatory and voluntary standards so they assist each other and don't confuse the market place.

Sometimes even financial incentives that mean no cost for the owner are not enough to encourage change. Anecdotal evidence in Germany shows there was less than 50% uptake in photovoltaics for power in Germany, even though they paid for themselves through offsets in power prices before then becoming an income-generating asset.

A similar situation occurred in the lack of take-up of free loft insulation in the UK. This was found to be due to people not wanting to have to move their stuff out of the attic in order to place the insulation. So a full service that included this had to be offered.

A study by WARM in Wales that found that 40% of people offered money for upgrades rejected the offer for the following reasons:

- too much trouble for the occupiers in their home
- potential reductions in floor space (for internal insulation)
- don't believe in the issue
- energy is too cheap
- potential intrusion into their privacy by strangers

These are all good examples of the need to understand the human aspect of any problem in order to be able to achieve results.

Support groups are very helpful in improving uptake of initiatives as well as identifying and sorting out potential problems. Groups we encountered include:

- Passivhaus Institute in Germany
- Passiefhuis-Platform in Belgium
- SenterNovem in The Netherlands
- Zero Carbon Hub in the UK
- Passive House California

The Zero Carbon Hub is a non-profit company limited by guarantee. It is a public/private partnership established to take day-to-day operational responsibility for coordinating delivery of low and zero carbon new homes as regulated by the government. Its stated aim is to *"to help you understand the challenges, issues and opportunities involved in developing, building and marketing your low and zero carbon homes."*

After finding its feet and working out the best way to work, it has transformed the dialogue between government and industry, and is helping to deliver vital assistance in making the Code a success. Some of the nitty gritty that has been being explored to make the Code work better includes possible fiscal incentives such as stamp duty exemptions on zero emissions homes, as well as the inclusion of off-site renewable energy production. Unintended consequences of the regulation are also being carefully considered. The Hub is rightly concerned that people are not driven down paths for technical solutions that will not be suitable in the future.

I believe the Green Building Councils provide similar support in the United States and Canada.

1.6 Issues arising

1.6.1 Competition

Generally, there seems to be a lot of positive talk about the UK Code and the way it is shaping the future for the industry. There was an initial reaction from the major house builders, as many realised the change would require them to develop totally new product – not keep adapting or patching up their existing products.

Medium to large UK home builders tried a few homes and found the first few expensive. However, the next time it was less so – demonstrating there is always cost involved in the new and uncertain. As people better understand what is to be done and how to do it, this problem is being resolved.

Barretts, one the major players in this area, had under the guidance of their CEO Mack Claire, produced a prototype for zero carbon housing within 9 months. This was 9 years ahead of the regulation and has now positioned them to deliver future proofed houses.

Why did Wales push for a 2011 deadline ahead of the British requirement for zero emission new buildings by 2016? Prof Phil Jones talked about how Wales, as a smaller country on the edge of England, has some pushy Ministers who had seen the opportunity that such a move could offer for business and industry to be ahead of the game. Industry has been engaged in this over the last 2 years. While initially they were not enthusiastic, they began to see the great business opportunities such a move offers and came on board.

1.6.2 Renewable energy

Architects Feilden Clegg Bradley from Bath believe the real problem with the definition of zero energy is the onsite energy generation, especially for higher density projects. They believe the UK really needs an integrated energy policy that the government (not the market) drives. They believe that market solutions are often inefficient and not necessarily sustainable.

Prof Koen Steemers from Cambridge University also notes the issue of renewables. While the current definition successfully drives the delivery of efficient buildings to reduce energy demands, the inefficiencies for on site renewable production in more dense situations is problematic.

1.6.3 Products

Good regulations provide a guaranteed market, which encourages and supports the development of great products. Such ideas include:

- improved windows – efficient, beautiful and with effective mechanisms
- variety of external window treatments – shutters, blinds etc
- range of photovoltaics for integrated construction – roofs, facades etc
- variety of options for insulation used for walls, floors and ceilings
- range of timber products that have been developed for increased insulation
- range of efficient heating options with sustainable energy sources (solar, bio fuels etc)
- many green roof solutions

1.6.4 Skills and sustainable design

Architect Meredith Bowles from Cambridge thinks we absolutely need legislation to move this issue ahead. The 2016 deadline has created great awareness of the need to design sustainably. He often has calls from people looking for skilled architects to help – sadly there are not enough around yet and we seriously need to address training across the industry.

One of the major problems with the home energy retrofits happening in California is the lack of a trained workforce – in all disciplines and at all levels. There are huge opportunities for retraining and creating new approaches to how we work and what we do, which should be done together.

Prof Susan Roaf from Edinburgh spoke about the cities of the future where planners and architects will no longer be required. What we will need are capacity calculators and resource allocators – skills neither profession is being taught, but should be.

Susan advocated for totally changing how and what the students of architecture are being taught – they need skills for developing sustainable cities, not useless pieces of sculpture that exacerbate the problems we will have from a changing climate.

1.6.5 Energy ratings and behaviour

And what about the general population – is this the best way to change behaviour? In fact, do regulations have any impact on the reduction of carbon emissions? It is interesting to note that the home energy star ratings in Australia only measure the potential energy performance of the building envelope – which then requires people to know and care how to make the houses work well. Additionally, the energy consumption measured by most meters includes all appliances, which are fast becoming the largest consumers of energy in houses (especially fridges and large TVs). Energy efficiency is not a passive sport – it requires active participants!

1.6.6 Certification and compliance

One of the more positive outcomes is the issue of certification. All new homes have to produce a certificate to show what Code has been achieved. In the UK, this has to be done by BRE certified assessors rather than relying on the overstretched local authorities, which seems to be producing reliable results.

At the City of Vancouver, Dave Ramslie is interested in how to make sure the buildings are actually built according to the regulations, and how to do this without crippling the council's inspectors. With nearly 90% non-compliance with building regulations (from very minor to major), this is a real issue. They are currently investigating the introduction of an outcomes based code with compliance bonds. This would force the issue of making sure things are done properly back onto the developers and builders, who are best placed to do this. While there might be many issues around how to ensure occupants make the building work well, such discussions will at the very least make us think more creatively about how to design and implement effective regulation.

Italy demonstrates what happens when you have regulations that are not prosecuted – no one takes them seriously and chaos prevails.

Cars parked in Rome with no evidence of parking police.

2 Technical Issues

So – how do we achieve net zero emissions housing? There are many technical issues to consider, most of which are common sense, but worth summarising and discussing. As David Johnson in a panel at the West Coast Green conference noted, “we should be working out accessible ways to better share knowledge on our failures, not just successes”.

2.1 Climate

It is becoming increasingly apparent that designing the same buildings for locations as varied as Singapore, Sydney and Rotterdam is misplaced from both energy and cultural points of view.

Buildings that are designed for where they are located and relative to their culture and climate, can be easily identified. Many of these buildings make the most of the local knowledge of materials and construction systems that are appropriate for their location and are readily (and often sustainably) sourced. Through attention to these issues, local cultural traditions become seamlessly embedded in the buildings.

There are many technical responses that are similar for temperate zones, a range that covers Sydney, most of the parts of Europe I visited, Vancouver and San Francisco. Key aspects to this include:

- use of passive design principles
- use of insulated thermal mass – amounts vary depending on climate and solar gain issues
- maximise solar access in winter and manage it at other times of the year
- use appropriate glazing systems that control heat movement – degrees of glazing varies for climates
- take care with east and west glazing and wall areas
- design for appropriate cross ventilation and passive cooling in summer
- site homes to access good breezes and protect against difficult winds
- draught seal and manage air flow
- use insulation to keep heat out in summer and heat in during colder times

While these should be well understood by all students graduating from our schools of architecture, they do not seem to form part of the education curriculum students are either able or keen to pursue at the moment.

2.2 Building form

Some architects express the inherent nature of a climatic design approach and the materials used. Some builders want to make them look just like existing houses. Appropriately, there needs to be a variety of approaches for a diverse population.

In our European travels we saw that most housing was provided by way of compact townhouses and apartments – very few stand alone houses. While this is done mainly for space/density reasons, it works very well from a thermal aspect as well as. We found that Los Angeles, Vancouver, Portland and San Francisco are all looking at how to make their cities denser by employing these typologies.

Zero emissions Olympic housing, Vancouver

Housing in Frieberg, Gremany

And what about size? In our discussions with various people, the following statistics were nominated.

Average area/person in:	Germany	40m2
	Netherlands	26m2 (up from the previous 16m2)
In the UK, minimum sizes:	2 bedroom	76m2
	3 bedroom	86m2
Welsh mining villages	2 bedroom	50m2/20-30 people (in the early 1900s!)

From the SMH November 30 2009, the average dwelling size for various countries is:

Australia	215 m2
Sydney	263 m2
United States	202 m2
New Zealand	196 m2
Denmark	137 m2
Greece	126 m2

As Rob Adams from Melbourne City Council notes [10]:

"So how do we sustain the Australian dream and make it an exemplar to all other post industrial cities worldwide? Is it possible?...There are many cities in Europe with high densities (100 – 200 people per hectare) that achieve this with highly sustainable buildings of 2 – 8 stories in height….

…120 people per hectare equates to about eight times the typical Australian urban density.

It is arguable that no new building needs to be higher than 8 storeys to achieve high density compact cities for the future. This built form is not only more sustainable but reduces the need for excessive embedded and operating energy; for example: windows can be operable and used for passive ventilation and cooling; stairs become alternatives to lifts for the lower floors; and the reduced height helps ameliorate excessive wind effects at ground level, which is characteristic of much taller buildings."

2.3 Windows and doors

While glazing is the weakest thermal link in the building envelope, it is also most important for ensuring:

- appropriate solar gain
- good natural ventilation
- views
- ingress and egress
- connections with our environment

It was obvious that the best window systems being developed at the moment are in Europe. They have been designed to help address the issues noted above, with the aim to be as efficient as possible by achieving U values of 0.8 – 0.9. However, glazing is about 8 times worse in thermal performance than solid walls and about 3 times as expensive.

Windows at Rolf Disch Architects

[10] Rob Adams "Transforming Australian Cities – for a more financially viable and sustainable future", May 2009, updated March 2010, varying pages including 7, 12

What is an appropriate amount of glazing? Dennis Wilde, a developer from Portland, Oregon notes that architects and clients are pushing for window areas that are more than 45% of the floor area. He thinks we should be aiming for less than 35% and going for triple glazing. Natasha Palich from Melbourne thinks we should be aiming for similar levels, with the majority of glazing on the north facades.

Architect Meinhard Hansen from Vauban commented on the problems that are caused by over-glazing, and the expense and area required to provide additional mechanical equipment to ameliorate the increases to heating and cooling they incur.

In the UK it is interesting to note a move away from highly glazed buildings to those with more thermal mass – resulting in an architecture of "monumentality" emerging.

Another interesting aspect in considering windows and doors, is their protection. Peter Pfeiffer, an architect from Texas speaking at West Coast Green, noted that well designed overhangs for windows save more per dollar spent than photovoltaics, and have many other benefits. Consideration of well designed building envelopes is critical in achieving energy efficiency.

2.4 Ventilation

Natural ventilation for comfort in the cool temperate climates of the countries we visited is notably less important than in many Australian climate areas.

However, the big issue in well-sealed housing is how to get enough fresh air into the house, particularly when there is significant external/internal temperature variation. Three main options being used in new buildings are:

- trickle vents in the window/door frames
- mechanical ventilation with heat recovery
- naturally forced ventilation with heat recovery

In Germany, mechanised ventilation with heat recovery with very efficient equipment is the main approach. These systems are often run throughout the year, even when the weather is fine.

Prof Chris Tweed from Cardiff University noted the huge enthusiasm for Passivhaus in the UK, but can see problems with such low ventilation rates. Unlike central Europe, the UK has issues with humidity and condensation. He does not think it a good idea for buildings to be dependent on complicated equipment, and thinks we should remember the idea of "long life loose fit".

While Passivhaus ideals are good – such as insulation and air tightness – Prof Susan Roaf from Edinburgh believes essential issues such as thermal storage, natural ventilation and good solar management are not utilised enough. She also thinks we need to design buildings that naturally ventilate – not mechanized boxes to live in. Rather than spending more and more on machines to create comfort, we should be spending more money on natural systems.

Kate Clark, current head of the Historic Houses Trust who worked previously in heritage in the UK, believes in leaky windows with heavy curtains reducing temperature loss when required. After the January 2010 snow storms in the UK, I inspected a house that worked on this principle. It had ice forming on the inside of the windows, which eventually melted into the room – not a great outcome.

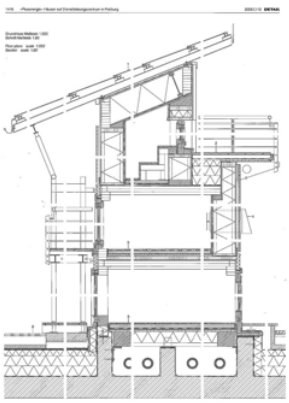
The Passivhaus movement based in San Francisco actively engages an open, un-mechanised approach when the weather is fine with equipment sized to help when the weather is adverse. This is an approach that I believe is more applicable in Australia.

2.5 Insulation

In Europe we found lots of it, and well installed so it is effective in achieving high performance standards. This often results in 300mm thick walls with very thorough detailing around all junctions and the structure, with a strong emphasis on proper installation.

Many products are being developed to assist in delivering this insulation in simple construction systems:

- composite wall systems with insulation that also acts as lining
- timber “brick” wall systems that can be easily assembled and insulation inserted
- integrated flooring systems that include both insulation and thermal mass



In addition, there is much research being put into developing new types and approaches to insulation. This includes:

- Professor Jo Eisel from Darmsdat University is involved in research with plastics that can be applied to the exterior of existing buildings to improve the façade efficiency with minimal impact on their appearance. This is being done in partnership with Rohn which is a major company involved in plastics in Germany.
- Professor Jo Eisel’s colleague Mr Pfeifer is working on houses without insulation – based on cybernetic technologies instead

There is a major problem in insulating existing buildings to increase their energy efficiencies. Many products have been developed for different situations, with more on the way. Issues arising out of this area include:

Insulating on the inside face of walls

- Are people prepared to loose floor space to accommodate the insulation?
- How are the wall materials affected if the warmth is no longer allowed to reach them in the winter?
- How will the performance of the room be affected during the year with the removal of the thermal mass benefits?

Insulation on the outside face of the walls

- How does this affect the heritage value of the property?
- What happens if the building has been built to the boundary already?
- How will the wall materials “breathe” if they are cut off from the external environment?

Cavity insulation

- How will moisture issues be dealt with if the cavity is bridged?
- How consistent can the application of the insulation be?
- How does the settling of bulk insulation impact on its efficiency?

Universities and special research institutions throughout Europe have special sections set up to undertake work on these issues.

In north-west America, there is quite a different approach to building construction. Totally sealed wall linings and claddings are used in preference to the cavity construction used in Australia – adding a layer of difficulty to the direct translation of techniques.

2.6 Thermal mass

Traditionally, many buildings in Europe have been built from various types of masonry, which are all high in thermal mass. While this approach has resulted in building types that largely do not require cooling in the short warm months, the ability to effectively heat these buildings in the longer winter months has been

problematic. Looking north, the highly insulated lightweight buildings of Finland and Sweden have been seen to offer a positive alternative.

Thermal mass has not formed a significant part of the North-west American building traditions, and their lightweight buildings are well placed to incorporate better insulation. Without undertaking thermal modeling for their particular climate zones, I am unsure how the absence of mass impacts on the natural comfort afforded to these buildings – from the experience here in Australia, it has much to offer.

As the levels of insulation required by regulation in Europe are so high, often much of the external wall zone needs to be occupied by insulation, with no room for thermal mass. Similarly, where people are choosing total timber building systems (including floors) for their renewable, carbon storage and low embodied energy features, more innovative methods to include thermal mass are being found.

Architect Meredith Bowles from Cambridge uses inventive approaches, such as introducing thermal mass through water systems integrated into the ceiling of his lightweight buildings. Others are finding ways of locating thermal mass in internal walls and floors.

Michiel Cohen, based in Amsterdam, believes that thermal mass is overrated requiring too much embodied energy that will never be offset by the energy saved. In Sydney, I certainly enjoy the benefits of thermal mass for most of the year. Paul Pholeros notes that in outback Australia thermal mass is hugely important in reducing the internal temperatures of housing and the amount of conditioning required to make them livable.

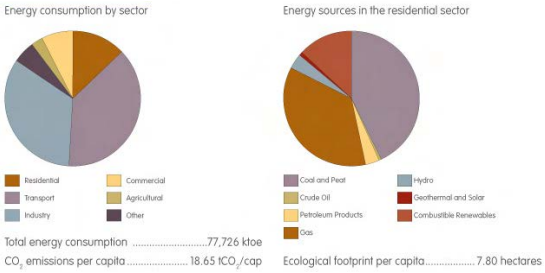
This illustrates the need for a detailed analysis to be undertaken for every design, to ensure the right decision is made.

2.7 Energy supply

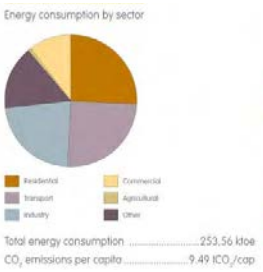
It is interesting to note the differences in energy usage and types of supply between Europe and Australia. These graphs come from the Carbon Compendium, prepared by the Zero Carbon Hub in the UK. They have different measurements to those used by the Australian Sustainable Built Environment (ASBEC) in its Second Plank Report – a further reflection of how people across the globe measure things differently. The data shown is for Australia and Europe.

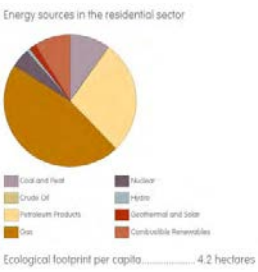
The differences in energy usage, types of supply and per capita footprint reveals a lot about the varying challenges we have ahead in moving to a low carbon future.

AUSTRALIA

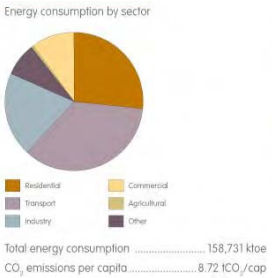


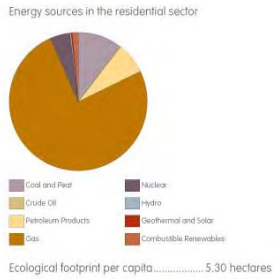
GERMANY



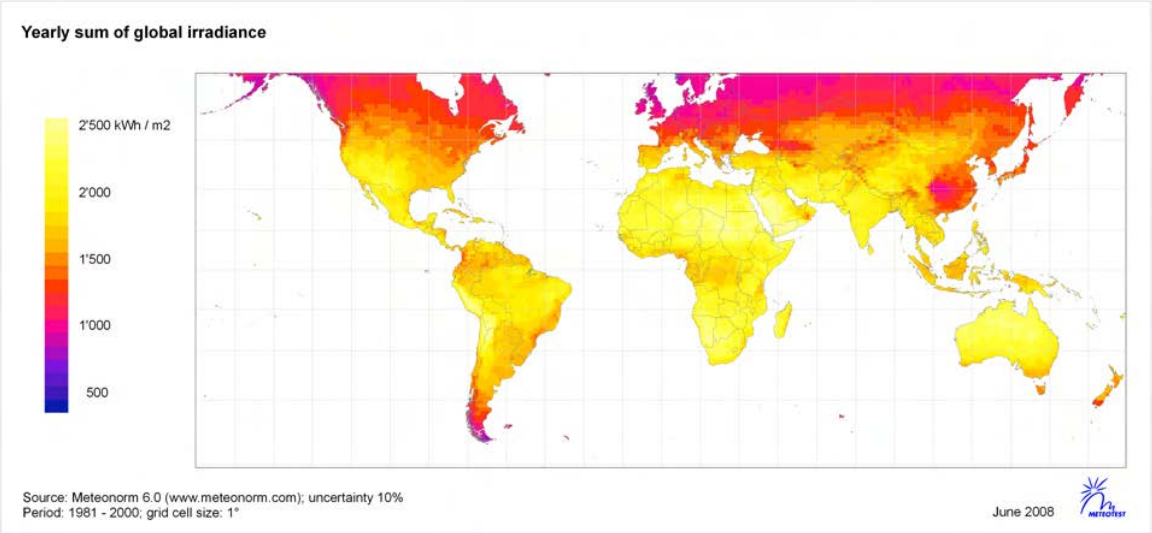


UNITED KINGDOM





I think it is also interesting to compare the amount of global irradiance available across the world. Australia's wealth in this natural resource is very obvious (especially when compared with many parts of Europe), which sadly has not been matched in support for its development to date.



In Europe and some parts of America there is a move away from any fossil fuels – including gas. In Europe, biofuels – especially timber pellets – are regarded as renewable, with zero emissions. The trees are grown specifically for the use for biofuels, capturing carbon in the process. When this is released through the burning process, there is an argument that this process is then regarded as carbon neutral. I am unsure how this accounts for the carbon used in production and from road transportation of the pellets to the site…. However, in a place with few other renewable energy sources, the benefits of an easily renewable fuel that harvests the energy from the sun when it can, to be released later, are not to be underestimated.

Photovoltaics (PVs) have been strongly supported in Europe, both as add on panels as well as integrated into the building fabric. This has been very helpful in the quest for net zero emissions buildings.

When east and west Germany were unified after the Berlin wall fell, manufacturing opportunities were sought to employ the people of the united nation. By providing generous gross feed-in tariffs for renewable energy (specifically from PVs), the country was able to create and support a new PV industry. This provided a double win, as it also provided a huge amount of new renewable energy to an overstretched network at the same time. Germany is now a world leader in this new solar industry.

The UK introduced feed-in tariffs for renewable energy on 1st April 2010. As we watch the transformation that happened here in NSW in 2010 with our generous feed-in tariffs, it should be interesting to see the impact this has in a more solar constrained country.

The approach to this issue in the USA is extremely varied. Al Gore launched "Repower America" in 2008, wanting to instigate a plan to repower the country with 100% clean electricity and revitalised national energy infrastructure. Added benefits were touted as national and economic security, while improving the environment. The move to a more conservative Republican led House of Representatives, heavily supported by the fossil fuel lobby, has made such moves less certain. We watch with great interest to see what happens.

The big issue is how to decarbonise the total energy supply system – a topic too big to be covered here. For more information on how this can be achieved in Australia see the Zero Carbon Australia Stationary Energy Plan prepared by Beyond Zero Emission,[11] which has developed a road map for this to happen by 2020.

[11] http://www.beyondzeroemissions.org/

2.8 Materials

Material choices are integral to the achievement of net zero emissions, as they are selected to assist with the provision of the required amounts of thermal mass or insulation. There are many complex considerations in getting their selection right. When we also consider the impact they have on indoor environment quality, it can get even more difficult.

BRE Innovation Park, Various Architects and various materials

There needs to be consideration of the overall equation involving payback for the embodied energy over the life of the building versus the operational energy saved. Issues that need to be considered in such calculations include:

- How long we allow for the life of the building and its parts – the longer the better, which is why we should be designing adaptable buildings with classic fitouts that last.
- How complex the buildings are, and how much mechanical assistance they involve which may add considerably to their embodied energy
- Size will impact on the amount of materials required, which in turn impacts on embodied energy. Efficiency of spatial design plays a critical part in this issue.
- As buildings become more efficient in their operation, embodied energy will become a larger proportion of the overall energy bill, requiring even greater scrutiny.

When the Commission for Sustainable 2012 was set up to oversee the sustainability of the London Olympics, they thought the major source of emissions would come from the transport of all the people involved in the organisation, construction and actual event. This was quickly dispelled as they realised that 2/3 of the emissions will come from the embodied energy of the buildings and infrastructure. They really do count! With considerable attention to this matter, the overall anticipated carbon emissions have been reduced substantially.

Olympic site in London under construction, January 2010

In both Europe and north-west America, we saw sophisticated timber industries, actively embracing the sustainability agenda. Rather than see the loss of timber flooring to concrete as a problem, they have been actively seeking whole of house solutions that cleverly include lots of timber.

Swiss architects in particular have showed how beautiful buildings can be when they explore and exploit the natural beauty of local materials and their inherent value.

Therme Vals, Architect Peter Zumthor

3 Design Challenges

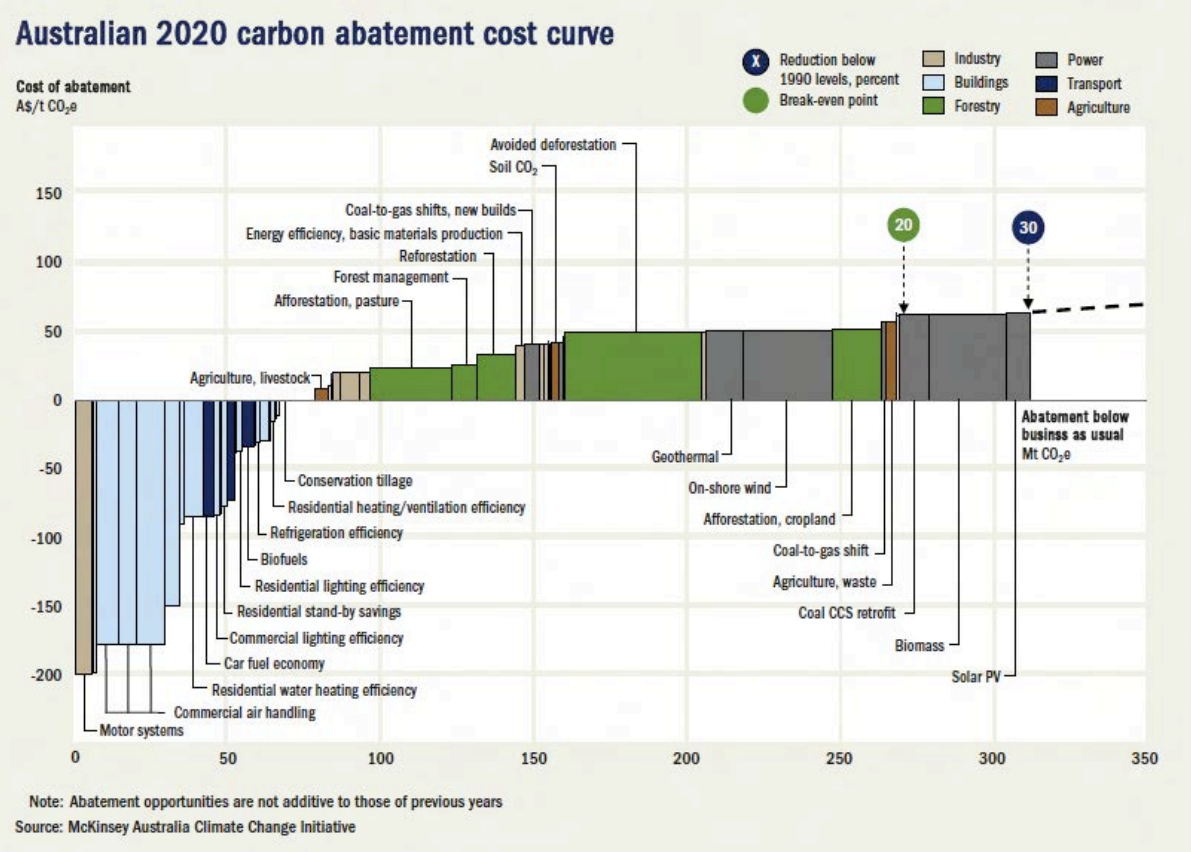
The following framework for discussing design concerns has been adopted from the Australian Institute of Architects awards criteria.

3.1 Conceptual framework

All designs are guided by a basic philosophy or set of core ideas. They are generally informed by concerns close to our heart and mind.

As we bear witness to scientific evidence, delivered in ever increasing quantities, confirming that human activity is increasing the amount of carbon dioxide in the atmosphere causing climate change, I believe architects need to ensure this informs their fundamental philosophies.

As noted in reports by McKinsey and the Australian Sustainable Built Environment Council (ASBEC), energy efficient buildings are the lowest hanging fruit on the carbon reductions tree.



It is clear from the above chart that architects are well placed to take a strong and effective lead in these areas. While some have dedicated their careers to this end, this has not been universal, particularly amongst the more iconic members of the profession.

Both the architects I met in Rome were embarrassed by the energy white elephant (MAXXI – the national museum of XXI Century art) recently delivered by world famous ‘starchitect’ Zaha Hadid. Even in the greenest part of Germany – Freiberg – it is apparently surprising to have a “sustainability” architect heading up the institute of architects. If climate change is the biggest moral dilemma of our lifetime, this is a sad indictment on our profession.

Prof Phil Jones from Cardiff University noted there are strong concerns that architects will loose the whole sustainability agenda to surveyors and engineers, just as they lost project management and planning in the past.

Many of the sustainable projects done by the offices of Rolf Disch and Meinhard Hansen from Vauban, were initiated by the architects. They identified what they thought was important, found opportunities to realise these ideals and then proactively worked to get them built. I gather this has been quite a cost burden, but immensely worthwhile in the development of their ideas, practices and ethics.

Prof Susan Roaf from Edinburgh believes that systems capacity is what is important. She thinks that Masdar – a new 'sustainable' city outside Dubai – is really important as it will guide a paradigm shift in thinking about the shape that cities should be. It is moving right away from the glass high-rise example we all seem wedded to in the west. These tall glass buildings are causing a 'peakiness problem', where the needs of these 1% of buildings on hot days, result in peaks of 10% in energy consumption. By 2014 in NSW, Susan calculates that 20% of our energy consumption will be required for 1% of the year.

As for innovation and new ideas – there seems to be very fertile ground for finding better ways of achieving great results, when it is required by regulation. All over Europe and north-west America we found clever people in academia and practice developing interesting solutions. Sometimes this involved updating old ideas to work in new times, sometimes it was through totally new technologies.

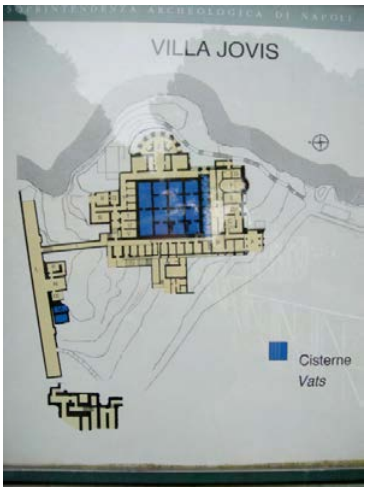
We architects need to be designing efficient buildings that are both delightful and empowering.

3.2 Relationship of built form to context

The many cities we visited in Europe were shaped by the need for security and accessibility, as well as preserving land for farming. This approach makes for very sustainable settlements that are good places to live and provide many opportunities for people to connect easily with each other.

Capri has been shaped by the need for self-sufficiency – especially food. The garden terraces across the island add great beauty while contributing to food security. Easier access to food from stores and the mainland, and less permanent residents has meant many of these gardens are sadly falling into disrepair.

Building designs based and shaped around intelligent approaches to their most fundamental requirements show great foresight. Villa Jovis in Capri, from which Tiberius ruled Rome for 20 years, was designed around huge water cisterns and thermally stable food stores – all other rooms were considered after these crucial issues were resolved.



Architect Cinzia Abate from Rome believes the creative reuse of existing buildings is important in our sustainable future. However, it seems that architects across Europe do not see the challenge in working on improving existing building stock – 85% of which is below the current building standards and offers huge opportunity.

Discussions in the places we visited in North-west America were very much about moving towards a change of approach to built form. The usual development model that prioritises cars over all other modes of movement is proving to be less successful than anyone had anticipated. Importantly, the impact this is having on people's carbon footprint is proving to be in serious need of redress.

This is an area of great interest to architects in Australia – how should we design our housing so that it connects us with external areas and each other (when we choose) in an energy efficient way? What should it look like? How should it be designed in relationship with the existing building stock? How can it help improve what we have while making the new as good as it can be?

3.3 Integration of allied disciplines

Architect Christian Muller from Rotterdam thinks we need to not only design in sustainable ways; we should also work in more sustainable ways. We need to bring as many members of the team together as early as possible – especially the builder. By doing this, we can better integrate the experience and knowledge of a wider group of people. As a result, we can rethink how we work and develop our projects.

When architect Mienhard Hansen works in towns outside Germany, he chooses to work with local architects. This builds local buy in, spreads intelligence about the Passivhaus approach and helps to ensure the projects get off the ground more effectively.

Professor Chris Tweed from Cardiff University noted that if you were to create the professions today, they would most probably not look anything like what we have now. He talked about the complexity in the division between planning and building surveyors in having to implement and check on the regulations that cross boundaries. There seems to be very little teaching of planners in the area of technical services that are now falling into their purview. Similarly for architects, we have many missing skills, and because of our focus on designing new buildings, we are not well placed to advise when the right answer sometimes is NOT a building.

3.4 Cost value outcome

Prof Lutzkendorf from Karlsruhe University believes in bringing the benefit of actual numbers and measurements to the field of sustainability. He argues this is the best way to ensure costs account properly for energy, life cycle, environment and social issues. We need to be really careful about which instruments we use and how we use them, as well as the boundaries within which they operate.

We also need to choose the language we use well – we need to speak so the people being addressed really understand. Accountants and engineers all speak differently to designers.

In Germany, integrated design will cost only an additional 0 – 5% for ENOB (energy optimised buildings performing 50% better than average). Integrated design is where the concepts of sustainability are considered right from the very start – not added on later to fix problems. Simulations need to be added as part of the architectural service in order to ensure the building is well modeled and tested to deliver the best possible result. This is well worth the initial upfront expense for clients. This is why Prof Lutzkendorf supports the recognition of a good design process in the national certification system.

Beddington Zero Energy Development (BEDZED)

From a review of what worked in BEDZED, the most effective measures for reducing carbon emissions were the car share club followed closely by water saving devices. The least cost effective measure was the sunspaces, although these spaces offered the great benefit of additional external space, with a different feel to the inside.

In Vauban, the construction of a car park station separate from the apartments, enabled the expense of car ownership to be directly attributed to those who own cars – not spread out among all residents. This also makes other forms of transport (such as bicycles, walking and trams) much more desirable and easy to choose.

When developer Joe Van Belleghem undertook extensive consultation with all stakeholders involved in his Dockside Green project in Victoria, BC Canada, he was able to identify potential problems and resolve them in ways that satisfied everyone. The positive buy-in this afforded his project meant a much faster process for approval and great publicity – both of which saved him more money than the value of the sustainable initiatives involved.

Dockside Green Victoria, BC Canada

3.5 Response to client and user needs

When architect Meinhard Hansen from Vauban talks to people about Passivhaus approaches, he talks about the performance and comfort they provide – not the energy savings, which he thinks is boring.

Developments that include input from future inhabitants as well as aspects of heritage from the past, feel more real from the beginning. Vauban is a great example of this. When the French occupying forces moved out of their barracks buildings (with mature landscaping), an Urban Ideas Competition became the foundation for a development plan. This was greatly influenced by the Forum Vauban Association which took on the responsibility for broad citizens' participation. The result is a development that feels very real, with an engaged group of residents who clearly love their homes.

Martin Townsend from BRE in the UK talked about going to visit 2 schools in Newcastle to award them with certificates for the same BREEAM scores. In spite of having identical teams of architects, consultants and builders, he was astounded to find very different outcomes. The school with the very engaged principal who organised weekly meetings with the project team, succeeded as a great meeting place with strong engagement from the staff and students. The school with the principal who wanted the keys at the end of the process, had very little resulting social interaction between its teachers and students.

It is interesting to note that this cannot be measured in any rating scheme developed yet.

Finally, we need to question the value of a net zero energy building that does not meet the needs of the users in delightful ways. The successful operation of any building relies on the meaningful engagement of its occupants. Importantly, its life will be extended if the building is cared for and loved.

Appendix 1 Outcomes from project

Strategies for my practice

See more detailed explanations under the following headings under Section R Recommendations:

R.3.1	Team building	We need to identify and build cross disciplinary teams early in the process to ensure their contributions can help shape a responsive designs that are buildable and cost effective.
R.3.2	Thermal modeling	Options for thermal modelling need to be improved and used more skillfully to deliver more energy efficient outcomes.
R.3.3	Heating/cooling options	After creating the most efficeint building envelope, Australians need to develop more efficient heating and cooling options that better understand the actual requirements.
R.3.4	Windows/doors	We need to design great spaces that connect us to the exterior, using less windows and doors of much better quality.
R.3.5	Ventilation	We need to seal up our buildings so we can manage the ventilation, while ensuring there is plenty of fresh air.
R.3.6	Design approach	Our design approaches need to embrace sustainability while responding in a diverse way to our clients' needs.
R.3.7	Collaborating with clients	We need to work closely with our clients to deliver responsive results, while helping them understand the opportunities and constraints of zero emissions housing, and their role in achieving sustainable outcomes.

Publications and promotion

By April 2011, the following articles have recorded aspects of my research.

Oct 2010	Article	Monument Magazine – "Zero-emissions housing is not rocket science" pp 35-36
Jun 2010	Article	Solar Progress April 2010 edition – "The Architecture of Zero Emissions Housing – Technical"
May 2010	Web article	Fifth Estate May 2010 by Lynne Blundell on ARBS talk and panel discussion (see below) – "Carbon neutral buildings – its time"
Apr 2010	Article	Solar Progress April 2010 edition – "The Architecture of Zero Emissions Housing – Regulation"
Apr 2010	Article	Ecolibrium April 2010 edition about my involvement in the ARBS panel (see below) – "CO2: Can we do better?"

Talks and discussions

By April 2011, the following talks and discussions regarding aspects of my research have been undertaken.

TBC	Talk	Talk at the City of Sydney to talk with general staff about the outcomes of my research
11.04.11	Talk	Talk for CMS at St Leonards on the outcomes of research to up to 120 architects.
11.11.10	Talk	Keynote speaker at breakfast seminar hosted by the British Consul General for Proctor Group - "Australia's place in a net zero emissions world".

10.10.10	Talk	Talk at Pittwater Sustainability Expo on “The Architecture of Zero Emissions Housing”
07.07.10	Talk	Talk at Stockland to discuss with 30 key staff in the Sydney office the outcomes of my research
13.05.10	Talk	Thursday Night Talk at the Faculty of Architecture, University of Sydney with approximately 80 people attending about the outcomes of my research
30.04.10	Talk	Talk at Landcom to discuss with 30 staff in their Parramatta office and a video link to 3 staff in Newcastle the outcomes of my research
21.04.10	Panel discussion	Member of panel at Green Building Council breakfast – “Building, selling, living green: sustainability in the residential sector” with approximately 200 people attending
16.04.10	Lunch + discussion	Lunch and discussion with Professor Susan Roaf and 20 key city stakeholders at the Sydney Town Hall about sustainable buildings and how to best achieve them
12.04.10	Talk + panel discussion	10 minute presentation and participation as member of panel at ARBS (conference – “Carbon capers - CO2 emissions in building performance: can we do better?” with approximately 50 people attending
19.03.10	Presentation	2.5 hour workshop style presentation at the Architectural Axis conference – “The Architecture of Zero Emissions” with approximately 100 people attending
02.03.10	Introductions	I helped arrange and attended a talk and questions with Sarah Sturrock, Head of Sustainable Buildings, Department for Communities and Local Government (UK) at the Sydney Town Hall with members of ASBEC (Australian Sustainable Built Environment Council) and others about implementing regulations requiring new houses to be zero emissions in the UK by 2016
18/19.02.10	Introductions	I introduced Sarah Sturrock, Head of Sustainable Buildings, Department for Communities and Local Government (UK) to contacts in Canberra to set up meetings with people from the ABCB (Australian Building Codes Board), Department of Climate Change + Energy Efficiency, ACT Planning and Land Authority etc about implementing regulations requiring new houses to be zero emissions in the UK by 2016
17.02 10	Radio Interview	Interview by Allan Saunders on *By Design* about “Learning from old buildings” with Kate Clark, Head of the Historic Houses Trust, discussing lessons from sustainable houses and what is happening overseas

Contribution to policy and regulation

By April 2011, the following contributions to policy and regulation have been made.

May 2010	Response to inquiry	National Building Energy Standard – Setting, Assessment and Rating Framework (see attachment)
2010	Member of ABCB	Participation in all discussions of the Australian Building Codes Board during 2010 as Industry representative on the Board, informed by research

Input into zero emissions housing in Australia

AUSTRALIAN SUSTAINABLE BUILT ENVIRONMENT COUNCIL (ASBEC)

The ASBEC Zero Emission Residential Task Group has not been progressed as far as anticipated at this stage. With a new Executive Director being currently sought, and a new Chair of the Task group to be appointed, the situation will hopefully change in the near future.

BEYOND ZERO EMISSIONS

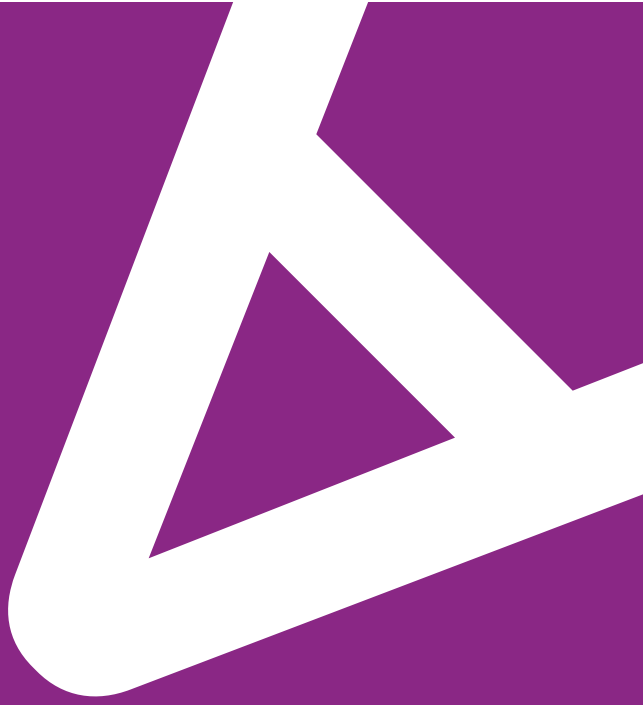
The team at Beyond Zero Emissions (BZE) in Melbourne has a main body of work called the “Zero Carbon Australia 2020 Project”.

“The project consists of a series of reports covering how each sector of Australia’s economy can transition to zero emissions by 2020… The ZCA 2020 Project consists of 6 separate plans addressing each sector of the Australian economy: Stationary Energy, Buildings, Transport, Land Use, Industrial Processes, and Replacing Coal Export Revenue…

The ZCA2020 Buildings Plan aims to demonstrate that there are no technical barriers to zero emission buildings in Australia. The Buildings Plan will also seek to quantify the maximum reduction in energy consumption achievable by implementing cost effective energy efficiency measures in all existing and new buildings. Broadly speaking, this is achieved through a planned energy efficiency retrofit of the existing building stock, a zero carbon low energy building standard for new buildings, onsite renewable energy generation, and electrifying current gas appliances…

The report will require collaboration between relevant businesses, industry bodies, all levels of government, and academic institutions to draw upon all existing knowledge, experience, research, and data.”

I am part of the volunteer group assisting with this, and am contributing knowledge gained from my research as well as connections made during my professional career to date.



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