Green Buildings – Issues for the Valuation Process

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Keywords: Green buildings, valuation, sustainability, residential, commercial, industrial, retail.

Abstract

Australia’s residential development industry is at least superficially embracing environmental and sustainability issues in urban design. Rapidly emerging use of recycled water, lower impact outfalls, the use of roof water and water sensitive design for both housing and landscapes are all trends of interest to the property profession.

The increasing tendency of consumers of commercial space to demand high levels of environmental compliance and sustainability has potentially huge impacts on our industry. The demands, for example, of Government for ever increasing energy ratings for buildings and the emergence of socially and environmentally aware corporations will have far reaching effects on our commercial building sector.

Introduction

This paper presents the rationale for green buildings and the political drivers influencing the uptake of sustainable features in the built environment across the residential, commercial, and industrial and retail sectors. Whilst focussing mainly on water economy and energy efficiency, the paper outlines the latest measures being adopted in Australian green buildings. Surprisingly buildings are responsible for 40 – 50% of energy end use, for 40% waste to land fill, for 16% fresh water demand, for 40% raw materials consumption and 25% of global timber harvest. The environmental impact of buildings is enormous and needs to be reduced, where markets are rapidly adjusting and property analysts need to closely monitor this change.

Importantly, consideration is also given the impact of increased sustainability on the primary approaches to valuation. With the greatest single influence on risk in the form of depreciation and obsolescence, every building must be individually assessed to identify the influence of sustainability. With an increasing profile in property circles for property owners, tenants and all stakeholders, it is critical that sustainability is fully understood and included in the valuation process. Inadequate understanding of sustainability will restrict the valuer from performing a valuation based on a hypothetical sale, where the purchaser and vendor are fully conversant with all aspects of property, especially sustainability and green building characteristics.
Part A – Sustainability in the Built Environment

Definitions of green buildings

Numerous terms are used to convene the meaning of buildings that reduce their impact on the environment. Examples include Environmentally Sensitive Design (ESD), sustainable, natural, environmentally-friendly, environmentally aware, ecological and biomimetic buildings. Each term embodies different approaches and philosophies with regards to green buildings, which in turns will influence the features that may or may not be included in the building design. However this is not a significant issue for valuers at this point and generally speaking, any building with this type of descriptor is claiming to be different from traditional or non-green buildings. Equally there are many definitions of green buildings as there are titles or descriptors. The dictionary definition is:

the practice of: increasing the efficiency with which buildings and their sites use and harvest energy, water, and materials, and reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal the complete building life cycle

Or the World Green Building Council’s definition is:

To significantly reduce or eliminate the negative impact of buildings on the environment and on the building occupants, green building design and construction practices address: sustainable site planning, safeguarding water and water efficiency, energy efficiency, conservation of materials and resources, and indoor environmental quality

The Australian Green Building Council defines green building as:

A green building incorporates design, construction and operational practices that significantly reduce or eliminate its negative impact on the environment and its occupants. Building green is an opportunity to use resources efficiently while creating healthier environments for people to live and work in

Overall these definitions share common aspirations such as to reduce the consumption of scarce resources like water, to recycle resources and waste less, to reuse materials wherever possible, to use renewable resources, and to improve occupant comfort and well being. Therefore the underlying intent of green buildings is twofold: to reduce environmental impact but also to provide better buildings. There is growing evidence there is a market for sustainability with accompanying enhanced value, potentially.

Built environment contribution to climate change

In short, buildings contribute to climate change through the consumption of fossil fuels (gas, oil and coal) which release carbon into the atmosphere. Electricity is merely a medium for transporting energy and is typically generated by coal fired or gas fired power stations – notably electricity usage also results in greenhouse gas emissions. At present there is an overwhelming consensus in the scientific community regarding the contribution of greenhouse gases to global warming and climate change; we have become the ‘weather makers’ are set to reap a harvest of extreme weather events globally and locally; increased frequency and strength of hurricanes, changing rainfall patterns and increased Il Nina’s (Flannery, 2005). Thus reducing the amount of fossil fuel consumption and greenhouse gases in buildings will make a substantial impact to total emissions - as Wilkinson & Reed (2006) demonstrated in a detailed study of 326 office buildings inn the Melbourne CBD office market, it is possible to reduce total emissions by around 50% by taking measures and using technologies already in existence. Thus green buildings can and do incorporate varied technologies. A clear brief is required to establish what the most important criterion are for the project, be it water economy, occupant health and comfort, energy savings and so on. The design teams need to follow an integrated approach to design, continually rerating the design concepts to-date and communicating to the team and client. The approaches and technologies most frequently associated with green buildings include:

- Energy conservation;
- Water conservation;
- Materials selection;
- Use of renewable materials;
- Occupant health and indoor environment quality;
- Construction process (to minimise waste and energy consumption);
- Site ecology; and
- Recycling.
It is not possible to focus on all of the different aspects of green buildings in this paper and therefore, the two main issues for Queensland, namely water and energy, require further discussion. Delegates are referred to the useful websites and references listed at the end of the paper for further information.

The rationale for green buildings: water use

Figure 1 confirms that Australia is the third highest OECD country water consumer, with a per capita usage over six times greater than that of the lowest consumer, Luxembourg. Clearly consumption levels are excessive, and it is this excessive consumption that is causing the water crisis in Australia.

**Figure 1: Water extraction per capita, OECD Countries, 1990** (Productivity Commission 2003)

![Graph showing water extraction per capita for OECD countries](image)

When sectoral consumption rates are examined, not surprisingly agriculture is the biggest consumer of Australia’s water supplies at 70%. When considering the built environment, residential or household consumption stands at 8% whilst manufacturing or industrial consumption represents 6% and other (including retail) is 2%. Collectively the built environment accounts for around 16% of total water consumption. *Is this consumption reasonable?* The answer is clearly ‘no’ when referring to figure 1 above.

**Figure 2: Australian water consumption by sector**

![Pie chart showing Australian water consumption by sector](image)

The question that needs to be asked is: *how much water do we need to use to be sustainable?* Table 1 below shows the different uses and the minimum and comfortable requirements in residential buildings. The third column reveals
the typical consumption in Australia which substantially exceeds both minimum and comfortable requirement levels. This is clear evidence of excessive and unsustainable consumption.

Table 1: Domestic water consumption requirements and consumption.

<table>
<thead>
<tr>
<th>USE</th>
<th>Minimum Requirement</th>
<th>Comfortable Requirement</th>
<th>Typical Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking/Cooking</td>
<td>5</td>
<td>20</td>
<td>30-50</td>
</tr>
<tr>
<td>Bathing</td>
<td>10</td>
<td>30</td>
<td>200-300</td>
</tr>
<tr>
<td>Washing laundry</td>
<td>50</td>
<td>20</td>
<td>100-15</td>
</tr>
<tr>
<td>Washing other</td>
<td>0</td>
<td>10</td>
<td>50-100</td>
</tr>
<tr>
<td>Watering garden</td>
<td>0</td>
<td>10</td>
<td>20-800</td>
</tr>
<tr>
<td>Dripping taps</td>
<td>0</td>
<td>0</td>
<td>10-30</td>
</tr>
<tr>
<td>Washing dishes</td>
<td>10</td>
<td>15</td>
<td>20-50</td>
</tr>
<tr>
<td>Toilet</td>
<td>15</td>
<td>20</td>
<td>30-70</td>
</tr>
<tr>
<td>TOTAL</td>
<td>60</td>
<td>125</td>
<td>390-1450</td>
</tr>
</tbody>
</table>

Note: Measured in litres per day (Source: Hurliman et al., 2004).

When considering the current situation in respect of dam capacity in Australia, the consequences of excessive consumption and dwindling rainfall levels are evident. For Brisbane the dam capacity is below 30%, where only Perth has lower levels at 28%. Not surprisingly Darwin has the highest capacity levels at 92%, with Hobart second at 75%; however most cities have around 40-50% capacity levels (Melbourne 47%, Sydney <41%, Adelaide 52% and Canberra 51%). With such low levels of dam capacity coupled with high consumption the time for action is now. But what has been driving such unsustainable water use? There are a number of factors including population growth, where migration into Queensland is a valid example of additional pressures exacerbating already low supplies. Other factors include increasing levels of water use per head of population (generally), over-consumption, decreasing quality of water sources, and uneven distribution of water sources.

Legislative action on water

Recently some action has been taken by state and commonwealth governments. The main legislation is the 1994 COAG (Council of Australian Governments) Water Reforms to implement a ‘strategic framework to achieve an efficient and sustainable water industry.’ This framework is based on the recognition that action is needed to halt the widespread degradation of natural resources, minimise unsustainable use of water resources and to establish integrated and consistent approaches to water resource management. The framework includes provisions for water entitlements and trading, environmental requirements, institutional reform, public consultation and education, water pricing and research. The time frames for implementation of the framework were set at five to seven years with full implementation by the year 2001, however were extended to 2005.

Critical environmental water issues were identified in the Water Reform Framework and include: allocation of water for the environment; ecological sustainability of new developments; institutional reform; the incorporation of environmental costs in water pricing; ecologically sustainable water trading; protection of groundwater; and implementation of the National Water Quality Management Strategy. In April 1995, COAG endorsed the National Competition Policy for Australia. Under this policy, payments are made available for states and territories that successfully implement a range of important reforms including the COAG Water Reform Framework. In June 1999 an assessment of the progress of jurisdictions in implementing COAG water reforms was undertaken and payment of over $1 billion was released to States and Territories in annual payments over the two year period to June 2001. In December 2002, the treasurer (Mr Costello) explained the states and territories would receive around $740 million in competition payments in 2002-03 after an independent assessment of their progress in implementing National Competition Policy reform commitments. The Treasurer accepted the recommendation that the $270 000 reduction in Queensland’s 2001-02 competition payments continue in 2002-03 for Townsville City Council’s lack of progress in respect of two-part water pricing reform.

In December 2001, COAG agreed to prioritise national water reform commitments and the 2003 assessment focused on urban water pricing and cost recovery, institutional reform, intrastate trading arrangements,
integrated catchment management and water quality reforms. The 2004 water assessment focused on rural water pricing and cost recovery, interstate trading arrangements and progress with implementing environmental allocations. In 2004 the National Water Initiative (NWI) was established this as a strategy driven by the government to improve water management. The NWI encompasses a wide range of water management issues and encourages the adoption of best-practice approaches to the management of water and is intended to drive a number of issues, but of relevance for the property profession is better and more efficient management of water in urban environments - for example through the increased use of recycled water and storm water. The NWI Agreement was signed by the commonwealth and all states and territories, with the exception of Western Australia and Tasmania which declined to sign at the time. From this, state governments have set targets for water recycling.

Water options in the built environment

When considering the available options with regards to water, there is a water source hierarchy in which reducing consumption is highest, followed by re-use of water (known as ’greywater’), then recycling on a large scale and finally the last resort of desalination. Note that it is possible to re-use and recycle water in most buildings. The measures that be adopted in all building types include:

- Low usage taps and showers;
- Rainwater harvesting and storage tanks;
- Low flush water closets (wcs);
- Sensor activated urinals;
- Greywater recycling;
- Sewer mining (black water recycling); and
- Chilled beams (to replace air conditioning using cooled air).

Dual water supply is possible where there is a water supply of potable (drinking quality) water provided to each house or building, with a second supply of non-potable water. Dual water supply systems have been successfully implemented in Australia at Mawson Lakes in Adelaide, South Australia and overseas in Singapore and California. However unsuccessful attempts to implement recycled water into communities have also occurred in Sydney, San Diego and the Netherlands - therefore successful implementation of schemes is by no means guaranteed. The reasons for adopting dual water supply can be highlighted by examining typical household consumption in table 2.

Table 2: Typical household water use.

<table>
<thead>
<tr>
<th>Use</th>
<th>Amount (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watering</td>
<td>54</td>
</tr>
<tr>
<td>Washing machine</td>
<td>11</td>
</tr>
<tr>
<td>Bath &amp; shower</td>
<td>14</td>
</tr>
<tr>
<td>WCs</td>
<td>9</td>
</tr>
<tr>
<td>Pool</td>
<td>2</td>
</tr>
<tr>
<td>Leaks</td>
<td>2</td>
</tr>
<tr>
<td>Tap</td>
<td>7</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
</tr>
</tbody>
</table>

(Source: Loh et al., 2003)

It is clear that the vast majority of use is for gardens; is this really a priority given our chronic shortage of water? Put bluntly, many imported plant varieties are unsuitable for the Australian climate where native plants are much lower consumers of water and entirely more appropriate. Other areas of high consumption include clothes washing. Clearly there are relatively simple methods of reducing consumption - for example, water reducing shower heads which can reduce flow rates from 27 litres per minute to 9 litres. In addition low water consumption appliances are available also to reduce washing machine usage. WCs reduce the flush rates from 6 litre flushes down to 4.5 litre flushes and eliminate unnecessary water usage. In other words it is possible to reduce water consumption by up to 90% in buildings and still have tenable and healthy conditions for users. Greywater recycling involves the use of ‘greywater’ - for example, water used for clothes washing being reused for garden watering or car washing and reduces the amount of drinking quality water used in buildings. Blackwater recycling is more controversial and involves extracting water from sewers and cleaning the water through filtration plant, and then either using the water within the building for non-potable use or returning the ‘cleaned’ water to the sewer system. Both are included in the case study in the appendices.
Barriers to water options

The barriers to implementation of water policy must not be underestimated - it is accepted that community acceptance is a major influencing factor as witnessed by the recent Toowoomba vote in Queensland. A further barrier is of course economic viability. The costs of recycled water have to factor in and accounted for. Overall water recycling is a complex issue for policy makers to address. It is suggested that reducing the complexity of the issue and the establishment of standards for water recycling will go some way to eroding these barriers. In Queensland the Water Recycling Guidelines of 2005 outline the scope and framework of the policy. The issue of community engagement is also covered but most importantly a Recycled Water Management Plan to manage the risks involved with the treatment and use of recycled water is included. The issue of water quality is addressed as are the technologies (for example see http://www.epa.qld.gov.au/environmental_management/water/queensland_water_recycling_guidelines/).

Price or costs is a central issue and table 3 compares recycled water prices through four schemes in Australia. It is noted the costs vary considerably, not only in the subsidised costs that consumers pay but the real costs estimates. The final column demonstrates the comparable drinking water (or current water supply) cost per kilolitre.

Table 3: Price comparisons of recycled water

<table>
<thead>
<tr>
<th>Location</th>
<th>Use</th>
<th>Recycled Price / kL</th>
<th>Real Cost Estimate</th>
<th>Drinking Price / kL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Springfield, QLD</td>
<td>Residential – toilet flushing, garden watering</td>
<td>A$0.43</td>
<td>A$1.45</td>
<td>Per quarter: A$0.65 $100-150kL A$0.90 &gt;150kL</td>
</tr>
<tr>
<td>Rouse Hill, NSW</td>
<td>Residential – toilet flushing, garden watering</td>
<td>A$0.28</td>
<td>A$3.00 – A$4.00</td>
<td>A$0.98</td>
</tr>
<tr>
<td>Olympic Park, NSW</td>
<td>Residential supply – toilet flushing, garden watering, laundry</td>
<td>A$0.83</td>
<td>A$1.60 (operating costs only)</td>
<td>A$0.98</td>
</tr>
<tr>
<td>Mawson Lakes, SA</td>
<td>Residential – toilet flushing, garden watering</td>
<td>A$0.77</td>
<td>Not available</td>
<td>A$0.44 &lt;126kL A$1.05 &gt;126kL</td>
</tr>
</tbody>
</table>


When considering the price issue, other factors such as connection charges and annual services changes need to be accounted for. For example, in the Mawson Lakes project in Adelaide consumers pay 44 cents per kilolitre (kL) for drinking or potable water (a thousand litres) for the first 125kL used and then $1.03 thereafter with an annual service charge of $141 levied. In comparison the recycled water is charged at a rate of 77 cents per kL where there is a one-off connection fee of $264 but no other charges are made. There are indirect or non market benefits to be accrued from recycled water such as reduced demand on potable water supplies, reduced amounts of ocean outfall, avoidance of drinking water restrictions, security of water supply, benefits to wetlands and higher nutrient levels. In fact the major barrier to the reuse of wastewater is psychological and not technical. The Maroochy case demonstrated that despite comprehensive community consultations, a vocal minority was able to sway public opinion by raising issues like the use of ‘gender bending hormones’. It showed the importance of media management in such campaigns. Much has been learned from such schemes; firstly persuasion will not work on the public and therefore authorities are required to engage with the community in an open, honest and timely manner. They have to work to gain trust and then maintain it, and in return to provide the community with knowledge and information to make considered and fully informed decisions. However attitudes are beginning to change as the Murray and Hawkesbury Nepean Rivers schemes for indirect potable reuse show that consumers believe a natural filter is applied to the water. In Singapore and the US direct potable reuse schemes have shown that consumers believe an unnatural process is being followed. It is time to move to a water paradigm, which involves reducing consumption in buildings and adopting systems such as grey-water and black-water recycling. It is possible to do so and to maintain a comparable quality of life.

Energy efficiency and buildings

The rationale for energy efficiency in buildings is related to the link between fossil fuel energy consumption and greenhouse gas emissions which exacerbate climate change and contribute to global warming (Wilkinson and Reed,
2006. Much has been written on this topic and readers are referred to other materials for further information as this paper focuses specifically on the measures which can be adopted in buildings to reduce energy consumption. Overall energy savings measures which can be adopted in most buildings to varying degrees include the following:

- Low energy appliances and equipment (such as computer monitors);
- Low energy lighting;
- Use of micro or on site energy generation (or co-generation from wind, solar or PV, sources);
- Heat recovery;
- Advanced services technologies (such as chilled beams or Phase Change Materials or PCMs); and
- Passive design strategies (such as building orientation to minimise excessive heat gain).

Other factors which add to overall energy use in buildings include embodied energy and transport energy. Embodied energy is frequently mentioned and is the quantity of energy is necessary for the fabrication of a specific material. When measuring embodied energy, all energy inputs from raw material extraction, to transport, manufacturing, assembly, installation and others are considered. Embodied energy as a concept seeks to measure the true energy cost of an item. Clearly some buildings have higher embodied energy than others and materials selection is important here. For example a building with high amount of aluminium windows compared to an identical building with timber windows will have higher embodied energy. On the other hand, transport energy is the emissions associated with journeys to and from the building made by the occupants. Therefore the location of the building, especially near to public transport facilities can have a substantial impact on overall transport energy use associated with an individual building.

In 2003 energy measures for Class 1 buildings were introduced into BCA (Building Code of Australia) at 4 star nominal stringency, then in 2005 the BCA energy measures for Class 2, 3 & 4 buildings took effect nationally. By 2006 BCA energy measures for Class 5 - 9 buildings were implemented nationally covering all commercial buildings. Also in 2006 BCA went 5 star nationally for Class 1 buildings. The star rating means that a certain level or standard of energy efficiency has been achieved in the building. The economic benefits are expected to be $3.4B at a cost $0.7B (10 years) according the Building Commission of Australia. The energy savings are expected to total 9.9 gigajoules per annum with a total greenhouse benefit of reductions of 17.8 Mt CO2 achieved. The Building Commission and legislators aim to achieve a market transformation with the measures; however only 2-3% is added to the total stock of buildings each year and therefore it is vital to consider improvements the existing stock. It should be noted that all buildings can be improved in terms of energy efficiency.

Part J of the BCA has eight sections which examine energy in building fabric, external glazing, building sealing, air movement, air conditioning & ventilation systems, artificial lighting and power, hot water supply and access for maintenance. The BCA is adopting best practice approach to energy efficiency in new buildings however the BCA is a minimum standard and not a maximum. The objective is ‘to reduce greenhouse gas emissions by efficiently using energy’ and a ‘building including its services is to be capable of efficiently using energy’. The performance requirement states that ‘a building, including its services, must have, to the degree necessary, features that facilitate the efficient use of energy appropriate to…’ The objective is that a building should be capable of reducing greenhouse gas emission if it designed to use energy efficiently. Note the objective is not occupant comfort or is it savings on running costs. Furthermore, current legislation considers operational energy use and not embodied energy, which may come in later. In addition the functional statement mentions capability which is important and this capability is obviously dependent on how the building is used. Energy efficient buildings need to be operated, managed and maintained well to achieve energy efficiency. The intention is to increase the amounts of energy efficiency required in buildings over time and also to extend the range of environmental or sustainability issues in the BCA. Therefore measures related to water conservation will become part of the BCA in due course.

Green industrial and retail sectors

The measures outlined above are equally suitable for adoption in other building sectors and property types, for example the industrial and retail sectors. However to-date in Australia there are relatively few examples of good green practice and other countries are well ahead in these sectors. This will change as global companies and international companies embrace the concept of corporate social responsibility practices into their businesses around the world. Retail shopping centres generate $51 billion in retail sales each year, employ nearly half a million people, and have an asset value of almost $69 billion. Overall there are 1,338 shopping centres in Australia from
large regional centres of more than 100,000 m² of retail space that generate sales of around $500 million a year down to smaller, supermarket-based centres of around 5,000 m² with sales around $30 million. They account for 28% of the retail space in Australia and generate 41% of retail sales (PCA, 2005). Across Australia there are 1.75 billion shopper visits annually which means, on average, each Australian visits a shopping centre twice a week. Refer to table 4 for summary statistics relating to shopping centres in New South Wales, Queensland, South Australia and Victoria.

From a financial perspective the retail sector also underwrites the retirement incomes of many Australians. It is estimated that nine million Australians have invested in retail property through their superannuation savings and investments in listed property trusts and property-backed life insurance policies. The ownership of shopping centres is narrowly distributed with the top 30 owners sharing 52% of total shopping centre floor space. However during the early 1990s, costs associated with occupying retail property have increased faster than sales (Millington, 1996). Australia has a mature retail market populated with knowledgeable shoppers, able to access information on the internet - unless regional shopping centres can continue to provide a comfortable shopping experience, retail consumers will choose to make their purchases elsewhere (Millington, 1996).

Table 4. Retail sector in New South Wales, Queensland, South Australia & Victoria (2000/2002).

<table>
<thead>
<tr>
<th>Retail Statistics</th>
<th>New South Wales</th>
<th>Queensland</th>
<th>South Australia</th>
<th>Victoria</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of shopping centres (sc)</td>
<td>289</td>
<td>210</td>
<td>85</td>
<td>164</td>
</tr>
<tr>
<td>Size – floor area sq. m</td>
<td>4.2 million</td>
<td>2.9 million</td>
<td>0.913 million</td>
<td>Na</td>
</tr>
<tr>
<td>Employment</td>
<td>170,000</td>
<td>129,229</td>
<td>32,000</td>
<td>106,300</td>
</tr>
<tr>
<td>Capital value of sc $</td>
<td>Na</td>
<td>9.6 billion</td>
<td>2.25 billion</td>
<td>7.5 billion</td>
</tr>
<tr>
<td>Investment planned over 5 yrs AUD$</td>
<td>Na</td>
<td>Na</td>
<td>150-200 million</td>
<td>1.5 billion</td>
</tr>
<tr>
<td>Sc turnover $</td>
<td>21.5 billion</td>
<td>13 billion</td>
<td>3.4 billion</td>
<td>10.7 billion</td>
</tr>
<tr>
<td>% of total retail</td>
<td>45.7</td>
<td>53</td>
<td>34</td>
<td>35.4</td>
</tr>
<tr>
<td>% of gross State product</td>
<td>2.7</td>
<td>Na</td>
<td>Na</td>
<td>2.2</td>
</tr>
<tr>
<td>Date of data</td>
<td>2002</td>
<td>2002</td>
<td>2000</td>
<td>2002</td>
</tr>
</tbody>
</table>

(Source: Shopping Centre Council of Australia, 2005)

Characteristics of retail stock

Large shopping centres were developed during the late 1950s to provide convenient and efficient distribution of goods to a fast growing population (Ingham, 2002). The design of shopping centres up to the 1970s was characterised by basic, pragmatic layouts and unimaginative exterior design. In summary, the centres were box shaped with large car parks, no links to the local community and little regard for the surrounding environment; in short embodying a ‘capture and contain’ mentality in design. Changes occurred in the later 1970s, notably in the design of the ‘Gold Coast Pacific Fair’ centre that featured open air shopping within ‘streets’, as well as places and parks to add variety and relief to the design. As the market matured and new developments competed to attract shoppers from existing centres, designs gradually became increasingly consumer focused.

Over time consumers demanded better retail environments. Recreation was commoditised during the 1980s and 90s and shopping centres began providing recreational opportunities such as cinemas, cafes and entertainment (Ingham, 2002). As urban regeneration was undertaken in the 1990s mixed use areas were embodied in shopping centre design. The retail market is heavily influenced by planning legislation with various issues developers need to consider, such as improving transport choices, pedestrian access, parking supply and urban design. Many factors that affect the design of shopping centres: firstly, the investor’s return occurs over the long term and the developer usually retains an interest in the property which encourages higher quality of designs. The second factor is financial viability and the developer needs to be confident that the investment is not threatened. Recent expansion of ‘out of town’ retail has meant that some shopping centres have not been refurbished due to poor financial viability of refurbishment where outlay exceeds anticipated return. Key design elements in shopping centre design and refurbishment in the 21st century include aspects such as planning, the provision of a specialist retail environment, and the tenancy mix, and entertainment, provision of people spaces and connectivity of the fabric to the community. However it is within the planning and provision of people space elements that energy efficiency issues can be best addressed. These elements note the requirements for comfort, lighting and efficient planning of the retail shopping malls (Ingham, 2002) where the highest potential to reduce the amount of energy consumption lies.
Characteristics of the retail property market

Retailing is a very competitive market and shoppers have an increasing range of options and can purchase goods from local outlets or the strip mall, in bulky goods warehousing, on-line, via the television, via catalogues or home shopping. In effect, if shopping centres are not attractive to consumers then they will not be attractive to retailers. Millington’s (1996) warning that retailers would leave regional centres in favour of cheaper property located in bulky goods warehouses has proved partly true, where the trade conducted in bulky good warehousing has increased. Furthermore bulky good warehouses are cheaper to fit out than shopping centres. The crux of any centre’s policy is the restriction of major out-of-centre retail development. Without restrictions, retail development will locate on less expensive land outside town centres - to the detriment of these centres and sustainable development more generally. The sharp increase in the amount of out-of-town retail that started during the 1960’s in the UK (Jones and Hillier, 2000) has been replicated in Australia. Retail developments that are allowed to locate outside centres generate their own demand for road and transport infrastructure and, where public resources are scare this may be at the expense of continuing public investment in designated town centres (www.shoppingcouncil.com.au, 2005).

The threat from bulky goods warehousing is real and the Shopping Centre Council is concerned about corruption of bulky goods zones when councils allow retailers whose retail offer is not ‘bulky’ to locate there. For example, warehouse and factory outlets do not need the larger spaces required for the handling of bulky goods. Of course, many outlet centres are located in retail zones, for example Harbourtown in Perth and Brand Smart in Parramatta. The abuse of bulky goods zones by general retailers gives these retailers an unfair advantage, through the lower land costs, and makes it harder for genuine bulky goods retailers to find good locations. These buildings are built with concrete tilt and slab methods, with very high ceiling heights designed for bulky goods storage. Coupled with high demands for artificial lighting, heating and cooling found in high end retail property the energy demand for this sector is comparatively much higher than it needs. Accordingly there is great scope for reductions.

Energy efficiency in retail

The potential benefits to owners from energy efficiency are clear and can be classed as environmental and economic. The British Retail Consortium (BRC) stated its vision is for: ‘a sustainable retail sector which combines promoting a competitive sector with valuing the retail workforce and our local communities, improvement to our environmental performance and prudent use of natural resources’. BRC priorities were embodied as ‘responsible retailing’, with ‘incentives for environmental improvement and best practice while avoiding burdensome environmental regulation and taxation’. On the one hand promoting ‘incentives for environmental best practice’ and then ‘avoiding burdensome environmental legislation’ encapsulates the paradoxical situation retailers find themselves in - how to reconcile increasing consumption and sustainability. Given the global economic outlook is pointing to a reduction in retailing consumption (Redican, 2006) and energy costs are increasing – if rents are going down then any reduction in operating costs will benefits owners and thus energy efficient retrofitting becomes more viable.

It is argued that the increased awareness of climate change and links with buildings and cars may lead shoppers ‘using local shopping outlets rather than driving to more distant centres’ although there is little evidence of this happening the likelihood of consumers shopping locally has occurred with large increases in petrol (Millington, 1996). However the drivers for the behavioural change in shoppers are economic and note environmental as Millington suggested. Another driver for energy efficiency is the reduced risk of physical obsolescence, if new centres are more energy efficient and have lower running costs they should present a better investment option and retain higher values.

The retail industry is beginning to become committed to improvement of environmental performance and to adopt the prudent use of natural resources, realising that its businesses cannot exist in isolation and that retailers are part of a local and global business community that is dynamic and complex. In the retail sector a number of larger organisations are looking to reduce energy consumption, especially in the light of recent increases in costs. For example in Australia, Coles Myer is examining ways to reduce energy consumption through more efficient use of lighting, refrigeration and power. To manage the reduction an energy committee was established 1995 to review energy usage throughout all ‘Myer’ brands. A year later, ‘Myer’ implemented an energy programme in September 1996 that has achieved an 11 per cent reduction in energy usage to 2005. The program was recognised in 1997/1998 by Energy Efficiency Victoria as the leading program across all industries and represents current best practice. Another part of the group, supermarket retailing has introduced a range of energy efficiency initiatives across its stores during refurbishments including:
**Lighting**
- Fluorescent tubes are replaced with triphosphor lamps that have twice the life, 15% more light, and contain 70% less mercury than standard tubes.
- During the 90’s, lighting engineers designed and developed new grocery aisle lighting. Power usage has been cut by more than 50% through better design. A recent development offering a further 50% reduction in operating and maintenance costs is being trialed in two stores.

**Refrigeration**
- Installation of energy saving microprocessor controllers to operate in-store refrigeration.
- Waste heat reclamation from the refrigeration plant and recycled for hot water and store comfort heating.
- Show cases manufactured from ‘CFC free’ foam insulation.
- Currently trialing new technology to reduce refrigeration energy consumption by 20%.


New retail stores are also more energy efficient and represent current best practice in environmental design.

Substantial use of increased natural lighting is reducing artificial lighting costs and requirements. In terms of energy efficient design, the use of thermal insulation is increasing to reduce heat loss and lobbies reduce heat loss through doors and entrances. Not only are energy issues being addressed but also water consumption in areas such as toilets and water features in landscaping. In addition, timber from renewable sources is also specified - the result is that new generation retail will be substantially more environmentally benign. These measures will off set some of the risks associated with premature obsolescence. Furthermore it is possible to adopt similar measures when retrofitting retail property. Thus it is possible and desirable to reduce energy consumption in the retail sectors by substantial amounts and the ‘early adopters’ in this sector are taking a lead to reduce running costs and in effect making economic and environmental savings.

**Retail property and energy efficiency**

Although the links between certain property types (e.g. CBD office buildings, see Wilkinson and Reed, 2006; residential property see Reed, 2006) and energy efficiency have been identified, retail property has different characteristics. The different types of retail property that can be grouped into the following categories:

(i) Major shopping centre (enclosed) – typically air-conditioned and fully insulated from the outdoor environments, this type of shopping centre can be found in most western cities and can often include up to 100 individual retail tenants including major anchor tenants.

(ii) Major shopping centre (unenclosed) – often older-style design with a flat open car park in the centre surrounded by individual shops and anchor tenant/s.

(iii) Mixed-use (e.g. office building) – the building is usually predominantly occupied by a different land use such as commercial office accommodation, where the retail component is often located on the ground floor.

(iv) Stand-alone retail (e.g. strip shopping) – traditionally this style of retail are independent retail shops that are detached or attached and sell a specialist type of good or service.

(v) Bulky goods warehouses – originally originating as a discount store or ‘factory outlet’ style of shopping, they have been upgraded providing a higher level of comfort for sale of whitegoods or hardware items.

Property characteristics relate to all components that form part of the real property itself including land, building construction and design, location and other physical characteristics. As a starting point these property characteristics have been identified as:

(i) Ownership - refers to the most common type of investor commonly linked with this type of property.

(ii) Tenure type - length of lease term or ownership.

(iii) Location - most common location of this type of retail property.

(iv) Construction type - dominant materials used in construction of core building.

(v) Embodied energy - measure of energy typically retained in the building materials.

(vi) Transport energy – estimate of distance travelled by target market.

(vii) Gross lettable area – typical area of buildings in this group.

(viii) Refurbishment frequency – emphasis placed on frequency of refurbishments.

(ix) Depreciation and obsolescence – rate of change of this type of property.

(x) Quality of fittings – level of quality and attention paid to detail.

(xi) Operating energy use – amount of energy used in normal operation.

(xii) Level of CO₂ emissions (m²) – rate of emission.

(xiii) Water consumption (litres/m²) – rate of consumption by the property.
Part B – Implications for the Valuation Process

Factors affecting the value of green buildings

Whilst the green building sector has substantially raised its profile, there has been a perceived lag with other stakeholders in the property market. Even though substantial advancements have occurred with sustainable technology and building processes, consideration must be given as to how the ‘value’ of a property is affected by its level of sustainability, and how this affects the business case for green buildings. For example, is a green building less or more risky? Furthermore, how is this reflected in the actual value of the building? Also, how is sustainability incorporated into the valuation process? To fully understand the relationship between green (or sustainable) buildings and value, consideration must be given to their influence on value.

90% of the Australian commercial property market was designed prior to the introduction of accepted rating systems (JLL, 2006). Conventional valuation analysis focuses on three primary forms of obsolescence: physical, functional and economic. Although there other forms of obsolescence also exist (e.g. legal), it can be argued that a fourth primary type of obsolescence has been added – sustainable obsolescence. Thus a building can have increased obsolescence (causing a loss in value or depreciation) if it fails to meet the market’s expectations of incorporating a level of sustainability. This can be in many forms including the design phase, the construction materials or the operational phase. Accurately identifying, fully understanding and then being able to quantify the level of sustainability, in a similar manner to understanding other forms of obsolescence, is rapidly becoming an essential part of the valuation process.

Implications for the valuation process

The degree to which an individual building is sustainable can vary substantially depending on a myriad of factors including:

- the location of the building and the proximity of alternative buildings, as well as transport and surrounding services and facilities;
- the architectural design and age of the building;
- the perception of building owners (and tenants) towards sustainability;
- the perception of the marketplace towards the environment and corporate social responsibility;
- the prevailing cost of energy, construction and transport;
- other factors that influence the financial decision.

It is increasingly likely that investors may consider paying a premium for assets with demonstrated sustainability potential which can be realised via cost-effective management or modification; on the other hand, owners who do not implement sustainable practices may find their buildings subject to a ‘non-sustainability discount’ by tenants over the next three to five years (JLL, 2006). Whilst it is not possible to accurately measure the effect of every sustainable aspect, consideration must be given as to how sustainability will influence the primary valuation approaches as discussed below.

1. Comparison (or market) approach

Based on the premise of comparing ‘like with like’ and making the appropriate adjustments, there are challenges when seeking to compare a sustainable building with a non-sustainable building. Consideration must be given to the level of sustainability incorporated in the subject property – does it have a small degree of sustainability or it a radical green building? For example, prior to the introduction of water meters the existence of a rainwater tank for a suburban residential house was considered to be of little interest by a prospective purchaser (from a willingness to pay more), although this has changed substantially in recent times. Other examples include the perception towards photovoltaic solar panels as well as the conventional solar hot water systems, which previously may have been perceived as having a minor or negligible contribution to the value of the property (in comparison to the analysed recent sales). On the other hand if the subject property does not have a solar hot water system and all of the analysed sales do, consideration must be given to the effect, if any, that the lack of a sustainable attribute has as a potentially negative influence on the value of the subject property.

As with all valuations, the emphasis should be placed on the added value of each component. Whilst hedonic modelling (via regression analysis) is commonly used to identify how certain characteristics (e.g. number of bedrooms) affects the value of a house, this in turn will incorporate sustainable aspects of the property. At present
there is little evidence to quantify exactly how much each sustainable aspect contributes to the overall value, although attention should be placed on the marketing programs by real estate agents where the emphasis is placed on sustainable aspects of a property. In areas where this is occurring, the valuation process should note the increased demand by purchasers for sustainability in the subject property and pay increased attention in the assessment of value.

According to the International Valuation Standards Committee (IVSC, 2006), ‘market value’ is defined as “the estimated amount for which a property should exchange on the date of valuation between a willing buyer and a willing seller in an arm’s-length transaction after proper marketing wherein the parties had each acted knowledgeably, prudently and without compulsion”. With the concept of sustainability being increasingly incorporated into property markets, the valuer must assess the concept of ‘willing’ with respect to the ‘willing buyer’. In other words, how ‘willing’ is a prudent purchaser with respect to the demand for sustainable attributes in a building? On the other hand, if a property is considered to be a ‘full’ green building (i.e. completely different to neighbouring properties), will a prudent purchaser be unwilling to pay the full market price for the property? This is subject to conventional supply and demand theories where a building with a lower level of demand (due to a perception that the property is unconventional or too ‘different’) will realise a lower sale value.

2. Capitalisation of income approach

The two components of the capitalisation of income approach, namely (a) the net operating income (NOI) and (b) the capitalisation rate can both potentially be affected by the level of sustainability in the property. (a) The net operating income reflects the amount the building (based on net lettable area) will realise after operating costs are deducted. There is increasing evidence to argue that tenants will pay a higher rate per m² for a sustainable building, although the actual amount would vary substantially depending on the perception of the tenants and the benefits to them. At present some of these benefits are intangible and difficult to quantify, such as lower staff absenteeism due to a healthier work environment. However, if a building is perhaps ‘too sustainable’ as perceived by certain tenants (i.e. with no airconditioning, waterless urinals) it would have a limited market and therefore may not attract a premium rent. Once again, the level of sustainability incorporated into competing properties, as well as the level of sustainability sought by tenants (e.g. if government tenants have a mandatory star rating that must be achieved such as ABGR 4.5 stars for the Victorian state government). From the level of perspective of outgoings, another important consideration is whether the leases are net or gross leases, which in turn affects who reaps the benefits from a sustainable building (with lower operating costs). If the leases are gross, the tenant may have little interest in accommodation in a sustainable building – inversely, a tenant with a net lease would prefer lower outgoings if possible although the owner may not be so willing to outlay additional capital expenditure for enhanced sustainability features.

The capitalisation rate (or ‘all risk yield’) reflects all future risk in the property – the added element of sustainability will clearly affect this risk and should be incorporated within the capitalisation rate. This may be undertaken via the following examples of adjustments to the capitalisation rate:

- lower level of (sustainable) obsolescence -> lower risk (capitalisation rate);
- higher perceived maintenance costs -> higher risk (capitalisation rate);
- lower operating costs -> lower risk (capitalisation rate); or
- potentially having a perception of being ‘too green’ -> higher risk (capitalisation rate).

Adjustments in the capitalisation rate need to incorporate all the aspects of sustainability, which will also be affected by wider changes in society towards the environment (via corporate social responsibility or CSR) and energy use (i.e. higher energy costs equate to perceived demand for sustainable buildings which will appear to be partly future-proof).

3. Discounted cashflow (DCF) approach

Due to the explicit nature of discounted cashflows, there are numerous variables that must be adjusted in a discounted cashflow to indicate how the level of sustainability affects the property. In addition to considerations discussed with regards to the capitalisation of income approach, other factors that may be affected DCF include:

- retention of existing tenants throughout the DCF (perhaps increased renewals in a sustainable building);
- attracting new tenants to a perceived sustainable building;
- lower discount rate to reflect less risk;
- lower reversionary yield to reflect less risk;
lower operating costs with regards to energy;
- possibly higher maintenance costs for specialised sustainable equipment (e.g. cleaning)
- higher capital costs e.g. photovoltaic cells;
- potentially a higher level of obsolescence after a 10 year period (i.e. if the building does not have the latest technology or if the sustainable technology is out-of-date).

Due to the inherent number of assumptions in a DCF, the issue of sustainability can further complicate the matter unless there is clear direction about the effect on the influencing value drivers. For example, although lower staff absenteeism is linked to sustainable buildings this may not be readily transferred into the calculations in the spreadsheet due to the lack of available evidence – the challenge for the valuer is to quantify the effect into a financial amount. Thus, the different levels of ‘sustainability’ must be reflected in the DCF – this refers to the environment, the ability of the property to ‘sustain’ income levels and the likelihood that that building will ‘sustain’ (or retain) its long term value.

4. Cost approach

Commonly used as a check method where appropriate, the cost approach relies heavily on the original replacement or reproduction cost with a allowance for depreciation – this is also commonly referred to as depreciated replacement cost (DRC). The cost approach can be defined as: “a set of procedures through which a value indication is derived for the fee simple interest in a property by estimating the current cost to construct a reproduction of, or replacement for, the existing structure plus any profit or incentive; deducting depreciation from the total cost; and adding the estimated land value” (API, 2007).

Clearly the determining factor with the approach is the level of depreciation or loss in value from the original cost, where sustainability has a varied impact of value. For example, it may be possible to validate the original cost of a sustainable improvement by referring to the payback period e.g. 5 or 10 years. However, some improvements have payback periods that far exceed the anticipated life of the buildings.

As the majority of savings are made over the long term, some homeowners may not keep their house long enough to fully recover the initial costs of complying with energy efficiency. On the other hand, energy efficient homes may produce immediate positive cash flows for owners as the savings in energy bills more than offset the higher monthly mortgage payments needed to finance the additional investment (Nevin and Watson, 1998). Research into the relationship between house values and energy costs in the USA concluded that properties with higher energy efficiencies had higher values, suggesting the housing market in the USA identified and valued improved energy efficiency. When referring to investment grade properties, the length of the payback becomes crucial. Thus, if the sustainable improvement can not be amortised over a reasonable period then it is not viable.

Another complication with using the cost approach is to use the initial cost as a starting point. It can be argued that many ‘green’ buildings that have been developed by government or public bodies (e.g. universities, city councils) have incorporated a degree of over-capitalisation. In other words, there are other external drivers that influenced the initial outlay for construction of the building – for example, a status symbol or flagship property. In reality the initial construction costs would not be commensurate with the market value of other neighbouring (or competing) properties and care must be exercised when relying on the capital value as a starting point. Overall when incorporating sustainability into the cost approach then a high degree of care must be applied. It should be remembered that the starting point (replacement or replacement cost) may be inflated due to over-capitalisation (the valuer should check the current market cost of construction) and the exact rate of depreciation may be hard to accurately identify.

Considerations for valuers

The increasing need for the built environment to be sustainable has adversely affected design and construction approaches, where valuers must now become fluent with additional jargon such as ‘purging’, ‘orbs’ and ‘chilled beams’. Until recently a ‘green building’ was extremely rare and considered vastly different, where many cities now boast a variety of newly constructed and refurbished or converted green buildings. In addition, the concept of a green building has been broadened to include buildings that incorporate different levels of sustainability. How these varying levels of sustainability are reflected in the final valuation figure are current challenges for valuers, although it is simply not possible to ignore their effect on risk and subsequently on value. A starting point for the valuation process is to consider how sustainability affects depreciation and obsolescence – see table 5.

<p>| Table 5. Comparison of varying property types – refurbishment, obsolescence and sustainability | 13 |</p>
<table>
<thead>
<tr>
<th>Property Type</th>
<th>Lease length</th>
<th>Refurbishment Frequency</th>
<th>Current Exposure to Obsolescence</th>
<th>Anticipated Effect of Changing Perception of Sustainability**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
<td>Medium*</td>
</tr>
<tr>
<td>Retail</td>
<td>Short</td>
<td>High</td>
<td>High</td>
<td>Low*</td>
</tr>
<tr>
<td>Industrial</td>
<td>Long</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Residential</td>
<td>Short</td>
<td>Varying</td>
<td>Low</td>
<td>Low-medium</td>
</tr>
<tr>
<td>Misc.</td>
<td>Varying</td>
<td>Low</td>
<td>Low</td>
<td>Low-medium*</td>
</tr>
</tbody>
</table>
(* would vary in other sectors) (** would vary according to net or gross leases, and which stakeholder e.g. tenant, owner)

There is an immediate requirement for the valuation industry to become conversant and aware of the relevance of sustainability in the built environment and factor it into the valuation considerations. A parallel can be drawn here with the past need for valuers to become fluent with the negative impact of asbestos when it rapidly emerged - any ignorance about understanding the effect of asbestos on value was clearly inexcusable. Sustainability is certainly progressing rapidly and reaching a higher profile. While the amount of material in the valuation industry has increasingly been incorporating sustainability issues such as in the Australian Property Journal (published by the API), it is important for valuers to gain exposure to wider sustainability issues. For example, many seminars are presented by local government and environmental organisations concerning energy use in buildings – this is also an opportunity to increase knowledge about technological advances in sustainability and green buildings. On many occasions a newly constructed (or refurbished) building developer (or owner) will encourage stakeholders in the property market to attend a release of such a building. Valuers should accept this opportunity to become familiar with the building’s characteristics, as well as discussing the catalyst for adopting a relatively high level of sustainability.

Conclusions

Green buildings incorporate a number of features, energy conservation, water economy, materials selection and recycling amongst other things. Energy use within buildings is responsible for large amounts of CO₂ emissions in Australia. Of particular concern is the energy consumed through the increasing reliance on mechanical heating and cooling, although different property types in a range of climatic regions will have large variations in energy consumption. When designed effectively, all building types can reduce substantial current energy use. Micro generation using wind turbines and the use of innovative design and technologies such as passive solar design through effective building orientation and material selection can reduce the amount of power required to heat and cool buildings. The need for water economy is becoming increasingly important. Valuers must become conversant with this new technology and factor the effect (or added value, if any) into their valuation calculations.

Commonwealth and state governments are beginning to tackle issues related to water and energy consumption; albeit slowly through the BCA and National Water Initiative for example. While energy and water consumption may decline, reliance on legislative tools is insufficient to make the greenhouse reductions required to mitigate climate change. Wider society has embraced climate change as a significant and immediate problem. Consequently we are reliant on the market adopting green building measures and there is evidence that some sectors are beginning to adopt green building features to offset obsolescence and have more efficient stock in their portfolios. An increasing number of case studies are available which demonstrate current best practice in green buildings. At this point in time most are offices or residential and it is imperative that examples of retail and industrial buildings are added. Whilst many stakeholders in the property market are factoring sustainability into their decisions, valuers must interpret the effect this has on value over both the short and long term, which in turn is affected by factors such as depreciation and obsolescence. It appears certain that green buildings are here for the long term and the valuation industry must be at the forefront of this change.
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Appendices

Appendix 1 - Water case studies

Case study 1 - Green residential buildings

Mawson Lakes is a residential development on a Greenfield site in Adelaide South Australia. It was decided to adopt a dual water supply system for non-potable recycled water use for all businesses, homes and buildings in the 620 hectare development. Operation commenced in April 2005 and the recycled water is used for the following uses:

1. toilet flushing,
2. watering the garden, and
3. washing cars.


The system is designed to reduce drinking water consumption by 50%. Recycled water is collected and distributed from two sources - SA Waters Bolivar Wastewater Treatment Plant (treated wastewater) and the City of Salisbury’s wetlands (treated stormwater) - mixed together and disinfected. The recycled water is held in a storage tank before being pumped via a pipeline (separate to the drinking water pipeline) to Mawson Lakes properties. Purple or lilac coloured taps, pipes and fitting distinguish the recycled water system. The recycled water is not suitable for pools and spas, personal washing or washing clothing. The schematic below illustrates the Mawson Lakes water recycling system.

![Schematic of Mawson Lakes water recycling system](image)

Case study 2 - Green commercial buildings

CH2 is the new City of Melbourne 6 Greenstar rated office building located on the corner of Little Collins Street and Swanston Street. The rationale here for adopting green water measures was;

* "A study involving a 500 person office building in the US found the majority of its wastewater (40 kL/day out of a total waste flow of 45.4 kL/day) is blackwater, with greywater comprising only 4.5 kL/day (WSAA 1998). This means that 90 per cent of the building’s water usage need not be of potable water standard.”*

Occupancy is due to commence in October 2006 and post-occupancy evaluations will determine the efficiency of the innovative measures in the building design. The measures adopted to reduce overall consumption by 70% (to around 8.4 litres per person per day) in this building regarding water include;
• water efficiencies (taps 4L/min, sensor triggered urinals, showers 9L/min, and low flush wcs 4.5L/min),
• water re-use (rainwater harvesting),
• water recycling - (for toilets flushing, cooling tower system, street tree watering, garden watering) and sewer mining or black-water recycling,
• Innovative water saving initiatives (shower towers, phase change materials, chilled water system and plant watering system).

Water efficiency alone will account for 30% of the savings. The following diagram illustrates the two water systems operating in this building, which functions they serve and also how they connect.. About 100,000 litres of black (toilet) water a day will be extracted from the sewer in Little Collins Street. 95 percent of a sewer system is water; this is a burden on the system and a waste of potable water. At CH2 the sewerage along with any generated in the building will be put through a Multi Water Reuse Treatment Plant that filters out the water and sends the solids back to the sewer. Some of the recovered water will supply CH2’s water cooling, plant watering and toilet flushing needs. The rest will be used in other council buildings, city fountains and plants. More water will be saved through recycling water from the fire-safety sprinkler system and from rainwater. Sewer mining or black water recycling is a three stage filtration system and is shown on the schematic diagram below;

Figure x: Schematic diagram showing black water recycling or sewer mining.

Energy case studies

Case study 3 - Commercial building CH2, Melbourne.

Council House 2 (CH2) is a visionary building and aims to change the way Australia approaches ecologically sustainable design. In April 2005, the Green Building Council of Australia awarded CH2 six Green Stars which represents world leadership in office building design. This project was the first in Australia to achieve the six Green Star certified rating, where the minimum rating is one star and maximum is six. The Green Star rating system separately evaluates the environmental design and performance of Australian buildings based on criteria, including energy and water efficiency, quality of indoor environments and resource conservation. CH2 has sustainable technologies incorporated throughout such as a water-mining plant in the basement, phase-change materials for cooling, automatic night-purge windows, wavy concrete ceilings, a façade of louvres (powered by photovoltaic cells) that track the sun – even the pot plant holders have involved a whole new way of thinking. Although most of the principles adopted in the building are not new – using thermal mass for cooling, using plants to filter the light – never before in Australia have they been used in such an interrelated manner in an office building.

Low energy computing
CH\textsubscript{2} will use LCD monitors which consume 50 per cent less energy than older, CRT monitors. These LCD monitors are energy efficient, anti-glare, do not flicker, do not emit radiation, produce less heat, generate less greenhouse gas in their operation and produce less pollution in their manufacture.

**Low energy lighting**
The use of T5 light fittings for ambient lighting and individual task lighting for workstations will consume 65\% less energy than the lighting system in the Council’s current inefficient building.

**Electricity from co-generation**
A gas-fired co-generation plant on the roof will generate electricity and heat, reducing reliance on the public electricity grid. The co-generation plant has lower CO\textsubscript{2} emissions than coal-fired electrical generation and will provide 60 kVA of electricity (around 30 per cent of CH\textsubscript{2}’s electricity needs).

**Heat from co-generation**
Heat from the co-generation plant (about 100Kw) will help CH\textsubscript{2}’s air conditioning plant. This heat can be used directly for heating or, via an absorption chiller, for cooling. It is estimated the co-generation plant will satisfy 80\% of the building’s fresh air heating/cooling requirements just by using waste heat.

**Heat Recovery**
Heat is recovered from the air that gets exhausted out of the offices. CH\textsubscript{2}’s fresh air system uses no re-circulated air so fresh air from outside needs to be constantly heated or cooled to be supplied at 18°C. Through a simple heat exchange process, the temperature of the air exhausted from the space is used to help heat or cool the fresh supply air.

**Solar hot water Heat Recovery**
About 60 per cent of the hot water supply will be provided by 48 square metres of solar hot water panels on the roof and on days with little solar heat gain, a gas boiler will heat water.

**Solar photovoltaic cells**
Around 26 square metres of photovoltaic cells on the CH2 roof will generate about 3.5kW of electricity from the sun’s energy which will power the movement of the louvres to shade the west façade.

**Wind turbines**
Six wind turbines will extract air from the offices spaces through ducts on the north façade. The turbines, especially designed for CH\textsubscript{2}, are 3.5m high and replace electric fans that would usually undertake this function.

**Shower towers**
CH\textsubscript{2} has five shower towers that shower water down a 3.5 storey enclosure to cool air and water through evaporative cooling. The cool air is used for the retail spaces; the cool water will be used to freeze the Phase Change Material, which is in turn used to store ‘coolth’ for the rest of the building

**Phase change material**
CH\textsubscript{2}’s Phase Change Material (PCM) tank is like a battery that stores coolness, or ‘coolth’. The battery comprises a series of spheres containing the PCM (see photo below). Each of the PCM spheres is surrounded by the heat transfer liquid (water) that circulates through the ceiling panels on each floor. Water cooled by the shower tower-cooling tower-chiller travels through a heat exchanger to reduce the temperature of the tank and freeze the PCM. A separate water circulation heat transfer loop passes through the tank to be chilled, travel through the chilled ceiling panels and chilled beams to cool the building and then return back to the tank to begin again.
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<th>Appendix 2 – Relevant Sustainability Websites</th>
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<td><strong>Australian Greenhouse Office</strong></td>
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<td><strong>Australian Business Council for Sustainable Energy</strong></td>
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<td><strong>Australian Building Codes Board</strong></td>
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<td><strong>Australian Council of Building Design Professions</strong></td>
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<td><strong>Aluminium Foil Insulation Association</strong></td>
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<td><strong>Australian Institute of Building Surveyors</strong></td>
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<td><strong>Australia Glass &amp; Glazing Association</strong></td>
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<td><strong>Concrete Masonry Association of Australia</strong></td>
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<td><strong>Council House 2 (CH2)</strong></td>
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<td><strong>The Department of Industry, Tourism and Resources</strong></td>
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<td><strong>Earth Building Association of Australia</strong></td>
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<td><strong>Ecospecifier</strong></td>
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<td><strong>Facility Management Association</strong></td>
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<td><strong>Green Building Council</strong></td>
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<td><strong>Home energy efficiency</strong></td>
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<td><strong>Housing Industry Association</strong></td>
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<td><strong>Illuminating Engineering Society of Australia &amp; NZ</strong></td>
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<td><strong>Insulation Council of Australia &amp; New Zealand</strong></td>
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<td><strong>Master Builders Australia</strong></td>
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<td><strong>Nathers</strong></td>
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<td><strong>National Association of Steel-framed Housing</strong></td>
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<td><strong>SALA homes</strong></td>
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<td><strong>SOLARCH Group</strong></td>
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<td><strong>Standards Australia</strong></td>
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<td><strong>Sustainable Energy Authority Victoria</strong></td>
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<td><strong>Timber Merchants Association</strong></td>
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<td><strong>Window and Door Industry Council</strong></td>
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