Maddocks

Are our buildings ready for a changing climate?

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Maddocks in collaboration with HASSELL

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Introduction

The built environment plays a fundamental economic, cultural and social role in our lives. Our residential, commercial and public buildings provide shelter and security. They affect our productivity, our health and our general wellbeing and amenity.

Climate change poses considerable challenges for buildings in two distinct ways:

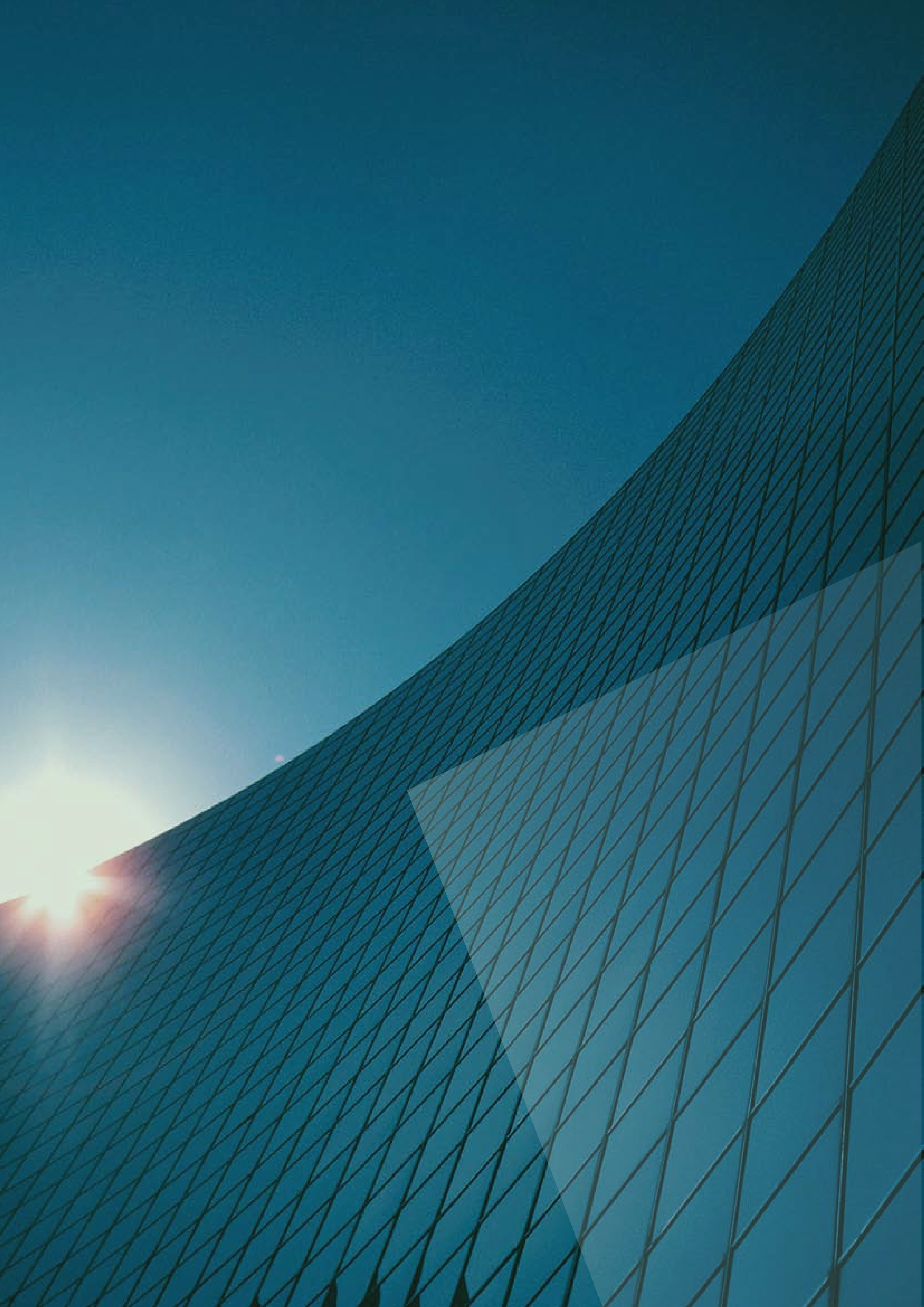
- First, buildings may be vulnerable to the effects of climate change – particularly storms and extreme events, flooding, bushfires and intense heat. *Adaptation* of buildings to these effects is likely to result in a transformation of Australia's building stock over time, particularly in areas where climate change effects are particularly pronounced or are predicted to increase in severity and frequency in the future.
- Second, buildings are significant emitters of greenhouse gases. In Australia, it is estimated that around 18% of Australia's total emissions are caused by the operation of buildings, particularly through the energy that they consume. In turn, these emissions contribute to the concentration of greenhouse gases in the atmosphere, which are driving changes in the physical environment. *Mitigation* of emissions from buildings through energy efficiency mechanisms will serve the dual purposes of reducing energy costs in these buildings as well as reducing Australia's greenhouse gas emissions.

Increasingly, building investors, developers, owners, operators and users will be implicated in efforts to adapt to and/or to mitigate the effects of climate change. However, assessing the impact of climate change on buildings and determining the best methods – legal and otherwise – to address those impacts is no easy task. This assessment is complicated for a range of reasons, including:

- The building sector is characterised by diversity in ownership and use, which is shared between private individuals, corporate entities and public bodies. This raises the question of the most appropriate model for allocating responsibility for addressing the effects of climate change.
- Building structure, design and age is equally diverse, particularly when the spectrum of residential, commercial and public buildings is considered. Such diversity presents particular challenges in devising and implementing rules that apply across-the-board to help buildings adapt to the effects of climate change and those that seek to mitigate buildings' emissions.
- Moreover, Australia's buildings are physically spread across a broad array of different climate zones, which will affect their vulnerability as well as their responsiveness to the challenges that climate change presents.

In this paper, we set out a framework to assist building investors, developers, owners, operators and users in understanding the mechanisms and practical options that exist or may be used to address the challenges presented by climate change. In particular, we:

- identify key elements of the regulatory framework that may facilitate the adaptation of buildings to the effects of climate change
- outline the main mechanisms to facilitate mitigation of emissions from buildings
- provide an overview of the impact on building owners, operators and users of these adaptation and mitigation measures.



Australia's building infrastructure

Ensuring that Australia's building regime is capable of responding to the effects of climate change necessarily entails an assessment of Australia's building stock. Such an assessment will help to ascertain whether particular types of buildings in specific locations are capable of withstanding the current and projected impacts of climate change and, if not, the changes that are needed to reduce vulnerability. An assessment of this kind will also help to identify ways in which emissions from buildings can be mitigated which could, in turn, help to limit the broader physical effects of climate change.

There are a variety of factors that may affect a building's ability to adapt to or mitigate the effects of climate change. Some factors are particularly relevant for residential buildings, others are most relevant for commercial buildings and yet others are relevant for both classes of buildings. These factors include:

- *Structure and design* - A building's structure and design, including the building envelope, foundation, orientation and the materials from which it is constructed, will affect its vulnerability to the effects of climate change. Building design will also affect the amount of lighting, heating, and cooling a building will require, which will have an impact on energy consumption.
- *Age* - New buildings are likely to be relatively more resilient to the effects of climate change and, therefore, more adaptable than older buildings. Similarly, newer buildings are likely to be more energy efficient and, consequently, produce fewer emissions than older buildings.
- *Size* - The greater the size of a building, the larger the carbon footprint is likely to be. Furthermore, the overall impact of climate change events on larger buildings and the scale of efforts needed to make them more resilient to such events will probably be greater compared to smaller buildings.
- *Climate zone* - The climate zone in which a building is located will affect its energy requirements for heating, cooling and lighting. Moreover, extreme climate change events, which could pose risks to buildings, will be more prevalent in some climate zones compared to others.
- *Equipment and appliances* - Appliances and equipment are responsible for a significant proportion of a building's energy use and emissions. More efficient appliances and better use of equipment has been estimated to account for 53% of the emissions reduction opportunity in commercial building retrofits.
- *Surrounding physical environment* - Buildings located in metropolitan and urban areas may suffer from an 'urban heat island effect', where the often treeless environments trap and retain heat. The temperatures of urban heat islands tend to increase with the number of inhabitants, the size of the city, and the density of buildings. Air conditioning and, therefore, energy demands are likely to be higher in these areas compared to less developed and rural areas. The existence of an urban heat island effect will, therefore, limit the potential for emissions mitigation and may also affect buildings' ability to adapt to the effects of climate change, particularly extreme heat.

The regulatory framework

The building regime

The main instrument that regulates buildings in Australia is the Building Code of Australia (**BCA**).

The BCA, which is produced and maintained by the Australian Building Codes Board on behalf of the Australian Government and State and Territory Governments, has been given the status of building regulations in all Australia's States and Territories. In addition to 'calling up' application of the BCA in the relevant jurisdiction, each state building regulatory framework also contains compliance and enforcement provisions to ensure that BCA requirements are met.

The primary goal of the BCA is to establish nationally consistent, minimum building standards to ensure health, safety (including structural safety and safety from fire), amenity and sustainability. The BCA contains technical provisions relating to the design and construction of buildings, including matters such as structure, fire resistance, access and egress, services and equipment.

The BCA is a performance-based code, which essentially means that deviation from prescriptive requirements is allowed through the use of alternative materials, forms of construction or designs. A building may comply with the BCA either by meeting the prescriptive 'deemed-to-satisfy' requirements or by an alternative approach provided that it achieves the BCA's performance requirements. In the case of an alternative solution, the building proponent must use an assessment method, which verifies that the performance requirements in the BCA have been fulfilled.

The building regime – and the inherent flexibility that the performance-based system enshrines – has the potential to play an important role in addressing the effects of climate change both in assisting buildings to adapt to and mitigate the effects of climate change. This role is explored in this paper.

The planning regime

The planning regime also plays an important role in addressing climate change. Planning is the process of making decisions regarding the appropriate development, use and protection of urban and rural land as well as infrastructure and facilities on that land.

While this paper focuses predominantly on the role played by the building regime in addressing the effects of climate change, it is worthwhile noting that the planning regime may be equally important. Indeed, planning provisions may complement and/or reinforce relevant aspects of the building regime, although, at times, the two regimes may be at odds. We refer to relevant aspects of the planning regime below.

Adaptation

Adaptation of buildings to climate change involves making adjustments to the way buildings are designed, constructed, located and operated so that they can respond to current or future physical consequences associated with climate change.

Adaptation could occur on a reactive basis once climate change risks become clearer. Alternatively, a proactive approach could be adopted to minimise the risk of damage to buildings before the effects of climate change have materialised or worsened. In either case, it is necessary to identify and assess the risks in question and to develop a strategy to address those risks.

In this section of our paper, we explore the scope that exists within existing regulatory provisions to respond to climate change and identify specific changes that have been made in the building regime to respond to the effects of climate change.

Impact of climate change on buildings

There are a range of physical phenomena associated with climate change that may affect the stability, operation and, potentially, the ongoing viability of buildings. These physical phenomena include:

- *Overheating* - Increased temperature and exposure to radiation could reduce the life of a building and its constituent elements due to expansion and breakdown of materials. Longer, hotter, and more frequent heat waves will also raise energy demand for air-conditioning.

- *Storm surges and extreme events* - Buildings will face an increased risk of damage from storms and other extreme events as the frequency and intensity of these kinds of events are likely to increase with climate change. Buildings will need to cope with strong winds, cyclones and heavy rainfall.
- *Flooding* - Buildings in coastal areas and in floodplains will be particularly vulnerable to sea level rise and storm surges. Flooding could lead to corrosion and material degradation as well as destruction. Urban areas, where the absorptive capacity of our landscapes has been diminished, could also be at risk when heavy rainfall events occur.
- *Bushfires* - The structure, design and location of buildings will need to account for increases in the risk and frequency of bushfires. Buildings in some rural areas are particularly exposed to this risk. However, recent events abroad and in Australia have illustrated the real and significant threat that bushfires may also pose to built-up urban areas.
- *Drought and erosion* - Drier conditions resulting from drought and erosion linked to changes in groundwater may affect the stability and performance of building foundations. This effect is likely to be particularly pronounced in rural areas.

Regulatory framework for adaptation of buildings

The main regulatory framework to support adaptation of buildings to the effects of climate change is the building regime although, as previously mentioned, the planning regime can also play an important role in this regard.

Resistance of buildings to physical impacts

The BCA contains provisions that require buildings to be designed and built to resist various impacts to which they may be subject, including a number of physical phenomena that are associated with climate change. More specifically, the structural provisions of the BCA[1] include amongst their performance requirements that a building or structure must:

- remain stable and not collapse
- prevent progressive collapse
- minimise local damage and loss of amenity through excessive deformation, vibration or degradation
- avoid causing damage to other properties

The BCA lists a variety of impacts that buildings should withstand, including:

- wind
- snow
- earthquakes
- rainfall
- thermal effects
- ground movement caused by swelling, shrinkage or freezing of the subsoil

[1] See, in particular, Part B1 of Volume 1 (*Structural Provisions*) and Part 2.1 of Volume 2 (*Structure*) of the BCA. Volume 1 of the BCA pertains primarily to Class 2 to 9 buildings (including apartment, office and retail buildings) whereas Volume 2 pertains primarily to Class 1 and 10 buildings (houses, sheds, carports, etc).

The associated deemed-to-satisfy provisions in Volume 1 of the BCA provide that the resistance of a building must be greater than the most critical effect resulting from these phenomena. This implies that a risk assessment has been undertaken to ascertain the critical effects to which a building is likely to be subjected during its life. These provisions also require compliance of building components and materials with relevant standards to ensure structural resistance.

While these general provisions provide the broad framework within which the effects of climate change may be addressed through the structural design of buildings, more specific provisions may be needed to respond to particular climate change effects.

Overheating

The BCA contains a range of deemed-to-satisfy provisions that may be relevant to reducing the risk of overheating for certain classes of buildings,[2] including:

– *Insulation* - The BCA contains general provisions regarding thermal construction for Class 2 – 9 buildings, which seek to ensure that buildings are adequately insulated. More specific provisions exist in relation to roof and ceiling construction, walls and floors.

– *Air Movement* - The BCA also contains provisions applicable to certain Class 2 and 4 buildings. The relevant provisions contain a specification of the minimum total ventilation opening area required per room based on the climate zone where the building in question is located.

These provisions may assist in adaptation to increased temperature and exposure to radiation. They may also help to reduce the demand for air-conditioning in a building and reduce the impact of increased temperatures on internal building materials.

These requirements accommodate some practical ideas that have been put forward to reduce the vulnerability of buildings and their occupants to over-heating, which include:

- designing cooling-load-avoidance measures into buildings through, for example:
  - passive solar design
  - exterior shading devices
  - insulation
  - reflective roofing
- incorporating natural ventilation, which may be useful as a cooling strategy during power outages
- requiring high-efficiency lighting and equipment, which will reduce the level of waste heat
- establishing standards for building spacing and green spaces (such as trees and green roofs) to minimise cooling requirements and reduce the impact of the urban heat island effect

HASSELL Studio Melbourne. Photography by Earl Carter.

[2] Section J of Volume 1 of the BCA.

Natural ventilation as a means to address overheating

The former Keatings Bread Factory in Fortitude Valley in Brisbane and a disused warehouse in the Melbourne CBD have been adapted and extensively refurbished to create new HASSELL studios. Both studios have open-plan workplaces with interconnected studio and hub areas. Use of natural ventilation was a priority in the refurbishment, leading to less dependence on mechanical ventilation and providing high indoor air quality.

In Brisbane, the principles of cross ventilation were adopted within rooms with independent air conditioning, providing a choice of either natural ventilation or mechanical air conditioning. Throughout the year, the active heating and cooling systems are turned off and the building operates passively. Further, there are dedicated air conditioning systems for meeting rooms to ensure that they only operate when the rooms are in use.

In the Melbourne studio, the ventilation rates for the studio areas and meeting rooms are set at 50% above the mandatory requirements, and the open plan facilitates cross flow ventilation through the building's original operable windows in temperate weather conditions.

HASSELL Studio Brisbane.

Storm surges

As noted above, the BCA requires that buildings and their constituent elements have sufficient structural stability to withstand a range of physical impacts.[3]

These provisions are complemented by BCA provisions dealing with the weatherproofing of buildings, including against storm surges.[4] For example, the BCA contains the following performance requirements:

– *Entry of stormwater into buildings* - Surface water, resulting from a storm having an average recurrence interval of 100 years, must not enter the building.

– *Disposal of stormwater* - Surface water, resulting from a storm having an average recurrence interval of 20 years and which is collected or concentrated by a building or sitework, must be disposed of in a way that avoids the likelihood of damage or nuisance to any other property.

The deemed-to-satisfy provisions include requirements to comply with relevant standards regarding stormwater drainage, rooftop materials, sarking materials used for weatherproofing of roofs and walls, and glazed assemblies to help increase resistance to water penetration.

In broad terms, these provisions support options available to address the risk of storm surges for buildings, including:

- designing buildings to survive extreme winds through, for example:
  - impact-resistant windows and exterior shutters
  - improved fixing of roofs to walls and walls to floors
  - high strength roofs
  - aerodynamic building design to reduce deflection and resonance
- external finishes and claddings that prevent water ingress

Flooding

The planning regime plays a significant role in addressing flood risks. The specific manner in which flood risks are tackled may vary from jurisdiction to jurisdiction. However, there are certain features that are common to most jurisdictions.

In particular, planning regimes will normally provide for the identification of flood prone areas, which are usually defined by reference to a particular flood event that is typically the worst flood event that is possible within a specific time period. Generally speaking, flood management planning frameworks seek to avoiding intensifying the possible impact of flooding by limiting or preventing development in flood prone areas. This may be achieved through the use of flood planning levels, which are thresholds below which flood-related planning controls are applied. Another mechanism is a floodway or inundation overlay, which may prohibit or restrict particular uses and/or development in areas that are subject to the overlay.

With respect to coastal areas, most planning regimes also require account to be taken of sea level rise caused by climate change when development applications are assessed. Typically, the notion of a 'coastal zone' is used to delineate areas in which special planning rules apply. State-based sea level rise projections provide the context within which these rules are applied. The higher the sea level rise projections and the faster the rate at which sea level rise is predicted to occur, the greater the need for strict planning controls to limit the impact of coastal inundation and erosion that will inevitably accompany such rises.

[3] See *Resistance of buildings to physical impact*s above.

[4] See Part F1, Volume 1 (*Damp and Weatherproofing*) and Part 2.2 of Volume 2 (*Damp and Weatherproofing*) of the BCA.

These aspects of planning regimes are complemented by relevant provisions of the BCA dealing with weatherproofing, which we discussed above in *Storm surges.*

Suggestions that have been advanced to help buildings adapt to increased flood risk include:

- avoid building on a flood-prone site
- raise buildings off the ground
- consider multi-storey construction
- use water-resistant materials or materials that can get wet and then dry out with only minimal damage
- design to ensure water can easily escape once flooding has subsided
- elevate vital mechanical and electrical equipment and services
- increased capacity stormwater drainage, including increased use of permeable surfaces and other natural systems
- integrate features to protect buildings from flooding such as building a levee or flood wall around the building or incorporating flood vents to allow floodwaters to escape
- use roofing materials to cope with increased drainage loads

Bushfires

The BCA contains provisions that seek to render buildings less vulnerable to fire risks.[5] The BCA requires a building to be constructed in a way that maintains structural stability during a fire taking into account, among other things, the nature of the fire hazard. It also requires a building to be provided with safeguards to prevent the spread of fire.

The BCA contains a range of deemed-to-satisfy provisions that are relevant to reducing the exposure of buildings to bushfire risks. These include:

- *Fire Resistance and Stability* - The BCA requires any material or assembly used in Class 2 to 9 buildings (including floor materials, floor coverings, wall and ceiling lining materials) to comply with certain specifications to increase their fire resistance.[6]
- *Construction in Bushfire Prone Areas* - The BCA requires that Class 2 and 3 buildings in 'designated bushfire prone areas' must comply with AS 3959.[7] This was updated in 2009 to improve the ability of homes in bushfire prone areas to withstand bushfire attack. The revised standard requires additional construction measures to be incorporated into new housing located in designated bushfire-prone areas if the 'Bushfire Attack Level' exceeds a prescribed threshold.

The identification of bushfire prone areas is typically undertaken in the context of state-based planning regimes, taking into account the level of bushfire hazard risk in each area. In some jurisdictions, such areas are identified by councils in their local planning schemes whereas in other jurisdictions this may be undertaken by an independent third party, such as a fire authority.

The planning regime may also provide for the establishment of 'bushfire abatement zones' or 'asset protection zones', which are essentially buffer zones between bush fire hazards and buildings, infrastructure and other types of development that might be affected by radiant heat, flames, ember and smoke attack. The location and alignment of bushfire abatement zones will depend on a number

[5] See Section C, Volume 1 (*Fire Resistance*) and Part 2.3, Volume 2 (*Fire Safety*) of the BCA.

[6] Part C1, Volume 1 of the BCA.

[7] Part G5, Volume 1 of the BCA.

of factors related to the risk of fires starting, spreading and causing damage, including vegetation type, land slope and type and levels of construction. Special controls can be tailored to the degree of bushfire risk in a particular zone.

The following ideas that have been put forward to reduce the vulnerability of buildings and their occupants to bushfires would appear to be supported by both the planning and building regimes:

- avoid building in bushfire prone areas
- install roofing that minimises the risk of wind-blown embers entering the house
- eliminate gutters or design and maintain them to minimise fire risk
- install high-performance, tempered windows
- choose building materials that will resist embers, radiant heat and flame contact as far as possible
- manage surrounding vegetation
- minimise openings that will allow fire ingress

Drought and erosion

The BCA does not contain provisions that specifically address the problems that drought and erosion may pose to building foundations, although the provisions requiring structural stability in the face of physical effects including 'thermal changes' are likely to be relevant. [8]

These provisions are complemented by the planning regime, which may control and/or limit development in areas that are prone to the effects of climate change through the designation of erosion zones and the use of erosion overlays.

Some of the options available to deal with drought and erosion include:

- avoid development in the driest regions
- use materials that can cope with dry conditions
- require water-efficient fixtures and appliances
- harvest rainwater
- only plant climatically appropriate trees and other vegetation in the vicinity of the building

[8] See *Resistance of buildings to physical impacts* above.

SA Water House. Photography by Earl Carter.

Water efficiency in drought-prone areas

SA Water House, located in the Adelaide CBD, is an exemplar for sustainable building, with a focus on water efficiency. In a state where drought is a significant and ongoing problem, the building's main tenant – SA Water – has ambitions to be a world leader in water management. The building has achieved a 6 Star 'World Leadership' Green Star Office Design rating using the Green Building Council of Australia rating tool.

The building achieves a reduction of approximately 60% in potable mains water consumption, saving 11 million litres of water per year, and a reduction of about 50% in greenhouse gas emissions and energy costs compared to a typical office building. Rainwater and recycled water from the building's sewerage is used for toilet flushing and cooling towers, and highly efficient water-cooled chillers are used instead of air cooled chillers. Waste water from fire testing is reused, fittings include AAAA rated tapware and toilets, and waterless urinals all ensure the greatest efficiencies possible.

Power outages

Power outages could occur as a result of any of the physical consequences associated with climate change. Therefore, the adaptation of buildings to climate change should include measures that will make those buildings less vulnerable to power outages. However, the BCA does not specifically address protection of buildings against such outages, although the provisions dealing with overheating may be relevant.

Suggestions that have been put forward to minimise the impact of power outages on buildings include:

- design buildings to maintain liveable conditions in the event of loss of power through, for example:
  - high-performance building envelope (high insulation levels, triple-glazed windows in cooler climates, etc.)
  - cooling-load-avoidance features
  - natural ventilation
  - passive solar heating
- establish site-generated electricity from renewable energy

On-site power tri-generation facilities

Brisbane Domestic Air Terminal is currently handling in excess of 13 million domestic passengers per year. Annual growth is over 9% and is expected to continue at 4-5 % per annum. HASSELL, in conjunction with Arup, has been commissioned to design and extensively re-develop the domestic terminal precinct to accommodate this current demand and future growth to 2018 and beyond.

The development of a tri-generation plant for central electricity will reduce peak grid electricity demand by approximately 17,000 tonnes/CO_2 per annum. Waste heat will be used to produce central hot and chilled water. Natural ventilation, efficient lighting, daylight sensor controls, and motion sensors for off-peak hours will further reduce electricity use by about 30% for this part of the airport alone.

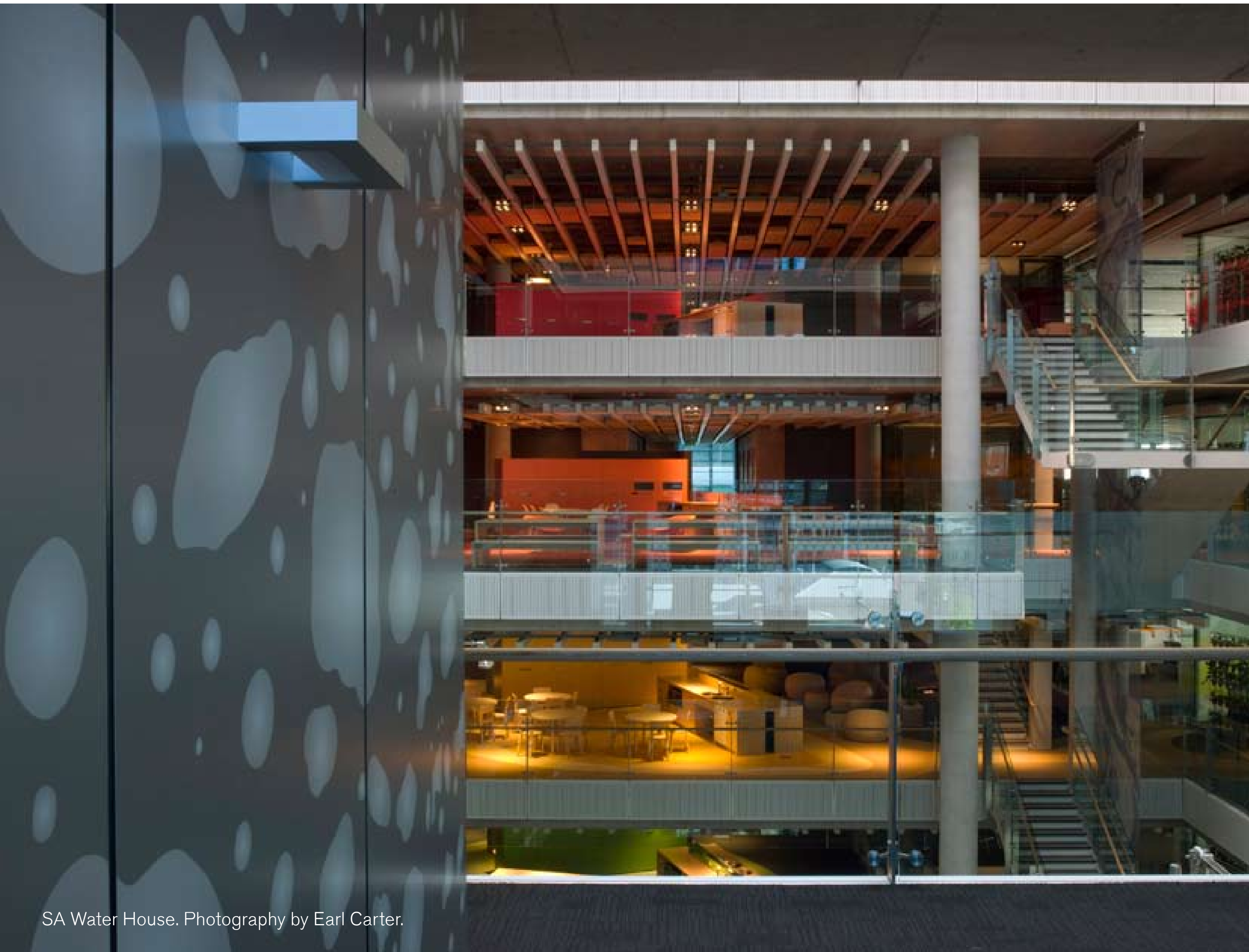
In the common user terminal, existing heating, ventilation, lighting, glazing and air conditioning equipment will be upgraded. HASSELL aims to use central chilled water for air cooling to improve energy efficiency in both the common user terminal and common user satellite. Connecting to a central energy plant aims to provide a saving of approximately 1000 tonnes of CO_2 per annum. Daylight penetration and natural smoke extraction will result in energy savings from reduced lighting and improved indoor environment quality. Variable speed drives on escalators in the common user terminal and pavilion, where the mechanism responds to demand, will also minimise total energy use. The design of the pavilion will provide solar control with shading, reducing total energy load and direct sunlight.

Conclusions

Inevitably, buildings will need to adapt to the effects of climate change. As the physical phenomena associated with climate change grow in intensity and frequency, this need will become all the more pressing. This raises the question of whether the existing regulatory regime meets the challenges that climate change presents.

In this regard, it is notable that, up until now, a holistic review of the building regime has not been undertaken to determine the extent to which it adequately responds to the effects of climate change and whether any modifications are necessary. Furthermore, explicit response to the effects of climate change through the building regime has largely been reactive and piecemeal in coverage.

While the BCA currently accommodates a range of practical options to address climate change risks, it is questionable whether existing BCA provisions will be sufficient to address the nature, scale and intensity of climate change events that we are likely to see in the future. Moreover, the applicability of BCA provisions that may assist with adaptation have limited application to older buildings, whose vulnerability to the effects of climate change will, in many cases, be greater than for newer buildings.



SA Water House. Photography by Earl Carter.

It may be necessary to take steps to facilitate and accelerate the rate of adaptation which will, in turn, help to lower the overall impact of climate change on the building sector. Some steps worth considering include:

- *Review and make any necessary changes to the BCA to help protect old and new buildings against current and future impacts of climate change.* Provisions that are specifically aimed at addressing the effects of climate change may stimulate greater innovation in building design efforts now, which will help prepare buildings when the physical effects of climate change start to escalate.
- *Review and make any necessary changes to the relevant technical standards to which the BCA refers.* The standard AS 3959 to address construction in bushfire prone areas was updated in 2009 to improve the ability of homes in bushfire prone areas to withstand bushfire attack following the tragic Victorian bushfires, which took place in that year. Ideally, standard reviews and changes of this kind should occur prior to the materialisation of climate change risks.
- *Ensure consistency and complementarity between planning and building laws to maximise building protection.* There are elements of both the building and planning regimes that may assist buildings in the adaptation to the effects of climate change. It would be useful to undertake an assessment of the extent to which these regimes are consistent and complementary. Revisions to either or both regimes may be needed to address overlaps and inconsistency in order to ensure that buildings are adequately equipped to withstand the effects of climate change.
- *Fast-tracking planning and building approval for buildings that effectively achieve adaptation to the local environment.* Fast tracking approvals for buildings that have been designed to withstand present and future climate change impacts will act as a strong incentive to encourage investment in climate change-friendly solutions.
- *Awareness and educational campaigns to clearly explain the risks associated with failing to adapt to the effects of climate change.* While building owners and users may be aware of the consequences of climate change, they may not fully understand the short and longer term practical implications for their buildings. Awareness and educational campaigns that focus on the risks associated with failing to adapt to the effects of climate change, but also the benefits of adaptation, will also help to motivate owners and users to upgrade their buildings to meet the challenges that climate change presents.

Adapting to the effects of climate change will entail costs. These costs are likely to be significant, particularly for older buildings for which proofing against climate change may involve a complete retrofit. Nevertheless, adaptation will also yield benefits not the least of which is protecting the building from costly damage in the future. Adaptation may also have a range of ancillary benefits, including lower energy costs and improved amenity.

Mitigation

Now we turn to the opportunities that exist for the mitigation of emissions from buildings.

Estimates indicate that, in Australia, buildings account for around 18% of Australia's total greenhouse gas emissions, with 10% attributable to residential buildings and 8% attributable to commercial buildings.

These emissions are predominately associated with energy consumption from building operation. Additional emissions are associated with:

- embodied energy in materials used in buildings
- energy used to provide services such as water, street lighting and waste treatment
- transport energy use due to locations of buildings relative to locations of other buildings, infrastructure and services

Mitigation through energy efficiency

Most efforts to reduce emissions from buildings in Australia are targeted at increasing buildings' energy efficiency, which essentially involves reducing energy consumption. Energy efficiency in buildings has been hailed as providing the most diverse, largest and most cost-effective mitigation opportunities. The rationale underlying mechanisms aimed at enhancing energy efficiency in buildings as a means of reducing emissions is that buildings may embody design imperfections, which can result in energy wastage. If corrected, the amount of power consumed by buildings and, in turn, building emissions could be reduced.

Apart from the significant contribution to reducing national emissions that energy efficiency measures in buildings can make, these measures also generate benefits for owners and occupiers alike. In particular, investments in energy efficiency measures are often cost neutral or even cost negative – that is, the expenditure associated with increasing energy efficiency is more than fully offset by the cost savings made through reduced energy consumption. Buildings that are relatively cheap to operate may attract investment capital more easily. Furthermore, energy efficient buildings are likely to be more valuable and have a marketing advantage over less efficient buildings for which the operational costs will be higher. This may position owners to charge higher rents and may increase occupancy rates and lease duration. Occupier benefits include reduced energy costs and improved environmental quality, which could improve productivity, health and wellbeing.

Utilisation of a range of building energy efficiency options

The building at 123 Albert Street, Brisbane, is a 35-storey high-rise building, located near Queen Street Mall in Brisbane's CBD. It will accommodate approximately 38,250 m^2 of flexible office space above a five-storey podium building. The HASSELL design represents both passive and active strategies to achieve a 6 Star Green Star rating for the project and 5 Star NABERS rating plus 40% CO_2 reduction.

Energy efficiency initiatives include:

- strategic orientation of building elements to maximise shading
- external shading combined with a high performance facade on the exposed elevations
- optimisation of daylight and state-of-the-art building services to reduce the building's impact on the environment.

The hybrid climate technology combines Variable Air Volume (**VAV**) and chilled beam air conditioning as an alternative to conventional air conditioning. The chilled beam system, one of only a few installed in Australia, has the advantage of using less energy.

The building also has an innovative automated blind system on the inside of all facades. Blinds automatically take into account the angle of sun on each side of the building and adjust their length accordingly, reducing the amount of glare and heat gain in the office space.

Regulatory framework for mitigation of emissions from buildings

There are a suite of policy measures at the federal, state and territory levels aimed at improving energy efficiency. The various measures play different roles in delivering energy efficient outcomes.

The National Framework for Energy Efficiency

Until relatively recently, Commonwealth, State and Territory governments separately implemented a range of energy efficiency policy measures. In order to address the varied nature of energy efficiency policies and programs, in 2004, the Council of Australian Governments (**COAG**) agreed to develop a national energy efficiency policy framework to harmonise these policies and programs across jurisdictions.

The National Framework for Energy Efficiency (**NFEE**) was created by COAG to 'provide a sound platform to improve energy efficiency performance nationally ... through coordinated action by Australian, State and Territory agencies'. The key measures of Stage 1 of the NFEE were directed at addressing impediments to the implementation of energy efficiency measures in a number of key areas directly affecting buildings, namely:

- energy efficiency standards and mandatory disclosure of energy performance for buildings
- minimum energy performance standards and labelling for appliances and equipment

It was subsequently agreed that further energy efficiency measures would be developed as part of Stage 2 of the NFEE, including:

- a strengthened and expanded Minimum Energy Performance Standards program
- a heating, ventilation and air conditioning systems strategy
- a strategy to phase out incandescent lighting
- government leadership through green leases
- the development of a national hot water strategy

National Strategy on Energy Efficiency

In October 2008, COAG agreed to develop a National Strategy on Energy Efficiency (**NSEE**) in recognition of the fact that additional efforts were needed to improve the uptake of energy efficiency opportunities. The NSEE builds upon the NFEE and has amongst its aims to improve minimum energy efficiency standards and to increase the uptake of energy efficient technologies and processes.

On 30 April 2009, COAG reaffirmed its commitment to the introduction of the NSEE. It agreed that the NSEE's scope would encompass all areas in the economy where substantial cost-effective energy efficiency opportunities exist. The measures to achieve energy efficiency in the strategy are framed around some key themes, which affect buildings:

- making buildings more energy efficient by improving energy efficiency standards
- reducing impediments to the uptake of energy efficiency by individuals and business by providing information and ensuring that the regulatory frameworks are in place to deliver continuing improvements to electricity markets through demand side initiatives and the energy efficiency of appliances and equipment

The NSEE now forms the core of efforts to achieve energy efficiency at the national level. It is supplemented by a range of energy efficiency initiatives that have been adopted by State and Territory governments.

Types of energy efficiency measures for buildings

There are a wide variety of existing and proposed future measures aimed at increasing building energy efficiency pursuant to the NSEE. These measures can be divided into three main categories:

- *Regulation* – that is, legislative measures that mandate the adoption of energy efficient measures. The types of regulation include:
  - energy efficiency standards for buildings and products
  - planning rules to facilitate energy efficient developments
  - energy efficiency reporting
- *Financial/commercial incentives* – these are measures that provide individuals and businesses with incentives to undertake energy efficiency action, including:
  - government grants, loans and rebates
  - market-based energy efficiency schemes
  - commercial arrangements that include energy efficiency obligations
- *Social marketing and information tools* – such tools can raise energy users' awareness about the benefits of energy efficiency, which may change behaviour. The tools include:
  - environmental rating systems
  - green jobs and skills training
  - education

Each of these categories of measures is discussed below.

Regulating to achieve energy efficiency

Regulation is an effective way to change standards, practices and behaviour in cases where such changes would not occur in the absence of regulation. Regulation can also speed up the rate of change and foster innovation.

A variety of regulations that have emerged at the federal, state and local levels require adoption of energy efficiency measures. Some relate to buildings and others relate to products that may be incorporated into residential and commercial buildings. In addition, some regulations seek to achieve energy efficiency more indirectly through, for example, requiring disclosure of energy efficiency performance.

(a) Energy efficiency standards

Buildings

Energy efficiency standards currently exist for residential and commercial buildings under the BCA. In essence, the requirement is that a building must have, to the degree prescribed, a level of thermal performance to facilitate the efficient use of energy for artificial heating and cooling. However this requirement is not applied consistently across all states and territories.

In 2009, COAG resolved to increase energy efficiency standards for commercial and residential buildings.

With respect to commercial buildings, COAG made the following resolutions:

- An increase in the stringency of energy efficiency requirements for all classes of commercial buildings in the BCA from 2010, which will apply to new buildings and major renovations.
- The BCA currently sets the benefit-to-cost ratio target for energy efficiency measures for commercial buildings at approximately 5:1. COAG agreed that this benefit-to-cost target should be reduced to 2:1, representing a significant tightening of the current BCA requirements.

Regarding residential buildings, COAG decided that:

- From 2011, minimum energy efficiency standards for new residential buildings will be upgraded from 5 stars to 6 stars or equivalent.
- New efficiency requirements for hot water systems and lighting will be introduced.

These changes have now been incorporated into BCA 2010. This action will be followed by major reforms to the standard setting and rating systems for buildings in 2011 to deliver national consistency in the way minimum standards for building energy efficiency are set and how performance outcomes and design are assessed and rated.

Products

The Equipment Energy Efficiency Program (**E_3**), which is co-funded by the federal government, state and territory governments and the New Zealand Government, includes initiatives that require a nationally consistent framework to improve energy efficiency and reduce greenhouse emissions from household appliances and equipment, and commercial and industrial equipment.

Mandatory Energy Performance Standards (**MEPS**) form the core of the E_3 program. These standards effectively increase the energy efficiency requirements for particular classes of products. MEPS are established nationally and incorporated into Australian Standards. State laws and regulations require compliance with the MEPS and prohibit the sale of products that fail to comply with the applicable standards, whether manufactured domestically or imported from abroad. MEPS have been developed in conjunction with a labelling program.

Currently, MEPS apply to a range of products that might be incorporated in residential and commercial buildings, including refrigerators, water heaters, air conditioners, incandescent lights, external power supplies and commercial building chillers.

COAG has recently proposed the establishment of national legislation for MEPS and labelling and, over time, there will be a move to add Greenhouse and Energy Minimum Standards (**GEMS**).

(b) Energy efficiency reporting

There are a number of existing and proposed schemes, which mandate reporting or publication of information on energy efficiency action, including in the context of buildings. It is both the information that is made available through such schemes and the obligations themselves that are likely to drive behaviour change. Furthermore, the information that is required to be reported could be used as context for structuring future energy efficiency incentives.

The Mandatory Energy Efficiency Disclosure Scheme is part of the National Strategy on Energy Efficiency and is due to commence in October 2010. It will originally apply to commercial office buildings over a prescribed size, but may eventually be extended to non-office commercial buildings, including retail, buildings, schools and hospitals.

The central requirement of the Mandatory Disclosure Scheme is that, when certain commercial buildings are sold, leased or sub-leased, an energy efficiency rating and assessment report must be disclosed by the owner (or tenant, if sub-leased):

- in any advertisement about that sale or lease, the disclosure requirement being limited to a valid NABERS Energy rating (discussed later in this paper);
- to prospective buyers and tenants – via a valid Building Energy Efficiency Certificate (**BEEC**); and
- to a central registry – via the disclosure of a valid BEEC.

The BEEC sets out the energy efficiency rating for a building, an assessment of the energy efficiency of the lighting and guidance on how energy efficiency might be approved.

The Mandatory Disclosure Scheme contemplates a range of enforcement measures for non-compliance, including criminal penalties in certain circumstances.

The scheme will enable a 'like for like' comparison of the energy efficiency of a commercial office building during the marketing, sale and leasing process, which, in turn, is likely to lead to increased focus by building owners and developers on the importance of a building's energy efficiency performance.

(c) Planning controls

An important objective underlying planning schemes is the control of development to ensure that basic community needs are met and that resources are used effectively and equitably. Accordingly, planning rules and policy are regulatory vehicles through which energy efficient outcomes for urban design, land use and development can be achieved.

As part of its recently announced 'Cleaner, Greener Buildings Policy', the Queensland Government will introduce a 'green door policy' into its planning scheme to encourage energy efficient developments. Expanded powers will be given to the Planning Minster to issue 'ministerial directions' to councils to fast-track approvals where a development exhibits sustainability features, including energy efficiency. A 'Green Door Advisory Committee' will be established to advise the Planning Minister on appropriate developments that should be considered for a ministerial direction. Committee members will include local government representatives as well as industry and sustainability experts. It is unclear how effective the 'Green Door' policy will be, although it is notable that similar policies have been adopted in a number of places in the United States.

In New South Wales, State Environment Planning Policy (Building Sustainability Index: BASIX) 2004 requires certain residential developments to comply with 'BASIX', which is a Building Sustainability Index. Among other things, BASIX sets energy efficiency targets.

In Victoria, the Victorian Planning Provisions (**VPPs**) also encourage energy efficiency in the context of land use and development. In particular, clause 15.12 of the VPPs require planning authorities to 'promote energy efficient building and subdivision design'. In practical terms, this clause means that the energy efficiency features would help to support a development application. However, there is limited guidance for local councils in implementing this provision, and it is unclear how effective it is as a tool to achieve real energy efficiency outcomes.

Financial and commercial incentives

Most investments in energy efficiency initiatives will pay for themselves through lower energy bills. Nevertheless, various financial and commercial incentives exist to encourage energy efficiency action in cases where action may not otherwise occur. The ultimate effectiveness of these incentives in achieving energy efficient outcomes will depend, to a large extent, on the nature and form of the incentive and the relative size of the incentive compared with the overall revenue and costs of the business.

(a) Market-based energy efficiency schemes

New South Wales and Victoria have implemented market-based energy efficiency schemes, which are often described as 'White Certificate' schemes.

The Victorian Energy Efficiency Target (**VEET**) scheme, which commenced on 1 January 2009, aims to encourage the uptake of energy efficient technology, initially in the residential sector.

The VEET scheme imposes legal liability on large electricity and gas retailers in Victoria to contribute to energy efficiency measures by acquiring and surrendering Victorian energy efficiency certificates (**VEECs**). A penalty will be imposed on entities that fail to surrender sufficient VEECs to meet their liability.

Each VEEC represents one tonne of carbon dioxide equivalent (**CO_2-e**) that has been abated by a 'prescribed activity', which are defined in six categories as:

- *Water heating* - Decommissioning of low efficiency water heating products and the installation of high efficiency water heating products. This category includes the installation of solar pre-heaters or solar retrofit kits.
- *Space heating* - Decommissioning of low efficiency ducted heating products and the installation of high efficiency ducted heating products and high efficiency space heating products.
- *Space conditioning* - Installation of insulation, thermally efficient windows and weather sealing products.
- *Lighting* – Installation of low energy lamps.
- *Shower rose* - Decommissioning of non-low flow shower rose and the installation of low flow shower rose.
- *Refrigerators/freezers* – Purchase of high efficiency refrigerator or freezer (refrigerator purchase) and destruction of pre-1996 refrigerator or freezer (refrigerator destruction).

Under the VEET scheme, 'accredited persons' are eligible to create VEECs for prescribed activities undertaken at residential premises. An accredited person is an individual or organisation accredited by the Victorian Essential Services Commission (**ESC**). Accredited persons may be subject to periodic audits by the ESC to ensure, among other things, that the prescribed activities are being undertaken in accordance with the requirements of the VEET scheme.

In the first three years of the scheme, retailers are required to deliver up VEECs totalling 2.7 million tonnes of CO_2-e per year. Around 180,000 households are likely to take part in the program each year.

The Victorian Government has announced that from 2011, VEET will be expanded to 5.4 million tonnes of CO_2-e/year and will be extended to energy efficiency measures in small and medium sized businesses.

A similar state-wide energy efficiency target and trading scheme has also been established in New South Wales as part of that State's 'Energy Efficiency Strategy'. However, the NSW Energy Saving Scheme applies to commercial as well as residential properties. The obligation on retailers to surrender energy efficiency certificates starts with a modest energy efficiency target of 0.4% of electricity sales but ramps up to 4% in 2014.

Such schemes have the benefit of guaranteeing energy efficiency improvements, given that the energy efficiency targets are reflected in legislation. However, there has not yet been time to evaluate their operation in Australia and it remains to be seen whether a similar scheme will be introduced at a national level.

(b) Government grants, loans and rebates

There is a range of measures through which federal and state governments are providing or have provided financial support to home-owners and businesses to assist them in becoming more energy efficient. A representative sample of these types of measures are set out below:

- *Green Building Fund* (Federal fund offering $90m over 5 years. This fund has since expired. However the government has recently pledged to top up the fund by $30 million as a transitional measure prior to the introduction of a 50% tax break for investments in energy saving measures for commercial buildings) - This fund supported action to reduce greenhouse gas emissions by reducing the energy consumed in the operation of existing commercial office buildings. Grants were available from this fund for:
  - Owners of existing commercial office buildings to reduce energy consumption by retro-fitting and retro-commissioning these buildings.
  - Relevant industry associations to develop the knowledge, skills or capability of those involved in the operation of commercial office buildings, to improve energy efficiency and reduce emissions.
- *Australian Carbon Trust* (Federal fund, $50 million allocated) - The Australian Carbon Trust has been established to promote energy efficiency in the business sector. The Carbon Trust will cover the up-front capital costs of energy efficiency investments through seed funding and businesses will repay the Carbon Trust from the savings they make.
- *Tax breaks for Green Buildings* - The federal government has announced as an election policy that, from 1 July 2011, businesses will be able to claim a bonus tax deduction of 50% of the cost of capital works to improve energy efficiency of existing buildings. To be eligible for the tax break, the retrofit will need to be assessed by an accredited NABERS assessor before and after the project.

(c) Commercial arrangements that include energy efficiency obligations

Increasingly, commercial arrangements that relate to the design, construction and operation of commercial buildings include energy efficiency obligations. While the cost of constructing or refurbishing a green building may be higher than for a conventional building, ongoing operating costs will be lower. Studies have also suggested that green buildings outperform conventional buildings in terms of occupancy, sale price and rental rates.

Two main types of commercial arrangements have emerged in Australia that require energy efficiency action to be taken – specifically, green leases and energy performance contracts.

Green leases

A ‘green lease’ is a lease between a landlord and tenant of a commercial building which contains mutual obligations for tenants and owners to minimise environmental impact caused by energy and water use and waste.

The uptake of green leases may be limited by the potential for so-called ‘split incentives’ – that is, a situation where the landlord invests capital to ‘green’ the building without a means of generating a return on the investment because the savings accrue directly to the tenant. For example, a landlord may invest in energy efficient lighting. However, the tenant accrues the benefit of this action through energy cost savings.

The lease will need to address how the costs and benefits associated with greening a building will be allocated as between the tenant and the building owner to address the problem of split incentives.

Energy performance contracts

Energy Performance Contracting (**EPC**) has emerged to overcome some barriers to delivering cost-effective energy and water efficiency, including the problem of 'split incentives' referred to above in the context of green leases. EPC is effectively a form of outsourcing for energy efficiency and energy consumption management.

EPC will involve the engagement of an energy service company (**ESCO**), who will normally undertake the following activities for a building owner:

- identify and evaluate energy saving opportunities
- develop engineering designs and specifications
- manage the project
- arrange for financing, if required
- train staff and provide ongoing maintenance services
- guarantee that savings will cover all project costs

ESCOs are usually paid a management fee out of any savings made from the energy efficiency actions they recommend – if no savings are made, there is no payment. Therefore, if the project does not yield the promised energy or cost savings, the ESCO will be out of pocket rather than the building owner.

Standard form EPC contracts are being developed. There is likely to be an increase in energy performance contracting as the benefits become more widely understood and financing packages are established.

Social marketing and information tools

Social marketing and information tools have the potential to play a powerful role in motivating individuals and businesses to invest in energy efficiency, particularly in cases where regulation does not apply and/or financial and commercial incentives are not available.

(a) Environmental rating systems for buildings

There are several rating systems in place that help to determine the level of 'environmental friendliness' of a building. The two principal systems are:

- *National Australian Built Environmental Rating System* (**NABERS**). NABERS is a rating system for existing buildings. It rates commercial and residential buildings on the basis of their measured operational impacts on the environment, including the energy usage of such buildings.
- *Green Star* is an environmental rating scheme administered by the Green Building Council of Australia (**GBCA**), which is a national non-profit organisation. Green Star is predominantly concerned with new developments. A Green Star Rating cannot be publicly claimed unless GBCA has certified the rating at 4 stars or more.

Rating tools empowers those purchasing or leasing a building to integrate energy efficiency into their decision-making – that is, to know which buildings will be more or less exposed to a carbon price if and when one is imposed under a carbon tax or emissions trading scheme.

(b) Green jobs and skills training

The federal government recently outlined a plan to 'green' the workforce through a $94 million job creation and training program to create 50,000 new green jobs, traineeships and apprenticeships aimed at developing new skills that will be relevant in a low carbon environment.

This program will complement state-based green training programs, such as Queensland's $1.4 million Green Building Skills Fund, which is aimed at up-skilling 3,500 industry participants with green building skills.

These programs will help to address lack of professional and contractor expertise regarding energy efficient design and construction.

(c) Public education

Effective education and social marketing campaigns have the potential to produce significant results, including increasing social awareness and clearly demonstrating the ways in which individuals and business can contribute to the sustainability agenda through energy efficiency.

There are a variety of ways in which governments are attempting to increase the public's awareness of options to enhance sustainability, including through energy efficiency.

One example is the federal government's 'Living Greener' website, which provides a starting point for obtaining information about living more sustainably and reducing environmental impact. It also includes information on government programs and financial support. The website provides links to federal government websites and, in the future, will also link to relevant state, territory and local government websites.

Another example is a media campaign in Victoria to reduce residential energy consumption. The state government used the image of a 'black balloon' to represent society's greenhouse gas emissions, which proved highly effective. Among other results, the campaign resulted in a significant increase in the number of Victorians opting to purchase GreenPower energy generated from renewable sources.

Barriers to uptake of energy efficiency

Despite the diversity of energy efficiency measures and options that are available, and notwithstanding the attractiveness of energy efficiency as a relatively cheap and effective way to reduce Australia's greenhouse gas emissions, so far, the uptake of voluntary energy efficiency measures has not been as encouraging as the benefits would suggest. There are a number of possible explanations for this.

– *Information barriers* - While there is an abundance of public information available about the various energy efficiency options, individuals and businesses may suffer from an information overload, particularly given that, currently, there is a plethora of energy efficiency options and there is no single source of comprehensive information on those options. Consolidation, integration and harmonisation of the various legislative schemes will help to address this problem.

– *Complexity and costs of assessing options* - It may be difficult to identify and assess the relative merits of the various energy efficiency options, including the payback period and the appropriateness of a particular technology in a building, especially if the technology is relatively new or has not been widely used.

– *Capital constraint* - Investments in energy efficiency measures require up-front capital or financing while the benefits of lower energy may take some time to accrue, which may deter investment.

– *Absence of a carbon price* - Carbon has not been priced in Australia to date, which means that it has not been possible to fully quantify the benefits associated with reducing energy consumption and, therefore, the volume of carbon in the atmosphere. The introduction of an emissions trading scheme will help to address this problem. In addition, the roll-out of smart meters in Australia will allow energy users to more easily make decisions about timing and quantum of consumption.

– *Market barriers* - Market barriers include non-market electricity pricing, split incentives, lack of scale and long decision cycles. Some businesses have little incentive to reduce their energy use as they have fixed fee or very low energy charges. Split incentives arise when the building owner makes the building equipment decisions while tenants get the energy savings. Lack of scale increases transaction costs and long decision cycles mean that equipment is not replaced in the short to medium term.

– *Habit* - Some businesses argue that, while they can see the merits of energy efficiency, initiatives to increase energy efficiency are not necessarily part of their core operations. In a time when capital is constrained, they will typically make strategic decisions favouring their core business, even if energy efficiency offers a higher rate of return. This problem is exacerbated by the fact that returns on energy efficiency investments may be relatively small by comparison with the total revenue and costs of the business.

Kingston Education Program.

Mitigation through other measures

There are measures other than those related to energy efficiency that can be used to assist in reducing emissions from buildings and which may, consequentially, assist in adapting to the effects of climate change, including:

- *Green roofs* - Also known as rooftop gardens or eco-roofs, green roofs are planted over existing roof structures. They consist of a waterproof, root-safe membrane that is covered by a drainage system and growing medium for plants. Green roofs reduce rooftop and building temperatures, filter pollution, and reduce the heat island effect.
- *Green power* - Buildings could consider shifting to using renewable energy rather than energy generated from fossil fuels, which will reduce emissions.
- *Distributed energy* - Distributed energy is the decentralised generation and use of energy. The objective is to use the electricity as close as possible to the site of its production, which reduces energy lost in transmission. Local electricity generation, which typically uses natural gas, is less carbon intensive than grid-based generation that is largely sourced from coal. Local co and tri-generation plants can provide heating and cooling as well as power.
- *Reducing reliance on energy-intensive construction materials* - Selection of construction materials that are relatively less energy-intensive can reduce the overall carbon footprint associated with a building.

The benefits of green roofs

Sustainability is a key driver for the new Kingston Education Program in Tasmania. The master plan designed by HASSELL, in association with JAWS Architects (Hobart), integrates the buildings into the landscape and environment with sustainable materials, green roofs, wetlands, vegetable and native gardens. The 8,600m^2 area is to accommodate 750 year 7-10 students.

The client's aspiration was a campus designed to achieve the highest levels of sustainable design possible for a school in Australia. The target is to achieve a 5 star Green Star design rating and includes heat pump driven hydronic floor heating, passive solar design, heat recovery systems, grey water recycling, and environmentally sensitive material selections. However, of the various sustainable design initiatives, the incorporation of extensive green roofs to two of the six learning 'pods', has become the signature of the school's green credentials, largely due to their visibility.

The green roofs provide multiple tangible benefits to the overall facility. They assist in the site's stormwater detention strategy, reducing roof water catchment volumes by around 20 percent and easing release of water during peak storm events. They also provide at-source water treatment by capturing airborne pollutants and improving the quality of water released from the site. As part of the overall site water strategy, the buildings' grey water and roof water is collected for passive treatment, using planted sand filters and is then stored for irrigating the green roofs and gardens and for toilet flushing.

Other notable benefits of the green roofs are improved thermal and acoustic insulation of the buildings and, as a result, reduced energy consumption and CO_2. As each building will be separately monitored, a comparison of energy consumption and indoor environmental conditions between identical buildings with green roofs and those with traditional metal deck roofs can be undertaken.

Kingston Education Program.

Sustainable building materials and design

The new Turruwul Park kiosk and change rooms provide the Rosebery community, a south Sydney suburb, with new facilities for their sporting and leisure activities. The project undertaken by HASSELL combines sustainable materials with renewable energy technology to create a facility with minimal energy and maintenance requirements and a low carbon footprint.

A key feature of this project is the façade constructed from timber obtained from sustainably managed forests certified by the international Forestry Stewardship Council. A woven rhythm of blackbutt battens forms the screen. The zigzag cut, which creates an intricate pattern, was designed carefully to enable each two adjacent battens to be cut from one piece of timber, minimising waste. A simple change to a cutting schedule enhanced the mottled and textured character of the timber, conveying a sense of craft.

The client supported many ecologically sustainable initiatives including the use of photovoltaic cells, solar hot water heating, natural ventilation and lighting, rainwater reuse and the use of sustainable materials. The project uses bore water to irrigate all soft landscape areas. Run-off water from the paths and tennis courts is treated via grass swales before being released into the stormwater system.

Conclusions

Currently in Australia, there are a diverse range of measures that are targeted at achieving energy efficiency for buildings. The measures are a mix of regulatory and non-regulatory responses, which target buildings directly, products and appliances embedded within buildings, as well as the operations and activities that are undertaken within buildings.

Over time, as efforts to increase energy efficiency continue to grow, it will be necessary to assess the merits of retaining all of these measures and whether the mix of measures achieves the best energy efficiency outcome. Criteria that should be used to undertake this assessment include:

- effectiveness in driving emissions reductions
- economy to society and stakeholders
- equity between stakeholders
- administrative feasibility and workability
- consumer needs and preferences
- cost and who pays
- risk of perverse incentives

Ideally, energy efficiency measures should be streamlined and harmonised and unnecessary duplication should be eradicated. The measures should be targeted at areas where efficiency gains are likely to be greatest. Furthermore, it should be possible to track and quantify these gains, particularly in the context of mandatory regulatory requirements that require enforcement. Measures that incrementally achieve energy efficiency improvements should not be forgotten at the expense of larger, transformational changes. In addition, consideration should be given to focusing building improvements on achieving more than just energy efficiency, such as water efficiency and broader sustainability outcomes.

Other mitigation measures should be used to supplement the contribution made by energy efficiency initiatives – such as green roofs and distributed generation. Additional incentives and changes to applicable regulatory frameworks may be needed to motivate further investment in these types of measures.

Impact of climate change on building sector participants

Climate change can be viewed as a negative phenomenon, which only leads to additional costs and regulatory burden. However, climate change also presents numerous opportunities and benefits including for building sector participants.

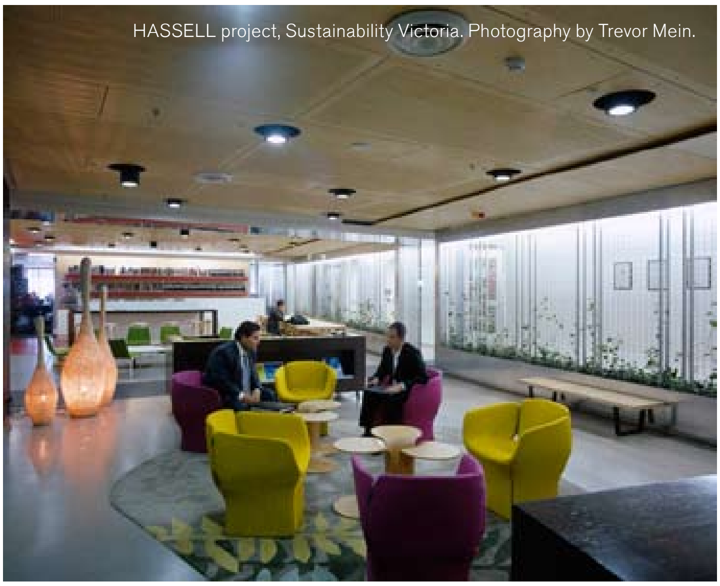
The objective and primary benefit associated with climate change adaptation is to protect buildings from the effects of climate change whereas the principal benefit associated with building mitigation is to reduce energy demand, emissions and costs. In addition, there are a range of ancillary benefits that have been linked to adaptation and mitigation measures in both residential and commercial buildings:

- Residential buildings
  - increased comfort
  - healthier environment
  - increased amenity
- Commercial buildings
  - avoiding or reducing liability
  - increased productivity and lower employee turnover
  - enhancing reputation by meeting community expectations
  - increasing value and access to capital

The benefits of sustainable building design

A productivity study undertaken when Sustainability Victoria moved into their new workplace in Melbourne illustrated the benefits of a sustainable workplace. It demonstrated a fall in sick leave of 30% per employee, a productivity increase of 13%, and, generally, a rise in staff comfort.

Importantly, 96% of respondents to the survey indicated that the workplace represents the values of Sustainability Victoria. Through initiatives such as zoned and addressable lighting, an energy reduction scheme, improved ventilation rates, indoor planting, increased day lighting and views, Sustainability Victoria demonstrated to staff and stakeholders alike the commitment they had to addressing the impacts of climate change.


HASSELL project, Sustainability Victoria. Photography by Trevor Mein.

A new benchmark for sustainable building

The ANZ Centre in Melbourne's Docklands, designed by HASSELL and Lend Lease design, provides leadership in sustainability and embraces the culture and values of ANZ while reducing the development's environmental footprint.

It is the largest single-tenanted commercial office building in Australia; a world leader along with internationally recognised sustainable benchmark projects such as ING, Amsterdam; RBS, Edinburgh; and Bank of America, New York.

The design evolved around the idea of an 'urban campus', focused on a central 'common', with a hierarchy of shared spaces, an openness fostering interaction, and a rich variety of settings providing scale and complexity; an interactive, flexible and connected workplace.

The project incorporates significant carbon reduction innovations. Recently awarded a 6 Star Green Star - Office Design v2 rating from the Green Building Council of Australia, ANZ Centre is designed to achieve further outcomes in Australia with the Green Star – As-Built and Office Interiors; NABERS, and VicUrban environmental ratings.

Indoor environment quality, greenhouse gas emissions and water management were identified early in the design process as fundamental to achieving ANZ's corporate and social outcomes. The indoor environment relies upon three key related components; the incorporation of an Underfloor Air Distribution (UFAD) system to maximise the quality and quantity of fresh air available to occupants, extensive zoning of the mechanical ventilation system and maximised thermal performance of the facade through double glazing and extensive external shading.

Floor-to-ceiling glazing and central atriums ensure consistent daylight access and strong visual connections to the external environment. Manual internal blinds and external fixed shading are provided to manage glare, while the atrium has automated internal shading devices to control direct sunlight.

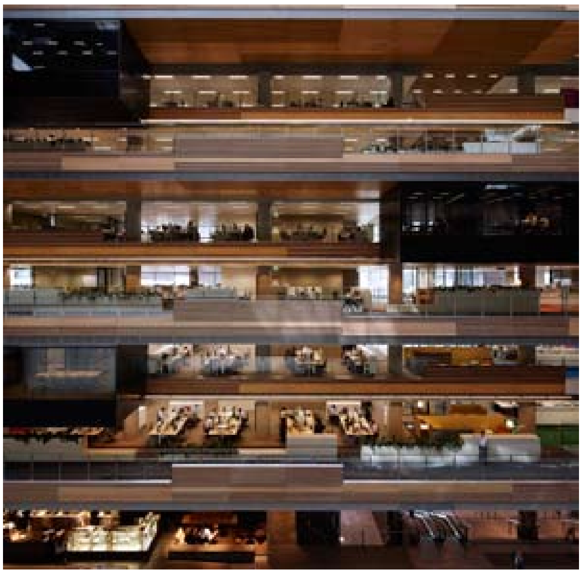
Passive carbon reduction strategies include a significant north-south orientation of the building with major facades shaded effectively; and extensive shading on east and west facades.

Active systems for heating and cooling incorporate three key components: UFAD, tri-generation and river cooling. The UFAD system delivers approximately 100% fresh air to the office space. Waste heat generated by the tri-generation system supplements the heating, while additional heating is provided via energy-efficient natural gas-fired boilers. Heat from the condenser water loop is rejected to the Yarra River, reducing water and energy consumption.

Cooling is provided by waste heat from the tri-generation system, converted into cooling via an absorption chiller, and occasionally supplemented by energy efficient chillers.

On-site energy generation for the building is provided via three systems. Tri-generation provides electricity, heating and cooling and comprises four natural gas-fired reciprocating engines representing approximately 36% of base building peak electricity demand. A 135kW, 1,365sqm rooftop photovoltaic array will generate approximately 150,000kWh of electricity and six Quiet Revolution QR5 vertical axis wind turbines will generate approximately 51,000kWh per annum.

Rainwater collection and recycled fire system test water is reused for irrigation. A Membrane Bioreactor blackwater treatment system collects and treats all wastewater to Class A standard.

ANZ Centre. Photography by Peter Bennetts.

Notably, climate change will have an impact on all building sector participants, with most participants facing advantages as well as disadvantages as a result of the new environment:

- *Investors and developers* - Investors and developers will need to carefully assess sites for prospective developments to determine whether and, if so, the extent to which those sites are likely to be vulnerable to the effects of climate change. Developers will need to ensure that their buildings comply with the relevant mandatory building requirements, including those aimed at adapting and mitigating climate change effects. Developers are likely to face increased costs for energy-intensive building products, material and transport if and when an emissions trading scheme is introduced in Australia.
- *Owners* - Owners will typically bear the costs of adaptation and mitigation for their buildings. They will need to ensure that their buildings comply with the relevant mandatory building requirements. They face the risk of their buildings being damaged by the effects of climate change and, therefore, may choose to introduce measures beyond those that are mandatory to minimise this risk. They could face litigation claims from occupiers and users of their buildings if the steps taken to address climate change hazards are not commensurate with the risk. Furthermore, owners could face increased pressure from insurers to proof their buildings against the effects of climate change.
- *Occupiers* - Occupiers will need to manage cost and risk exposure under green leases that they may have entered into with their landlords. Occupiers will need to ensure that the appliances and equipment they install in buildings meet the relevant energy efficiency requirements. They may also need to take short-term steps to minimise damage to buildings and their occupants in the face of climate change risks that have actually materialized – particularly, flooding, bushfires and extreme climatic events.
- *Purchasers* - Purchasers should properly assess the climate change risks associated with a building they are contemplating purchasing. They should also bear in mind the current and possible future regulatory environment, which may enhance the value of the building or imply current or future costs.
- *Vendors* - Vendors that have invested in adaptation and mitigation measures for their buildings are likely to be rewarded with higher prices compared with buildings that merely comply with minimum mandatory standards.

For further information about the issues raised in this paper, please contact a member of the Maddocks Sustainability & Climate Change team.

Preparedness for and responsiveness to the effects of climate change will be critical for the value and viability of buildings in the future.

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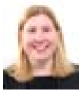
This paper was prepared by Dariel DeSousa with assistance from John Thwaites, Bronwyn Weir, Andrew Chapman and Jake Dabscheck. All case studies were provided by HASSELL.



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