FutureMap
MELBOURNE 2030

CLIMATE CHANGE TASKFORCE

an initiative of the Committee for Melbourne

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FUTUREMAP
CHAIRMEN'S FOREWORD

Mr. George Pappas
Chairman
Committee for Melbourne

The fundamental approach the Committee for Melbourne has taken to dealing with climate change is to say that Melburnians should be proactive in the way that we adapt and in the policies that we take in respect of mitigation.

It's very easy to say that there is doom and gloom on the horizon, that there will be higher costs attached to any action, and so we should delay our response as long as possible.

On the other hand, if we are not proactive, if we don't use the vast innovative and technological resources that our community has, we will be adversely affected by climate change and we have an opportunity to establish leadership positions in many new technological areas and in mitigating and adapting to climate change.

The Committee's Taskforces are our main tool for enhancing our city's livability and prosperity. We convened our Climate Change Taskforce because our Members wanted to identify the impacts of climate change on the community in which they live and work, and discover how they could respond to the unique prospects facing Melbourne as a result of climate change.

FutureMap is unique in that it details the impacts of climate change specifically for Melbourne. It also breaks new ground by identifying opportunities for policy and action to positively impact the future of Melbourne across economic, social and environmental platforms. To leverage these opportunities will require resources – people, technology and intellectual capital – that Melbourne has in abundance.

The sum of the Climate Change Taskforce's work – this *FutureMap* – will go further than simply answering this request. It will galvanise us, as Members of the Committee and citizens of Melbourne, to advocate for the changes and take the actions that are required for Melbourne to seize and deliver on the opportunities that are presented by climate change.

The Committee, via its secretariat, will now take on the role of coordinating delivery of the outcomes imbedded in this *FutureMap*. What we are aiming for is a city that has adapted to climate change and positioned itself as a leader in mitigating the effects of climate change. We will measure outcomes and report back to our Members on our progress, on a regular basis.

Climate change is the most pressing issue facing us. As a Committee, as businesses and as individuals, we need to strive for sustainability together and catalyse a greater response to this challenge. This is an exercise in leadership and it is an exercise we have to get right.

Climate change is a complex area and therefore this document is the result of countless hours of work. I would like to personally thank the organisations and individuals, too many to list here, who generously contributed their time and expertise in its making. In particular I'd like to thank several members which supported this Taskforce by seconding staff. They were GHD, AT Kearney and KPMG. We are fortunate to have had Dr Philip Moors and Mr Tony Wood leading our Climate Change Taskforce. I thank them for their leadership. I also acknowledge the Committee's secretariat staff for their assistance in this process, and congratulate the entire Taskforce on the results of their efforts.

Dr. Philip Moors
Co-Chair of the
Climate Change Taskforce
Director & Chief Executive Officer
Royal Botanic Gardens, Melbourne

A large part of the Climate Change Taskforce's work over the past 12 months has been assessing the impacts and implications of climate change for Melbourne. The result of this assessment, in short, is that climate change is a serious issue requiring Melbourne to plan for reserves, redundancy and resilience.

Through our close working relationship with the Victorian Government and its statutory bodies, and with our local universities and the CSIRO, we have sourced a large amount of solid – and I must say sobering – data. This data provide an accurate summary of the impacts already observed on Melbourne's climate, as well as those forecast to occur over the next two decades.

The consensus from global scientific research is that these climate change impacts for 2030 are 'locked in' because of the increased concentrations of carbon dioxide already present in the atmosphere.

In order to react positively to our current situation and to the forecasts for 2030, we have to adapt and to mitigate. Mitigation actions have to be taken today, but they can only reduce the impacts of climate change beyond 2030. The impacts of climate change already observed are large enough to threaten the economic, social and environmental resources upon which our community relies. Therefore, it is absolutely essential that we start to adapt to climate changes right now, and to build resilience into our city, our infrastructure, our industries and our lifestyle.

We need to utilise and leverage Victoria's innate capabilities to build our adaptive capacities and to mitigate climate change impacts. Crucially, the Melbourne that we leave for our children and for our grandchildren will be determined by the actions that we take now and in the next few years.

Mr. Tony Wood
Co-Chair of the Climate Change Taskforce
Adviser to the Ross Garnaut Climate Change Review
Director, Victoria & Tasmania Origin Energy

The Committee for Melbourne is uniquely placed to play an important role in moving Melbourne towards climate change adaptation and mitigation through advocacy, policy intervention, education, and action.

Our role involves advocating for clear policy intervention in light of the enormous challenge which climate change represents. However, we also recognise that all sectors of the community must contribute. This means individuals, organisations and governments must identify and commit to actions of both adaptation and mitigation.

Our response must be focused, not all-encompassing. The six opportunity areas identified within the *FutureMap* are those within the Committee's realm of expertise and sphere of influence, where we have the capacity to make a difference.

Inevitably, as we benefit from this tight focus, the breadth of the issue that is climate change means that we did run the risk of missing issues that don't neatly fit the mould. Therefore, we have also identified overarching actions that are required to underpin an effective adaptation and mitigation response by Melbourne.

In each area of opportunity, we have considered the issue in the context of why it is important, what actions we can take as members of the Melbourne community, and what policy positions we need to advocate.

If we are successful, then we will deliver outcomes that will ensure Melbourne is on the path to be a truly sustainable city in the face of the greatest market failure the world has seen.

We must help business and the community deal with potential adverse effects of climate change, including the effects on low-income households, and take advantage of the opportunities resulting from the introduction of a price on carbon.

Moving to a low-carbon economy creates extraordinary opportunities for Melbourne's businesses and the wider community. By taking proactive and innovative action, we will become more competitive in a global market by encouraging investment, developing new technologies and positioning Melbourne as a city of excellence in a low-carbon economy.

Mr. George Pappas
Chairman, Committee for Melbourne

Dr. Philip Moors
Co-Chair, Climate Change Taskforce

Mr. Tony Wood
Co-Chair, Climate Change Taskforce

EXECUTIVE SUMMARY

Confronting a global shift in climatic conditions, Melbourne faces impacts of profound proportions. Predicted changes in temperature, rainfall, sea level and the number and severity of extreme weather events, will resonate across the lives of Melburnians. Indeed, evidence indicates that the changes are already affecting us.

In August 2007, the Committee for Melbourne formed a Climate Change Taskforce. Our Taskforces engage our Members who come from business, academia, community and government. They also leverage our Members' expertise and passion for Melbourne to produce outcomes. These outcomes are in most cases, advocacy positions and tangible actions.

The Climate Change Taskforce was established to consider the impacts of human induced climate change on our city, and examine what can be done to mitigate and adapt to these impacts. It also considered what specific opportunities this might present for Melbourne. For the past 12 months, 80 of our Members – our largest ever Taskforce – have collectively volunteered thousands of hours to bring clarity to the issue of climate change for Melbourne.

FutureMap details the impacts and opportunities identified by the Committee's Climate Change Taskforce.

Melbourne's climate in 2030

By 2030, we can expect warmer conditions throughout the year, more hot days and fewer frosts. Drier conditions will prevail with less rain, fewer rainy days and hail storms. However more intense rainfall events are predicted. Indeed, frequency of extreme weather events in general is expected to increase with more storms, floods and drought years. There will also be higher sea levels.

Although science suggests that our actions before today have already dictated the climate change expected by 2030, actions taken as soon as possible will help curb the negative effects felt by our children, grandchildren and the generations beyond. Therefore, this *FutureMap* focuses on the timeframe to 2030.

Impacts of climate change

The key impacts of climate change considered by the Taskforce included the likely effects on our climate, including reductions in runoff and increased stormwater at periods of intense rainfall, and the implications for infrastructure. Coastal and riparian zones will be threatened by inundations from higher sea levels, tidal and storm surges. Alpine regions are likely to suffer reduced snowfall and increased bushfires. Tourism and leisure, and our natural resources, including biodiversity will be impacted.

The future health of Melburnians is also discussed. Changes in climate may mean more skin cancers, and increased injuries and mortality from associated storms and heat stress. There may be an increase in the distribution and abundance of disease transmitting insects, but there will potentially be a reduced incidence of respiratory viruses.

Trends suggest that climate change will lead to significant industrial restructuring, so labour requirements and training will need to be considered.

Key issues for the building sector include: consideration of the urban heat island effect; managing water and energy demand, and waste disposal; the need to create or retrofit buildings for energy efficiency; and consideration of embodied energy in construction materials.

There are also significant implications for transport and industry, with community expectations providing added pressure for energy efficiency and responsible action.

The impacts of climate change are drawn from modelling, predictions and extrapolation, but the opportunities it presents are current, concrete and tangible. The challenge for Melbourne is to take existing and nascent technologies, and develop capabilities of international status to address climate change issues.

Barriers to change

The investigations undertaken by the Climate Change Taskforce, however, have found a lack of cohesive policy across the issues, and strategies sometimes at odds across sectors. The Taskforce also reports institutional barriers to curbing carbon emissions, such as tax incentives and concessions for some vehicle use. There are particular areas of weakness in public knowledge. Likewise, there is a risk that adopting broad brush greenhouse mitigation actions could unfairly penalise lower income earners, especially tenants.

Enabling opportunities

The Taskforce recognises the need for a holistic approach to address the challenges associated with climate change, and to assist Melbourne to take advantage of the opportunities it presents. Key areas were identified where the Taskforce felt Melbourne organisations, including Committee Members could take specific actions or advocate for change. Specific recommendations in key areas are:

BUILDINGS:

- Provide guidance and decision support programs for tenants and building owners, to expedite retrofits of existing buildings
- Advocate for mandatory building standards

LOW EMISSION ENERGY:

- Urge the State Government to work with the Federal Government and business to step up and coordinate funding support for research, development and commercialisation of low-emissions technology
- Advocate for the Federal Government to direct the Essential Services Commission, in conjunction with the Australian Energy Regulator, to review regulatory arrangements that could be creating perverse incentives that constrain development or implementation of low emission/renewable energy technologies
- Coordinate an independent position paper which takes into account previous State Government and other research to assess the practicality for commercial implementation of low emission coal technologies in Victoria
- Introduce a 'Low/Zero Net Emissions Award' to recognise the efforts of companies in implementing best practice carbon management strategies that achieve genuine net emissions reductions

TRANSPORT:

- Set strong national vehicle emissions intensity targets to align our vehicles with the best practice, lower benchmarks of the European Union
- Reform federal tax arrangements to remove perverse incentives that maximise car use and discourage the use of public transport
- Advocate for the State Government to include greenhouse gas performance targets in all tenders for the provision of public transport services
- Increase government investment in transport infrastructure, particularly public transport, to assist in reducing emissions
- Encourage Melbourne organisations, including Committee Members to introduce staff travel behaviour change programs

SOCIAL EQUITY:

- Advocate for the acceleration of public funding availability through capital grants or rebates for low-income home owners to purchase energy efficient products
- Conduct a round table with private rental market investors, superannuation funds, industry associations, real estate agents, body corporates, financiers and NGOs to discuss measures to help low-income private renters adapt to climate change impacts

URBAN RESILIENCE:

- Incorporate vegetative roofs into building standards and promote the creation of 'green' roof credits
- Modify Melbourne metropolitan planning and zoning to include mandatory standards for more green space

BUSINESS PROCUREMENT:

- Create an index of sustainable procurement organisations
- Develop educational curricula and training activities for decision support

OVERARCHING RECOMMENDATIONS:

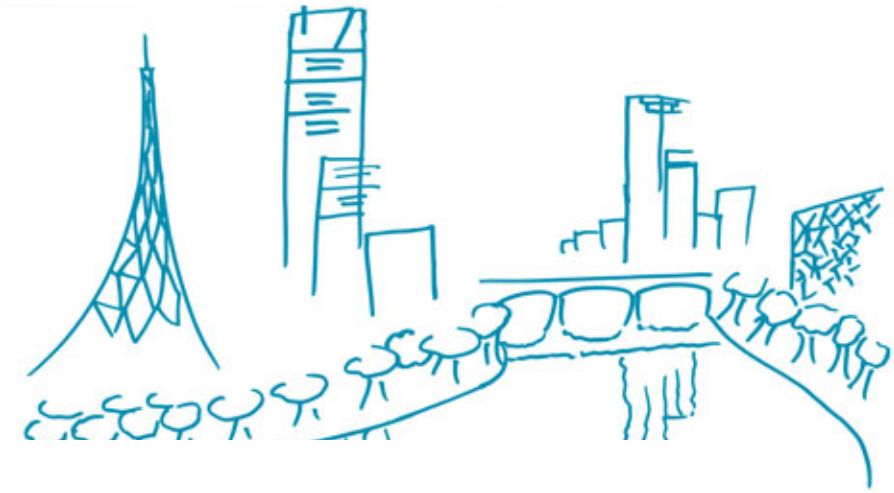
- All new and proposed amendments to Government legislation should require a climate change impacts assessment including measures to accommodate resilience to the effects of climate change
- Advocate substantial amendments to existing planning schemes to include mandatory standards for sustainable retrofit of existing buildings and minimum levels of urban green space as well as 'as-of right' 6-storey/30m height development along high frequency public transport routes, subject to local green space and heritage considerations
- Utilise the Asia Pacific Institute for Sustainable Cities (APISC) to facilitate the co-ordinated uptake of existing funding schemes and business investment across Victoria. The APISC will facilitate the exchange of ideas, information and resources between the public and private sectors and NGOs to encourage reductions in GHG emissions

Role of Members

The Taskforce considers that Committee Members should assume the task of pioneering many of its recommendations. Community leadership is required to commit to and implement the scale of change required. Members are in a strong position to influence policy and behavioural change, and lead the uptake of mitigation and adaptation initiatives.

Concern over climate change and its impacts has already prompted a shift in community attitude, creating behavioural change. Where we live, how we live, how we use water, our modes of transport, heating, cooling and waste disposal are now under scrutiny for energy use and long term impacts. The legislative background will see a national emissions trading scheme by 2010. Federal, state and local governments are now addressing water use efficiency, greenhouse gas abatement and land use with a new focus.

Melbourne is well placed to take advantage of the increased awareness of the impacts of climate change, and use its capabilities and resources to leverage associated opportunities. Working together, Melburnians can reduce these impacts, share their knowledge and expertise, and become international leaders in meeting the challenge of climate change.



1. INTRODUCTION

1.1 Melbourne in Context

Melbourne is a diverse and cosmopolitan city. It is regarded as one of the cultural, culinary, sporting and shopping capitals of Australia, with a multicultural community and a multitude of environments and events to entertain locals and visitors alike. Melbourne is also recognised for the excellence of its educational institutions and its dynamic business community.

The central business district of Melbourne is situated on the banks of the Yarra River and close to the mouth of the river where it meets Port Phillip Bay. The Melbourne region encompasses the geographical area corresponding to the Port Phillip and Westernport Catchment Management Authority (CMA)[3] *(Figure 1)*.

Metropolitan Melbourne's 7694 sq km of suburbs are extensively spread, particularly to the south-east. The suburbs extend more than 40km to the south and are hemmed in by the Dandenong Ranges 30km to the east. They extend up to 20km to the north and across flat basalt plains to the west.

The quality and diversity of Melbourne's natural environments, including its parks and gardens, are one of the Melbourne region's special features. These oases of open space set in a busy urban environment make a significant contribution to Melbourne's reputation as one of the world's most liveable cities.

Melbourne has a strong and diversified economy attracting investment and supporting business growth across a wide range of industries. Melbourne has an annual turnover of approximately $243 billion dollars[5]. The Melbourne region is also home to some of Australia's largest and most successful companies.

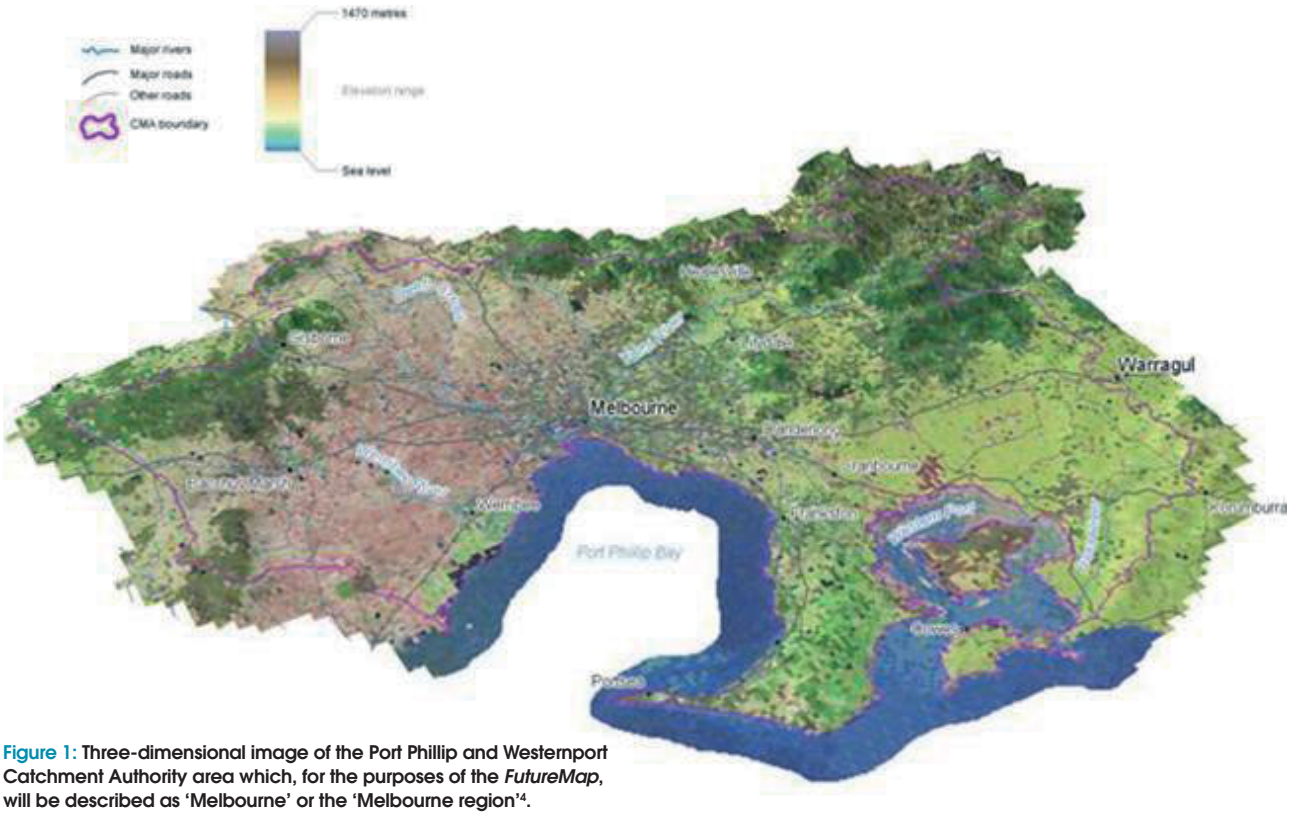


Figure 1: **Three-dimensional image of the Port Phillip and Westernport Catchment Authority area which, for the purposes of the *FutureMap*, will be described as 'Melbourne' or the 'Melbourne region'[4].**

1.2 Melbourne's Climate

Melbourne's climate typically has mild to warm summers with average temperatures between 22 to 24°C near the ocean and in elevated areas, and 25 to 27°C in inner Melbourne and further inland. In winter, average maximum temperatures range between 12 to 14°C. Frosts occur but are rare near the coast and inner-urban areas. Melbourne's average annual rainfall is approximately 900mm, ranging from just less than 600mm to the west to more than 1500mm in the hill country in the east[6].

Within the Melbourne region, temperatures are affected by the urban heat island effect which is seen in most large cities. The effect can be felt most clearly on calm nights *(Figure 2)* when the temperatures in the outer suburbs cool more rapidly than those in the inner city.

1.3 Climate Change Projections

The ambit of this section of our *FutureMap* is based upon the most up-to-date information received as a result of our close working relationship with the Victorian Government and its statutory bodies, our local universities and the CSIRO.

Projected changes to our climate will have major implications for Melbourne's population, water and energy supplies, infrastructure, services, industries and businesses, biodiversity, and human health. Preparing Melbourne for the unavoidable impacts of climate change is imperative. *FutureMap* seeks to inform the population of Melbourne about climate change and the impacts it is predicted to have on the Melbourne region, both now and in the future.

Projections of climate change are made using global climate models but, although they are based on a physical understanding of the climate system and validated using past climate data, they do not all correlate. This introduces some uncertainty as to what the future climate might be. This discrepancy can be large when we focus on localised regions. While projected changes in temperatures have a high degree of likelihood, projections of other variables such as rainfall, or extreme events such as thunderstorms and hail storms are less certain. These differences should be kept in mind when considering the projections described in *FutureMap*.

FutureMap identifies threats and opportunities for the common interests of Melbourne arising from human induced climate change predictions. The threats can be placed in two categories: those that are immediate or proximate, such as rising temperatures and extreme weather events; and those that are underlying or ultimate, such as rising GHG concentrations.

Increased levels of GHGs, such as carbon dioxide and methane, are likely to lead to climate changes and impacts in the years ahead, whatever future mitigation and adaptation measures are put in place. As a result, the timeframe of the impacts and opportunities addressed in this *FutureMap* applies to the period from 2008 to 2030, when the unavoidable impacts will occur. Despite some level of climate change being unavoidable, there is still an urgent need to implement actions aimed at stopping even greater climate change impacts.

In our *FutureMap*, 'mitigation' refers to the implementation of policies that reduce GHG emissions or enhance carbon sinks. Underpinning the actions recommended in this report is the assumption that an ETS will be implemented in Australia in 2010, with accompanying national targets for reducing GHG emissions. Included in mitigation, then, are the actions that are required to make the carbon price more effective and efficient as well as address equity concerns. 'Adaptation' refers to measures to reduce the vulnerability of natural and human systems to the impacts of climate change, be they currently observed impacts, unavoidable future impacts, or the possibly dangerous impacts that will occur if mitigation is unsuccessful or slow.

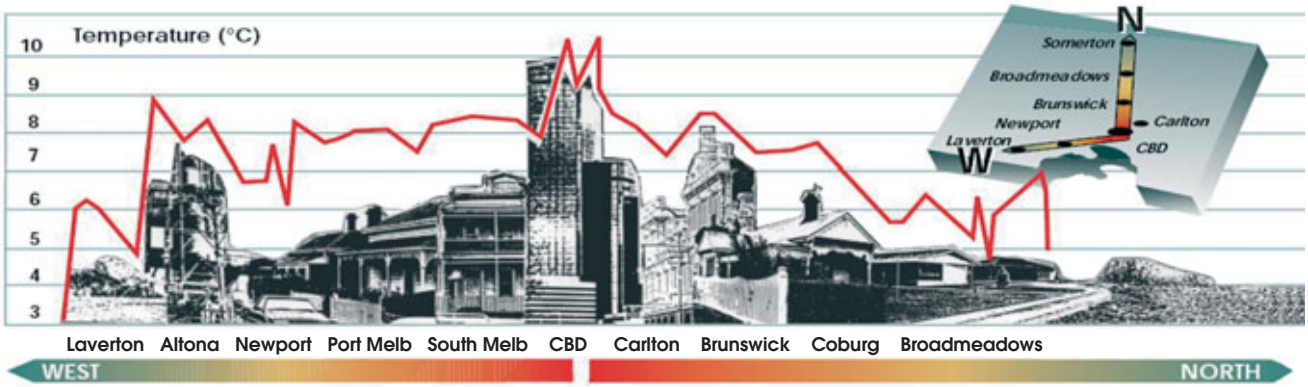


Figure 2: The heat island effect: a snapshot of a winter's night, showing how temperatures vary greatly from central Melbourne to outer suburbs and open land. Source: Australian Bureau of Meteorology[7]

2 HOW HAS MELBOURNE'S CLIMATE CHANGED?

Temperatures and rainfall over the past ten or so years have been unusual. While some of these changes might be due to natural cycles, there is increasing evidence that we are beginning to experience these changes as a result of human induced climate change. We are already experiencing 'a promise of things to come' as the enhanced greenhouse effect has more and more impact. The following section outlines climate changes already experienced in Melbourne.

2.1 Annual Temperature

Average annual mean temperatures in Melbourne have increased since the 1950s *(Figure 3)*. Over the past 50 years, annual maximum temperatures have increased by 0.81°C (0.14°C per decade) and minimum temperatures by 1.79°C (0.32°C per decade). Due to local heat island effects associated with urban development, there is a stronger warming trend in the inner Melbourne area, attributable to urbanisation, something discussed later in the Opportunities section of our *FutureMap*.

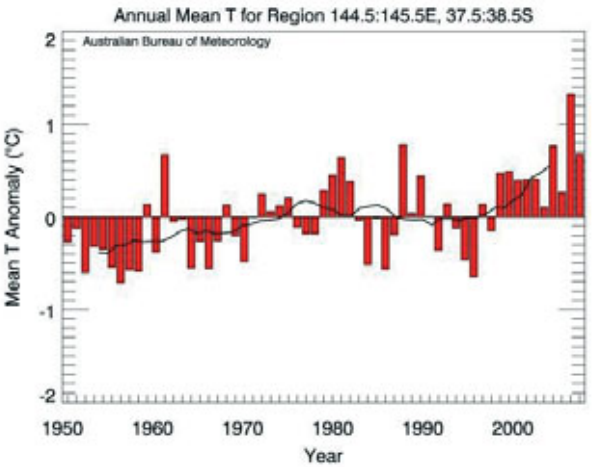


Figure 3: **Trends and fluctuation in mean temperatures for the Melbourne region (1950 to 2007). They represent trends independent of urban heat island effects and reflect both natural climate variability and, most likely, the effect of increasing greenhouse gases. The bars indicate anomalies relative to the 1961/1990 average and the black line is the five-year running mean. Source: Australian Bureau of Meteorology**

2.2 Rainfall

The long term natural variation in average annual rainfall *(Figure 4)* (1950 to 2007) for the Melbourne region shows that the last five years represent, on average, the driest on record.

A special climate statement released by the Bureau of Meteorology late in 2007 noted that Victoria has been one of the states hardest hit by the 11-year (1997/2007) dry. Figure 5 indicates that the most recent three-year period (May 2006 to April 2008) was either very dry or the driest such period in the historical record for much of the state. Most of the decreases occurred in autumn and in winter, while average summer rainfall actually showed a small increase. There have been 15 fewer rainy days each year, on average.

Over the past decade, temperatures and evaporation rates have been higher than average, making current dry conditions even worse[8]. This has led to a significant decrease in inflows into Melbourne's reservoirs over the past 10 years[9] *(Figure 6)*. Average inflows over the period 1997 to 2007 were only 67% of the long-term average inflow (1913 to 1996) – causing the lowest average inflows for nearly 100 years. The reduction in inflows to catchments of more than 30% reflects similar changes detected in south-western Western Australia.

Increases in temperatures have been attributed to the effect of enhanced GHGs in the atmosphere but the causes of the rainfall decrease are less clear. While GHGs are likely to have contributed, the decreases are far greater than predicted. It is likely they represent the combined effects of GHGs superimposed on a naturally occurring decadal-scale dry spell.

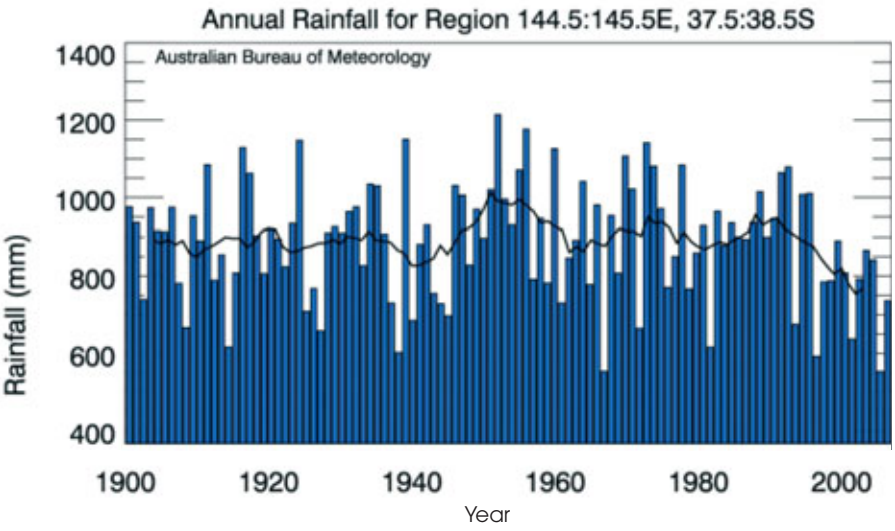


Figure 4: Trends and fluctuations in annual mean rainfall for the Melbourne region (1900 to 2007). The black line is the five-year running mean. Source: Australian Bureau of Meteorology

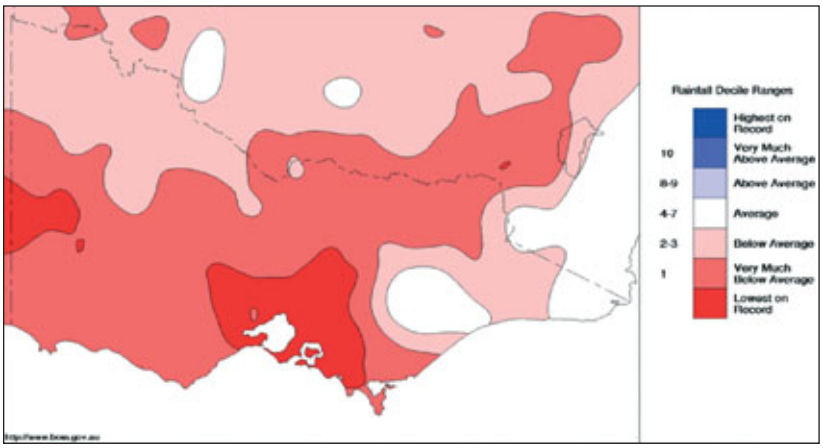


Figure 5: 36 month rainfall deciles (glossary note) for Victoria (May 2005 to April 2008). This shows that much of the state has experienced its lowest rainfall on record for this particular period. Source: Australian Bureau of Meteorology

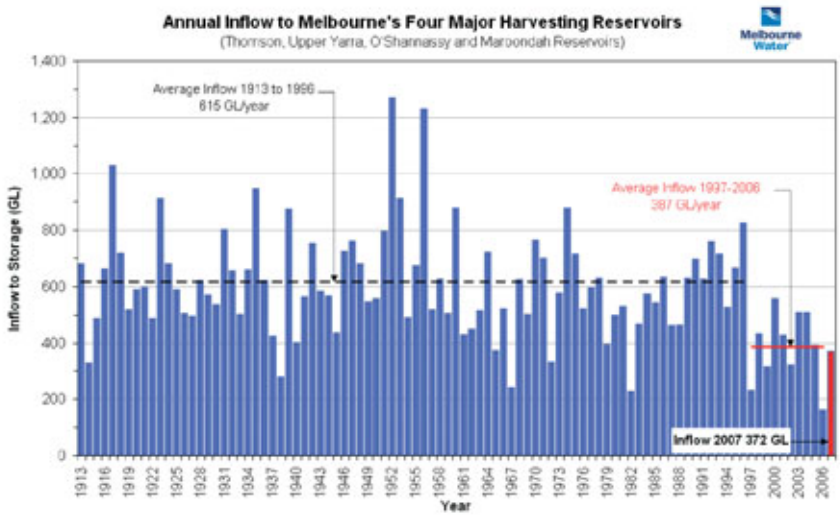
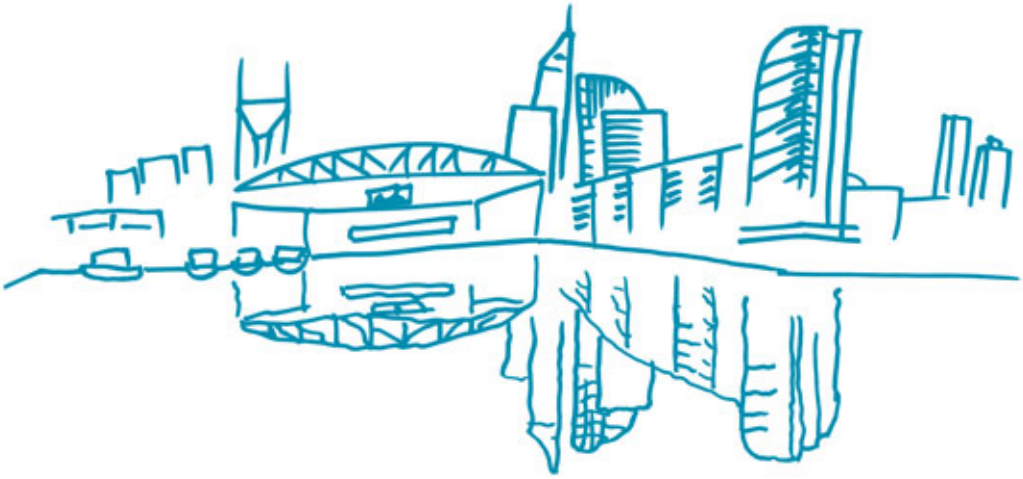


Figure 6: Change in Inflows to Melbourne's Major Water Storages. Source: Melbourne Water



2.3 Rising Sea Level

An increase in average sea level at Williamstown can be seen from historical records *(Figure 7)*. This has occurred mainly as a result of thermal expansion of the ocean's surface layers due to increasing temperatures, combined with additional fresh water from melting land-based ice from polar regions. Predictions for global sea level increases over coming decades are a matter of considerable discussion among scientists as new research is published and accredited[10]. At present, the observed rate of increase is tracking at the higher end of most published predictions and the potential impacts are likely to be greater than suggested in the 2007 Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC 4AR).

2.4 Extreme Events

There is accumulating evidence that extreme events, such as heatwaves, are increasing in frequency. Each year 33 more nights are recorded as being uncomfortably warm compared to mid-century, and 16 more heat-wave days are recorded each year[11]. We have not observed significant changes in heavy rainfall in Melbourne, but south-eastern Australia is observing more "droughts and flooding rains", along with long dry periods, particularly in the crucial autumn break, punctuated by extremely heavy rainfall events[12].

A combination of strong winds, high (spring) tides and high runoff events (flooding) result in storm surges. Within Port Phillip Bay, such surges are most frequently caused by periods of sustained westerly winds when cold fronts travel along the southern Australian coast[13]. For example, two storm events (May and November, 1994) resulted in the sea levels at St Kilda beach peaking at approximately 1.2m and 0.8m above normal levels and causing flooding[14]. Future projections indicate increasing frequency of these events.

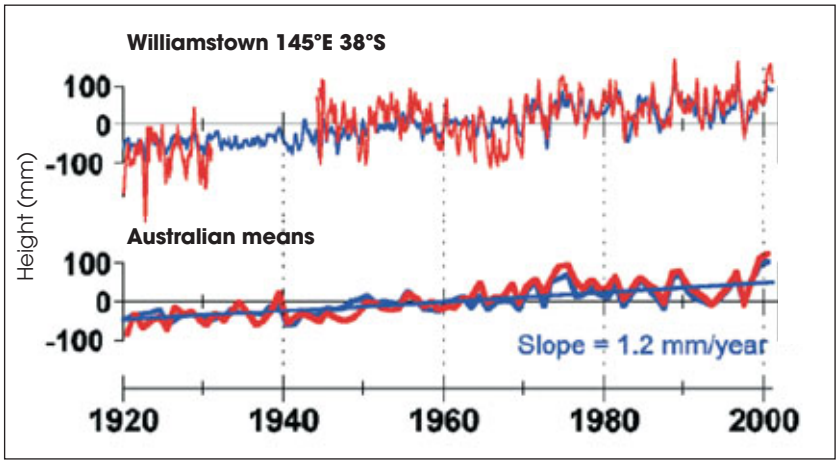


Figure 7: Observed (with coastal tide-gauges) and reconstructed sea level for Williamstown and Australia for the period 1920 to 2000[10]. Source: Hubbert, G. D., and McInnes, K. L. (1999)

In Australia, the heaviest insurance losses are due to storms and their associated flood, wind and hail damage. Annual average damages due to flood alone in the Melbourne region are estimated in the order of $245 million[15]. The frequency and intensity of major storm events over the past decade in Australia is unprecedented. For example, Newcastle experienced weather severe enough, in terms of insured losses, to rank in the top 10 largest natural catastrophes nationally of 2007. Gale force winds and rising flood waters from June 8 to 10 on the New South Wales coast caused the deaths of nine people and the evacuation of 6000. The interruption of the electricity supply to more than 200,000 homes and businesses, the interruption of water and gas supplies, and sewerage system pump failures resulted in substantial public health threats.

However, while heavy rainfall events and flood events might increase over time, there is some evidence that the severity of individual storms and associated hail events might decrease slightly.

The length of the Victorian fire season has increased since 1990 and four of the last five seasons have been among the longest on record *(Figure 8)*[16]. Overall, since 1940 there has been a small upward trend in expected fire season length based on meteorological data from Melbourne Airport[17].

This graph demonstrates the area burned during the season and the date of the start of that season. The area burned is getting larger and the date of the start of the season is getting earlier, translating to a longer season generally. The start date of the season is strongly related to weather conditions observed throughout the preceding winter.

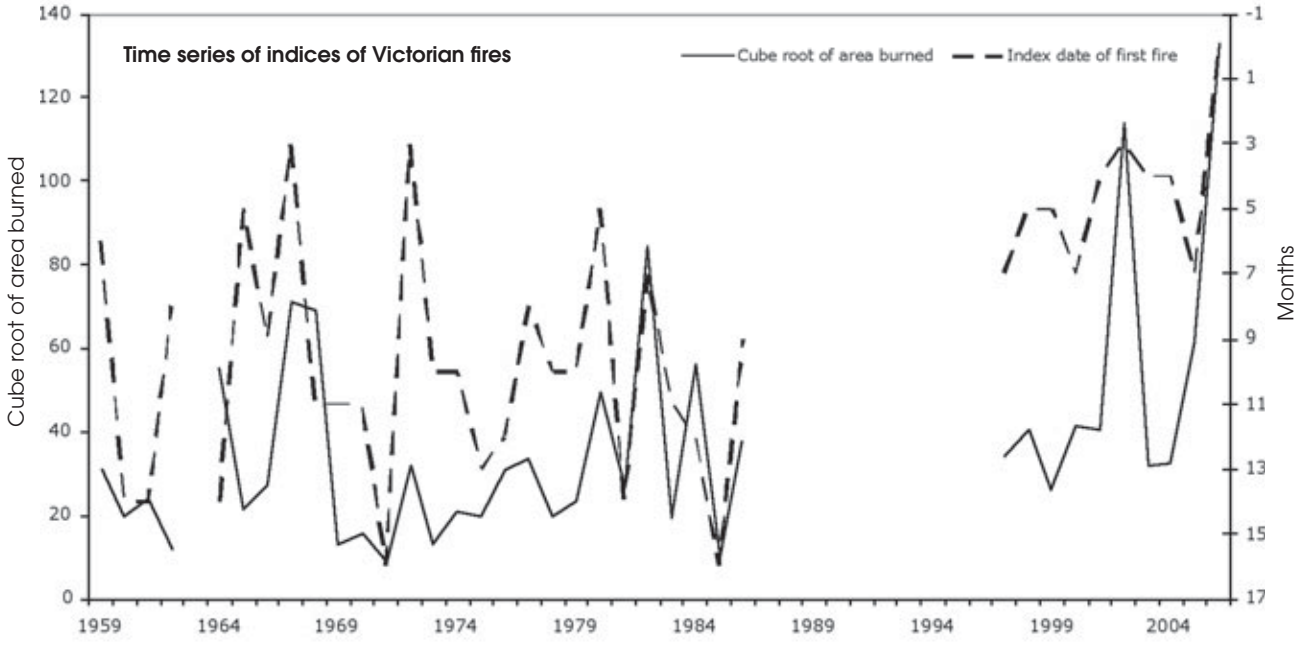


Figure 8: Time series of the cube root of minimum estimate of area burned (full line) and index date of first fire (broken line; scale reversed). The starting calendar year of the fire season is indicated on the horizontal axis (e.g. 1959 indicates fire season 1959/60). The figures associated with the 'Index date of first fire' represent months with 0 = June and 16 = February with tracking demonstrating half-month increments.[18]

3 WHAT WILL MELBOURNE'S CLIMATE BE LIKE IN 2030?

3.1 Melbourne's Climate 2030

Current climate predictions for 2030[19] agree that Melbourne residents and industry can expect:

- Warmer conditions throughout the year
  - By 2030, average annual temperatures are expected to rise by between 0.6 and 1.1°C, with 0.8°C being the most likely average increase. The greatest seasonal increase is expected in summer (0.9°C). By 2070, the average annual temperature is expected to increase by about 1.3°C for a low global emissions scenario or by 2.6°C for a high global emissions scenario
- More hot days
  - Number of days above 35°C is expected to increase from 9 to 11 by 2030
- Fewer frosts
  - Reduction in the number of frost days is expected by 2030[20]
- Less rain
  - Annual average rainfall expected to decrease by about 4% by 2030, with a reduction of about 7% in spring and 4% in winter
- More intense rainfall events
  - Annual average increases in the intensity of heavy rainfall events are expected to be about 0.9% with the strongest increases in winter and summer
- Fewer rainy days
  - Overall decrease of about 6% in the number of rainy days, with the largest decrease in spring
- Drier conditions
  - Increased temperatures are expected to result in an increase in evaporation of about 3%
- Fewer hail storms
- Higher sea levels around the coasts
- Changes to the frequency of extreme weather:
  - Increased frequencies of occurrence of extreme weather events. For example, a 5% increase in rainfall intensity will see the current one-in-130-year event become a one-in-100 year event
  - Droughts are likely to increase in relative frequency, intensity and duration[21]. Dry conditions that currently occur on average one in every four years might occur up to one in three years by 2030[22]

The impacts of these changes in our climate are set out in chapter 4.

Melbourne is a bayside city. The uncertainty of future sea-level rise in the long term, and the strong likelihood of increased storm surge in the near term, present a challenge to our planning and zoning processes. When combined with rising sea levels, storm events could pose a significant inundation risk to low-lying coastal areas.

4 IMPACTS AND IMPLICATIONS FOR MELBURNIANS

4.1 Impacts on Water Resources and Floods

Reduced rainfall, increasing temperatures and evaporation rates will continue to result in decreased runoff and stream flows. Melbourne's river catchments, the Bunyip, Maribyrnong, Werribee and Yarra, are expected to have a decrease in runoff of between 5 and 30% by 2030[23]. Due to the drier nature of catchments and their reduced soil moisture, it is expected that there will be a reduction in runoff during rainfall events leading to a reduction in long-term water yields.

Ironically, Melbourne Water has identified more than 100,000 properties that, at present, are at risk of flooding under the current flood protection standard of a one-in-100-year storm event. More than 40,000 of these properties contain buildings or dwellings that would be at risk of flooding above floor level[24]. However, this modelling is currently incomplete with the number of affected properties likely to be higher once modelling is completed. It is estimated that the average annual cost of flood damage across the Melbourne region is up to $245 million[25]. Additional intangible costs of flooding, such as loss to business and impacts to health and well-being, are not included in this estimate.

The main causes of flooding in the Melbourne region are from rivers and creeks (riverine) and from drains overflowing (overland flow). Around 20,000 properties across the metropolitan area are currently at risk of inundation from riverine flooding[26]. Again, increases in rainfall intensity and frequency of rainfall events, particularly for longer duration storms, are likely to increase the number of properties at risk of inundation.

Flood and tidal inundations provide the main insurance risks for the Melbourne region with some 40% of properties being susceptible. In comparison with several other major population centres, Melbourne ranks at the upper end of flood risk when compared with other major city centres in Australia, in terms of the area and the proportion of the population potentially exposed[27].

Although opportunities associated with water are not explored in detail within this report, one initiative emerging in the area of adaptation is the development of technology and methods associated with stormwater harvesting and the integration of this into the urban landscape. Our infrastructure is not currently able to cope with overland flow or riverine flooding. Currently the amount of stormwater discharged annually in Melbourne is approximately the same as the entire annual water demand of the city[28]. By harvesting this water using bio-filters and porous pavements, the green space which is incorporated into new developments could also offer benefits for water resources, river health and flood management.

4.2 Impacts on Coastal Zones

Port Phillip and Westernport Bays and their tidal estuaries are the receiving waters for many of the creeks and rivers with identified riverine flood risks.

In determining flood risks for these systems, assumptions have been based on historical tide analysis, which takes into account mean sea level as well as storm-related tidal surges.

For Victoria's coasts, the impact of higher sea levels will potentially increase during extreme weather events when complex interactions between strong winds, high runoff levels, tides and air pressure changes can rapidly alter water levels. Increased wave energy at such times can also exacerbate impacts.

Sea level rises, combined with storm events, could pose a significant inundation risk to low-lying coastal areas.

4.3 Impacts on Alpine Regions

Climate change is expected to result in shorter, drier winters with significant impacts on Victoria's alpine region and its flora and fauna, many of which are endangered. Species adapted to the highest elevations and coldest environments will have nowhere to go as the climate warms. Reductions in snow cover, increased risk of bushfires and the invasion of weeds and other pests will also have significant impacts. A decrease in area covered by snow, days with snow cover and depth of snow is expected by 2020[29]. The ski season might be shortened due to the predicted reduction in snow coverage and earlier spring thaws, coupled with the restrictions on availability of water and energy for snow-making at alpine resorts.

Communities in the alpine valleys also rely on the climate for much of their income. Niche agriculture (including stone fruit, viticulture and berries), autumn colour festivals and outdoor recreation activities are all at risk. A particular threat is the increased fire danger. Fires frequently occur in areas of rugged terrain in national parks and state forests with a large fuel supply and limited access. The impacts are wide-ranging. In 2003, the grape crop in the Alpine Shire was wiped out due to smoke taint. Severe fires can often be followed by extremely dangerous flash floods and mud slides, as well as long-lasting water-quality problems[30].

4.4 Impacts on Bushfire Risk

For the Melbourne region, the average number of days per year of extreme fire risk (currently three), is expected to rise by between 12% and 38% by 2020. Increased bushfire risk in catchments is an associated risk of the drier conditions created by decreased stream flow.[31] The likely increase of bushfires and more frequent prescribed burning to reduce fire risks close to Melbourne could lead to poorer air quality and more respiratory ailments, increasing demand for health support through the warmer seasons.

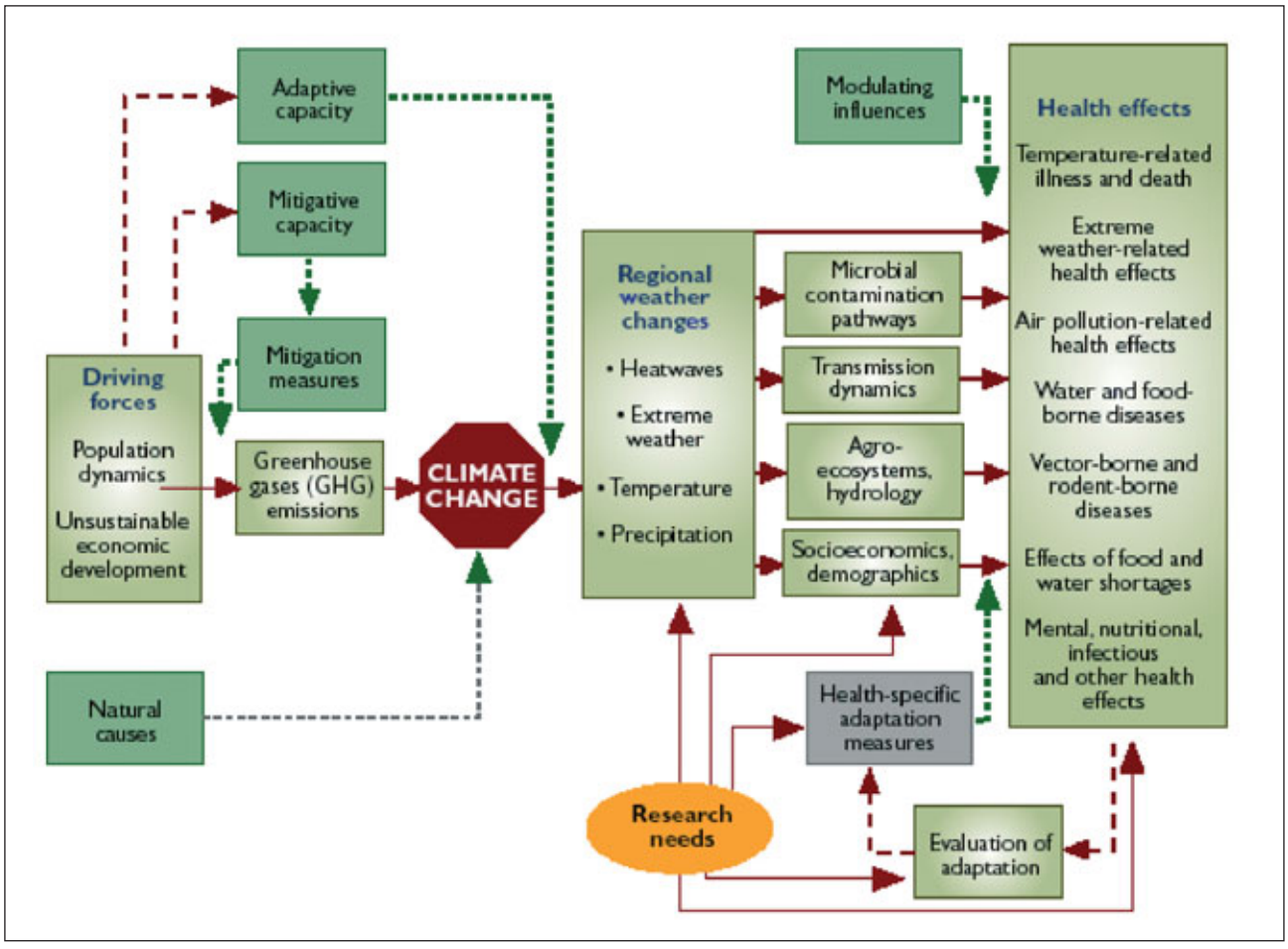


Figure 9: Climate change and health: Pathway from driving forces, through exposures to potential health impacts[37]. Source: DHS

4.5 Human Health

Climate change is forecast to have impacts on the health of all Melburnians. These will be influenced by how the population and the emergency and health care services respond to the potential changes. Health impacts[32] of climate change occur via multiple pathways[33] *(Figure 9)*. Some will be the consequence of direct effects, such as heat related stress and deaths, increased melanoma from higher levels of UV light and death and injury from floods, storms and extreme events. Other impacts will arise from indirect pathways, for example, increased distribution and abundance of disease transmitting insects, increased water-borne disease, and decreased water, air quality and food availability[34]. On the positive side, warmer winters might reduce the incidence of colds and flu, however other viruses might emerge that, in the past, have been associated only with warmer climates.

An increase in the frequency and intensity of heat waves caused by climate change might lead to increased mortality and morbidity among vulnerable sectors of the community, such as the poor, elderly and infirm[35]. The severity and duration of heat waves is compounded by the heat island effect in built-up areas[36]. *(Figure 2)*

With continued global warming, displacement of populations in neighbouring countries due to climate change impacts and sea-level changes is likely to occur. As a result, there could also be an increased demand on many of Melbourne's services including health, welfare and housing to support environmental refugees.

4.6 Human Capital

Trends suggest that climate change will lead to significant industrial restructuring as industries move toward a low-carbon economy in the context of an Australian ETS. Given Melbourne's current shortage of skilled labour[38], we need to plan for workforce changes to minimise disruption to the economy while creating and maintaining a skilled labour supply in the new and restructured industries. The need for new skills also presents an opportunity through education and training to reduce the numbers of unemployed and under-employed Melburnians[39].

4.7 Leisure and Recreation

Climatic change will affect how people enjoy Melbourne's outdoors. While an increase in extreme temperature days might reduce participation in recreational activities during summer, milder winters might lead to more opportunities for outdoor activities at that time of year. This could lead to a shift in the times of day and seasons in which particular sports are played. This would have implications, both positive and negative, for sports clubs and for local government and other agencies managing sporting venues.

In terms of impacts on aquatic activities, diminished flows in river systems, such as the Murray-Darling, and low water levels in lakes, such as Eildon and Wendouree, would adversely affect activities such as house-boating, fishing, water-skiing and canoeing. Nature-based tourism, an important component of the industry in Victoria, is under threat. A rise in sea levels would have a major impact; a 0.5m rise would drown many of our beaches and rocky shorelines and threaten coastal properties with flooding, especially from storm surges.

A reduction in snow cover during winter is a threat to the ski-fields. Victoria has already seen measures introduced to lessen the effects, such as improved snow-making from captured water.

4.8 Built Environment (Commercial and Residential Sectors)

In Victoria, 72.3% of people live in the Melbourne region[40]. Compared with most other cities in developed countries, Melbourne is widely dispersed with a low population density: 3.6 million people live in a 2000km^2 area. By 2030, Melbourne's built environment will need to accommodate an extra 630,000 households[41], making it important that the building sector undertakes GHG emission reduction at each stage of the supply chain, as well as management of existing building stock[42]. Key issues for the building sector include:

- Reducing the urban heat island effect through, for example, garden rooftops and porous paving
- Managing water and energy demand across whole communities
- Constructing and retrofitting buildings to be both resilient and comfortable in the face of current and future climate change, including extreme weather
- Maintaining and improving the efficiency of the essential services of energy, water and waste
- Addressing the embodied energy in construction materials

Most of Melbourne's existing buildings need to address their energy use and GHG emissions[43]. There are good opportunities to cost-effectively improve energy performance and energy savings through targeted operational improvements, upgrades and retrofitting[44].

Melbourne's infrastructure will be affected by the expected greater frequency of extreme weather. For example, more frequent torrential rainfall would challenge the capacity and maintenance of Melbourne's stormwater, drainage and sewerage infrastructure, leading to significant damage costs, environmental spills and associated public health risks. Drier soil conditions will damage pipelines for water supplies, sewage and stormwater. More electrical storms, higher wind speeds and increased flooding would damage transmission lines, interrupting the City's electricity supplies. Likewise, hotter conditions would lift peak electricity demand for summer air conditioners and reduce winter heating needs. Ground movement caused by drier conditions threatens damage to buildings, transport and telecommunications infrastructure.

4.9 Melbourne's Amenity

Melbourne's amenity, being its parks and gardens, are icons. The challenge is to control the City's expansion while creating new spaces and enhancing existing ones.

The requirements for more liveable cities are similar to those for more sustainable cities, namely:

- Increased population densities – up to 100-150 people per hectare
- Mixed-use developments
- Improved connectivity
- Utilising local solutions and retaining local character where possible
- Creating high-quality streetscapes and public open space[45]

As cities globalise, there is an increasing need to protect against gradual loss or modification of a city's built and natural heritage.

Over time, Melbourne's green spaces have become fragmented as a result of a lack of integrated management. These green spaces are at risk from the forecast direct and indirect impacts of climate change, with the danger that their social and environmental values will be lessened or eliminated.

Melbourne is a bayside city. The uncertainty of a future sea-level rise in the long term, and the strong likelihood of increased storm surge in the near term, present a challenge to our planning and zoning processes.

Increased population densities curb consumption of land needed for other uses, such as agriculture. They also reduce commuting distances, save energy and improve the efficiency of public infrastructure[46]. However, without appropriate attention to building and urban design, increased densities can also exacerbate the urban heat island effect.

4.10 Biodiversity

Native biodiversity and ecological systems are at risk from climate change, although the specific impacts remain uncertain. Increasing temperatures favour cold-sensitive organisms, but increase the risk to heat-sensitive organisms. This alters species distribution, migration and interaction. In addition to these direct impacts, climate also influences ecosystem components such as water availability and nutrient recycling, with a variety of potential indirect impacts on biodiversity.

In urban environments, development results in considerable habitat loss and fragmentation of remnants. Our environment is also highly altered through changes to air, water and soil, disturbance from clearing and fires, night lighting and noise pollution, increased impermeable surfaces and invasions by non-indigenous species. The quality of remnant vegetation as habitat is generally reduced, for example through the sanitisation of green spaces, involving the removal of leaf litter, understorey vegetation, and dead and dying plants. This reduces the availability of food and nesting resources for many animals. Habitat fragmentation reduces the ability of species to move throughout the landscape to access resources or to adapt to climate change. Survival and reproduction are impacted.

Acting now to preserve, enhance and manage native ecosystems across Melbourne is critical to prevent further habitat loss and contribute to national and state objectives for preserving biodiversity.

4.11 Transport

Melbourne has a very low-density, dispersed urban design. Steep rises in the cost of fuel mean that travel and freight costs are increasing. This will begin to affect Melbourne's competitiveness with more spatially efficient cities. There will also be further areas of significant transport disadvantage in many parts of the Melbourne region, gaps which must be addressed if people are to be encouraged to utilise more environmentally friendly transport.

Inner Melbourne is currently rich in public transport services and lends itself well to becoming pedestrian and bicycle-friendly. It is highly accessible by a wide variety of transport modes. Assuming that the residential, working and visitor population of inner Melbourne increases in the future, more of the road network will need to be allocated to public transport, walking and cycling. This urban consolidation policy will require sustained political will and increased communication with the public in order to be successful.

Overall, reducing transport GHG emissions requires an integrated systems approach. It is essential to engage all stakeholders including public transport, road authorities, port authorities, freight providers, vehicle manufacturers, energy providers, logistics planners and fuel technology developers.

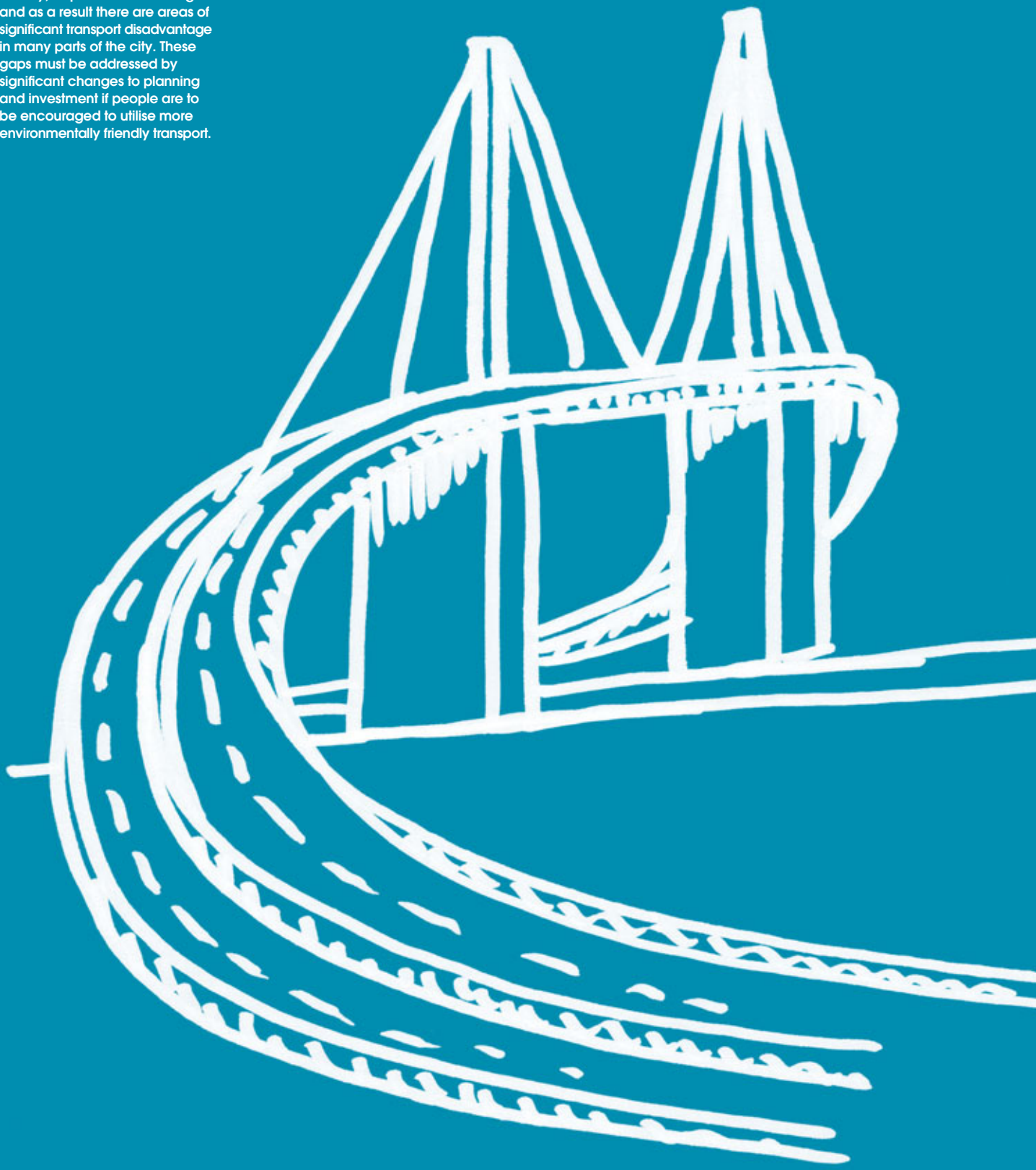
4.12 Industry

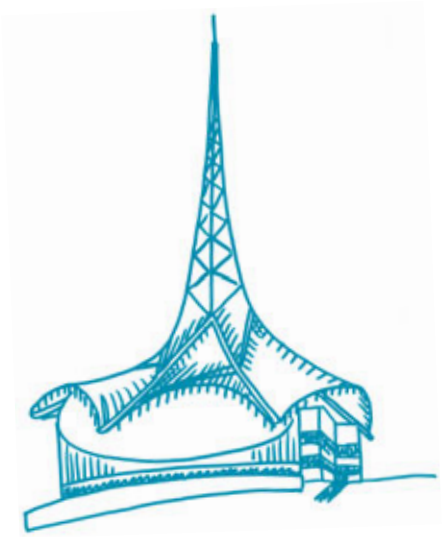
Climate change has the potential to affect all of Melbourne's industry sectors with some of these impacts already being felt today[49]. Melbourne's industry sectors, including infrastructure such as wharves, airports and rail terminals, need to identify and quantify climate change risks to assets and investments.

Each industrial sector needs to be prepared for a combination of exposure to environmental, economic and social changes, changing market conditions, new sources of competition, new government regulations and increased shareholder pressure.

Rigorous analysis needs to explore ways to reduce the negative impacts of climate change, while maximising any opportunities that might arise. Melbourne's industry sectors should seek to capitalise on the new jobs, new technologies and new markets that will flow from the transition to a low-carbon economy.

Melbourne has a very low-density, dispersed urban design and as a result there are areas of significant transport disadvantage in many parts of the city. These gaps must be addressed by significant changes to planning and investment if people are to be encouraged to utilise more environmentally friendly transport.





5 OPPORTUNITIES FOR MELBURNIANS

5.1 Introduction

The previous sections of this *FutureMap* have described the key impacts and implications of climate change facing Melbourne. These impacts and implications need to be communicated to and understood by the wider Melbourne community. The Committee will contribute to this challenge. The message is that Melbourne must adapt to the unavoidable consequences of climate change by taking clear and decisive action now, and continuing over decades, to avoid or mitigate future accelerating impacts. In embracing this reality, the Committee also recognises that such a response will give rise to tremendous opportunities across many sectors, and the following sections report on a range of the key opportunities to address climate change and its impacts.

The Committee is uniquely placed to play an important role in moving Melbourne towards climate change adaptation and mitigation. This role involves advocating for clear policy intervention in the light of the enormous environmental externality that climate change represents. However, we also recognise that all sectors of the community must contribute; individuals, companies, organisations and governments must identify and commit to adaptation and mitigation.

The Committee's response should be focussed, not all-encompassing. There are specific opportunities within the Committee's realm of expertise and sphere of influence where there is capacity to make a difference – and these are the areas where the Taskforce consolidated its efforts.

The Committee has considered six major areas of opportunity. Overarching these are several fundamental actions that are required to underpin an effective adaptation and mitigation response by Melbourne to the impacts of climate change.

These overarching recommendations are:

- Legislation: All new and proposed amendments to legislation at both State and Federal levels must include a climate change impacts assessment
- Planning: Local and town planning and infrastructure decisions must include measures to accommodate resilience and adaptation to effects of climate change, such as:
  - Impacts of extreme events: storm surges, intense storms and increased frequency of flooding and bushfires
  - Water: more efficient and sustainable approaches including stormwater capture and use, recycling, reuse and desalination
  - Health: there must be provision for health services to be able to respond rapidly to events such as extended heat waves, or the appearance of previously absent vector-borne diseases
  - Emergency services: The plans and resources of all emergency services must be reviewed against the range of impacts described in this *FutureMap*. For example, the current bushfire management system must be reviewed and updated to ensure relevant organisations have the resources to comprehensively respond to extended fire seasons
  - Ecosystem services: Land-use management, green space protection and enhancement, biodiversity conservation and ecosystem benefits such water and air quality must be safeguarded by co-ordinated planning and decision-making
- Utilisation of the Asia Pacific Institute for Sustainable Cities to facilitate the co-ordinated uptake of existing funding schemes across Victoria

The Taskforce initially considered 12 key climate change opportunity areas from the multitude suggested through assessment and the broader knowledge and experience of Members. A two-stage opportunity assessment process was developed and implemented.

Firstly, a timeframe and likelihood of implementation (‘early’), was paired with the effectiveness and coverage (‘deep’) for each opportunity. Assessed in this manner, all opportunities were ranked, with the highest score given to those offering Melbourne the earliest and deepest opportunities to mitigate or adapt to climate change.

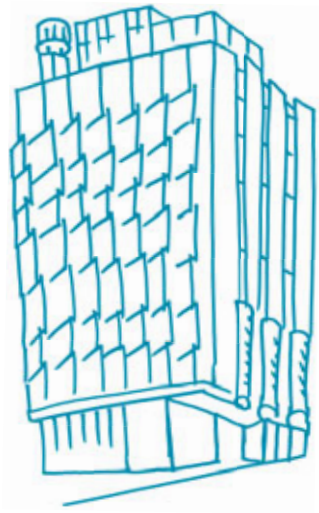
Secondly, seven criteria relevant to the perspective of the Committee for Melbourne were then applied against the ranked list of opportunities. These criteria were not rigid or highly technical, but provided a practical ranking model. These criteria were that the opportunity:

- Is likely to deliver benefits by 2030
- Would utilise the Committee’s structure and Membership
- Could be achieved by Melbourne independently and respond to specific Melbourne needs
- Had the potential to deliver early and deep benefits in terms of emissions reductions
- Would help profile Melbourne as an action-oriented city
- Would be cost effective in triple-bottom-line terms
- Is based on existing or soon to be available technologies/ capabilities

As a result of this two-stage process, six key opportunity areas emerged: buildings, low emission energy, transport, social equity, urban resilience and business procurement. These are described in the following chapters.

As a consequence of this process, some opportunity areas with significant climate change implications were not explored in detail. There are references to some of these excluded areas, such as water, within this *FutureMap* where the benefits of adaptive actions, such as stormwater harvesting, are explored within specific opportunity areas.

The Taskforce’s decisions also took into account the knowledge and skills of its Members, and assessed whether the Committee for Melbourne could add value to the current debate.



5.2 Buildings – Optimising Energy Performance and Resilience to Climate Change

Background

The building sector throughout Australia contributes approximately 23% of Australia's total GHG emissions[b],[47]. The office sector alone is responsible for 27% of commercial building emissions and 3.8% of Australia's total GHG emissions.

Improving the environmental performance of buildings is a key challenge facing Melbourne. New buildings account for only a tiny fraction of building stock across the City and, in order to make real progress and reduce emissions, the performance of existing buildings must be improved. Mass retrofitting of energy saving devices and renewable energy equipment to commercial buildings provides the opportunity to reduce GHG emissions and generate economic benefit, both from energy savings and direct employment generated through the retrofitting activities.

Many of Melbourne's existing buildings are poor performers in terms of energy and GHG emissions. Retrofitting existing buildings, rather than developing new buildings, is preferable in terms of embodied carbon emissions within building materials. Moreover, existing buildings make up the vast majority of the building stock and there are good opportunities to cost effectively improve their energy performance through targeted operational improvements, upgrades and retrofitting. Even improving the maintenance and operation of existing systems can deliver greatly improved performance and energy savings. Modelling conducted by the Centre for International Economics concluded that electricity demand in residential and commercial buildings can be halved cost effectively by 2030 through energy efficiency, reducing the need for costly infrastructure investments otherwise required to meet the demand of a growing city.

b Note: This figure includes operational emissions from energy use in both the commercial and residential sectors. It does not encompass embodied emissions inherent in building materials or expended during their demolition.

Retrofitting requires an understanding of how current buildings work so that they can be optimised for better energy, water and waste performance. Incorporating environmental performance criteria, including the sustainable use of resources, energy efficiency and air quality, into the design and procurement process can deliver better buildings which also meet traditional criteria of cost, functionality and aesthetics.

Increasing building resilience to the impacts of climate change such as heatwaves, floods and storms is an important adaptation process for Melbourne. This could be achieved by rethinking placement of electricals, carpet materials, external drainage and entrance levels. There is an opportunity for sustainable building retrofits to include resilience measures that address the impacts of climate change.

The Building Code of Australia (BCA) provides for a nationally consistent approach to the achievement of minimum standards of health, safety, amenity and sustainability within buildings. The BCA is enforced within Victoria through the Building Act 1993 and Building Regulations 2006. Energy-efficiency requirements have been included within the BCA for all building classes, both residential and commercial.

Of specific note within the Victorian context is the requirement that all new houses and apartments be of a 5-Star standard as required in the BCA, Victoria Appendix Volume 2. This requirement was extended to home renovations and relocations from 1 May, 2008. This is a minimum and Governments need to move towards higher standards.

Compliance with the 5-Star standard requires a 5-Star energy rating for the building fabric plus water savings measures and the installation of either a rainwater tank or a solar hot water service.

For new commercial premises the energy efficiency requirements for multi-unit residential were extended in 2006 to Class 5 to 9 buildings (offices, shops, warehouses, factories, health care buildings, auditoriums, schools etc.)

Opportunities

Key opportunities exist for reducing emissions and improving energy efficiency and sustainability in the built environment. These include:

- Retrofitting existing buildings

Sustainable buildings can deliver a suite of financial and environmental benefits. These benefits, such as energy and water savings, should be looked at through a whole-of-life or lifecycle-cost methodology, not just evaluated in terms of upfront costs. From a lifecycle-savings standpoint, investments in better building performance typically pay for themselves in terms of reduced outgoings and improved productivity. This was highlighted in the report `An Australian Cost Curve for Greenhouse Gas Reduction'[48], where the building related initiatives were considered to be at low or

negative cost. Utility costs are generally a small portion of property and construction industry input or operational costs, so it is important to understand the range of benefits that constitute the component parts of the business case study for a building retrofit.

Modelling undertaken for the City of Melbourne's recently updated Zero Net Emission by 2020 strategy shows the commercial sector accounts for 3474kt CO_2 equivalent or 55% of the total GHG emissions from the municipality[49]. Actions outlined in the strategy identify 1004kt CO_2e of possible savings by 2020, 383kt CO_2e of which comes from retrofitting existing office buildings. To achieve this Melbourne will need to retrofit about 1200 buildings over eight years with an average improvement in energy performance of 38%.

Barriers

A range of barriers are currently inhibiting Melbourne's ability to retrofit its existing building stock, these include:

- Split incentives: In many cases, the party incurring the capital cost of energy efficiency measures does not receive the cost savings from the upgrade, e.g. between landlords and tenants of a building
- Transaction costs (especially measurement and/or verification): Recognising resource savings and emission reductions from building retrofits often requires aggregating a large number of small energy saving and building retrofitting actions. In some cases this makes transaction costs of realising the incentives prohibitive
- Access to capital: While retrofitting buildings can provide an attractive return, there are many competing and better understood demands for investment capital
- High hurdle rates and incrementalism: The selective take up of opportunities which could be considered 'low-hanging fruit' impedes the implementation and cost effectiveness of deeper saving programs. Technology for energy savings cannot be applied on a purely incremental basis. To achieve greater savings and synergies projects must be tackled in an integrated way
- Time horizon: The differing time horizons of Melbourne's building owners, occupiers, investors, developers and community are a key barrier to implementing retrofitting

Enablers

Enabling activities which will assist in reducing emissions and improving energy efficiency and resilience in the built environment include:

- Awareness: A general lack of knowledge and awareness exists within the community, business, professionals and government about sustainable building retrofit. An opportunity exists to create education strategies to explain building retrofitting and encourage its uptake
- Financial incentives: There is a significant opportunity to encourage building retrofits through rebates and financial incentives. These include:
  - Investment allowances: A tax deduction based on the cost of qualifying expenditure
  - Tax credits for energy efficient commercial buildings and retrofitting products and services
- Building audits: Building audits involving a holistic, staged approach including auditing, implementing savings and monitoring and verification of efficiencies could help to optimise energy performance and resilience to climate change. Audits would require the energy services industry to deliver performance contracting, a well established but little used technique to implement energy efficiency. The incorporation of meters and monitoring systems in existing buildings could also significantly increase audit accuracy by providing a breakdown of energy uses. There are several auditing/rating tools in the market which assess existing building stock and opportunities for improvement. Building audits and simulation play an important role in justifying building retrofit activities

KEY RECOMMENDATIONS

Action

1. **Provide broad-scale guidance and decision-support programs** for Melbourne organisations, including Members, aimed at both tenants and building owners, to facilitate the rapid upscaling of current retrofit measures for existing buildings.

These are necessary to provide relevant information, contacts, business cases, case studies and support for organisations wishing to retrofit their buildings. The Committee will work with and encourage Committee for Melbourne Members to achieve minimum targets for energy, water and waste within their buildings.

Advocacy

1. **Advocate for mandatory building standards**

Advocate mandatory standards for the construction of new buildings and the sustainable retrofit of existing buildings, both commercial and residential. Existing building owners would be given a period to comply with ratings via retrofitting.

5.3 Low Emission Energy – Implementing Low or Zero-Emissions Energy Technology

Background

One of the competitive advantages that has underpinned Melbourne's economic prosperity is its access to relatively low cost energy generated by the Latrobe Valley's vast brown coal reserves. As a result, Victoria generates the largest emissions nationally from stationary energy (80.5mt CO_2 equivalent in 2005) and carbon intensity of energy (amount of carbon burned as fossil fuel per unit of energy). The production and use of energy accounts for more than 70% of Victoria's net emissions, with electricity generation alone accounting for more than 50% of net emissions[50].

In the context of an emerging global commitment to stabilising GHGs, Australia is expected to commit to reducing its emissions by 2050 to a level between 60% and 80% of 2000 levels. This is consistent with the Federal Government's current target and the Garnaut Review Interim Report; requiring a progressive and fundamental transformation in the way we produce and consume energy. Such a transformation will only be delivered by a combination of policies that provide a market pull as well an investment push for the development, demonstration and deployment of low and zero emission energy production technology (supply side), complemented by policies that address the consumption (demand side) of the equation.

Regulation and technology, promoting development, production and export of innovative solutions in demand-side management, fuel switching, and new technologies in energy delivery will be the key drivers to achieve lower emission levels.

Low emissions coal and gas based generation technologies, including CO_2 capture and storage, and zero and near zero emission technologies can reduce the carbon intensity of electricity supply. Ultimately, in a carbon constrained world, renewable technologies will have to provide part or all of the sustainable energy solution.

The Federal and State Governments have a number of current and committed policies that will support the transition, such as:

- The national ETS expected to commence in 2010
- Encouraging low carbon alternatives through the Federal Mandatory Renewable Energy Target (MRET) and the Victorian Renewable Energy Target (VRET)
- Demand side management through the mandatory Energy Efficiency Opportunities (EEO) program, the Environment and Resource Efficiency Plans (EREP), and the recently announced Victorian Energy Efficiency Target (VEET)
- The Federal Government's Low Emission Technology Development Fund (LETDF)
- The Victorian Government's Energy Technology Innovation Scheme (ETIS)

It is anticipated that there will be a rationalisation of these in the coming 12 months. While a national ETS will be a core policy, it may need to be supported by complementary policies because of market failures or limitations, to deliver full requirements[51].

Opportunities

New market price signals through the introduction of the national ETS and increased opportunities for public funding provide an opportunity for Melbourne to become a hub for low and zero emission technology development.

A range of technologies can be used to create energy with low or zero GHG emissions. These include:

- Solar: Solar panels produce about 50 megawatt hours (MWh) of power in remote areas[52]. Solar power is currently expensive for on grid connection, however prices are falling and a large export industry has developed, earning Australia $100 million per year[53]. The manufacturing and deployment of solar technology represents a significant opportunity for Victoria and will be supported by the recent Victorian Government announcement of a feed-in tariff. In addition, there are opportunities for larger scale solar technologies which inevitably would be located outside the metropolitan area. For example, a 154MW heliostat solar concentrator power station has been announced for northern Victoria. The $420 million project will generate 270,000MWh per year, enough for more than 45,000 homes. This project received $75 million from the Federal Government under the Low Emissions Technology Demonstration Fund (LETDF), as well as receiving support from the Victorian Government for approximately $50 million[54]
- Geothermal: The Geothermal Energy Resources Act (2005) has provided the legislative framework and impetus for geothermal exploration in Victoria[55]. A total of 12 geothermal exploration permits covering 73,396km^2 were awarded in Victoria to five companies in April/ May 2007 with exploration expenditure totalling $64.2 million over five years. Companies are now exploring for a diverse suite of geothermal energy sources in Victoria[56]. Geothermal energy is an emerging energy power that has the potential to provide clean, consistently available and renewable electricity from 'hot rocks' and water reservoirs beneath the earth's surface
- Wind power: Wind generation is set to expand in Victoria, based on the incentives provided by the proposed expansion of the MRET and VRET schemes, even if VRET is absorbed into an expanded MRET as currently anticipated. Encouraging the use of renewable energy is also a key element of the Victorian Government's Greenhouse Challenge for Energy, with a specific policy to facilitate up to 1000MW of wind-generated power in environmentally acceptable locations, and to increase the share of Victoria's electricity consumption from renewable sources to 10% by 2010[57,58]
- Low emission coal technology: According to Geoscience Australia, Victoria has many hundreds of years of brown coal resources and our existing power stations have several decades of operation ahead of them if they can transition to a low-carbon technology and processes[59]. The key to unlocking this future is to develop and deploy technologies to facilitate the capture and sequestration of CO_2, both as retrofit to existing plants and as technologies for greenfield plants. Victoria could be a centre of technological development to reduce the GHG emissions intensity from the processing of brown coal. In the short term this might include: increasing the thermal efficiency of existing plants, in particular by pre-drying the coal; gasification technology, co-firing with gas and various CO_2 capture approaches, both pre- and post-combustion. In addition, geological data indicate that Victoria has significant potential for CO_2 geosequestration from coal and gas fired generation and from gas production, both in depleted oil and gas reservoirs and in deep saline aquifers. Victoria is also well placed to benefit from significant carbon capture and storage opportunities, and trials are currently underway in the Otway Basin to explore the potential for biosequestration[60]

Other opportunities include:

- New markets and services: Adaptation and mitigation responses to climate change will drive a range of opportunities for which normal commercial drivers are likely to be sufficient. These opportunities cross a range of sectors and include:
  - Energy services and specialist suppliers such as appliance manufacturers, technologists and technicians
  - Carbon trading and contracting services
  - Carbon accounting, reporting and verification services
  - Associated technologies such as smart metering, data management and remote monitoring
- Demand-side initiatives: such as energy efficiency, were recognised by the 2008 McKinsey report, `An Australian Cost Curve for Greenhouse Gas Reduction'[61] as being a major source of low-cost mitigation. Price signals and regulations are likely to work in tandem to help decouple our economic activity from fossil fuel CO_2 emissions. With 23% of GHG emissions being associated with energy use in residential and commercial buildings, the opportunities that arise from building and appliance standards are significant. These are covered in the Buildings Opportunities Area of this *FutureMap*
- Decentralised energy production: Encouraging decentralised energy production will increase the penetration of renewable energy. This design would provide an enabling marketplace, leading to increased efficiency through reduced costs and losses, as well as providing sound business sense as the grid could buy back excess. Decentralised energy production also reduces the impact of system failures currently observed in our vulnerable centralised production

Barriers

Barriers to achieving the low or zero emission energy technology implementation include:

- Lack of integrated long-term policy: While current government policies provide an overall direction for the energy sector, there are critical details that will determine the extent and pace with which the sector will be able to change, and the resulting, associated overall cost to the economy
- Diffuse nature of low emission technology: The nature of some low emission technology implies the need for extensive equipment deployment and large construction and collection areas
- Regulated pricing structures: Electricity distribution networks have incentives that work against the implementation of distributed generation and energy efficiency
- Lead time: Lead times between concept and development can be long. This gap needs to be significantly reduced to achieve GHG emission reduction
- Complexity and uncertainty: Australia's energy system is complex, involving many markets and decision makers and large scale, long lived and capital intensive infrastructure. Such complexity acts as a barrier for implementing emerging technologies. The uncertainty of new technology and future carbon prices has also led to increased market and investment uncertainty

Enablers

Key enabling themes to achieve low or zero emission energy technology include:

- Core policy framework: It is expected that the Federal Government will, in 2008, announce the details and initiate the legislation for a national ETS to be implemented from 2010. Within this scheme a long term emissions reduction target and a trading mechanism will give a clear pricing signal and this will trigger development of low emissions technologies
- Complementary policies: Developing policy to complement emissions trading and achieve power generation from integrated low or zero emissions technologies. Such policy will drive significant industry restructuring and technological change that will have flow on effects for the Victorian economy. Areas for consideration could include tax incentives or accelerated depreciation
- Research and development: Funding significant research and development in areas where Victoria has some existing expertise, and/or locally specific opportunities or problems, through public and private funding structures
- Support, funding and frameworks for demonstration: Demonstration projects to showcase low and zero emission energy technologies

KEY RECOMMENDATIONS

Actions

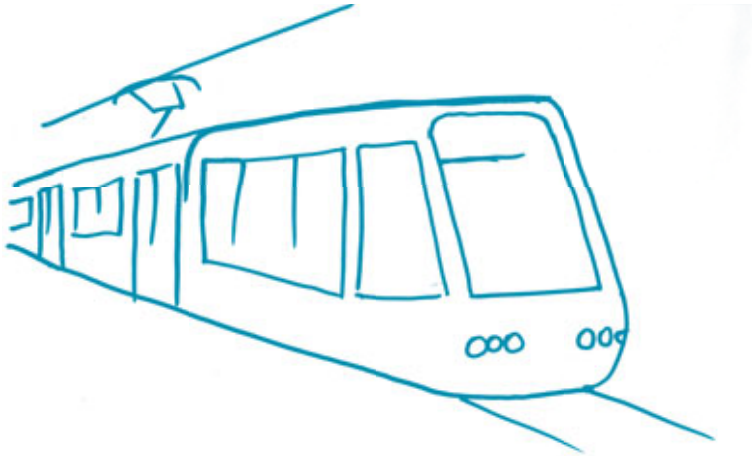
1. **Coordinate an independent position paper** which takes into account previous State Government and other research to assess the practicality for commercial implementation of low emission coal technologies in Victoria.

2. **Introduce a 'Low/Zero Net Emissions Award'** to recognise the efforts of companies in implementing best practice carbon management strategies that achieve genuine net emissions reductions.

Advocacy

1. **Urge the State Government to work with the Federal government and business** to step up and coordinate funding support for research, development and commercialisation of low emissions technology.

2. **Advocate for the Federal Government** to direct the Essential Services Commission, in conjunction with the Australian Energy Regulator, to review regulatory arrangements that could be creating perverse incentives that constrain development or implementation of low emission/renewable energy technologies.



5.4 Transport: An Accessible City in a Carbon Constrained World

Background

The transport sector in Victoria is a significant source of GHG emissions, representing 17% of the state's total emissions. Transport emissions are the second fastest growing source of GHG emissions in Australia. Without further intervention, road transport emissions will be 64% above 1990 levels by 2020, compared with around 31% above these levels in 2005[62]. Underlying these forecasts are dramatic increases in freight movements and a higher proportional share of light passenger vehicles for personal travel.

The functionality of a city requires people and goods to be easily mobile. A shift to cleaner fuels, more fuel efficient transport and a reduction in car trips can all showcase a highly mobile urban centre reducing its emissions. By world standards, metropolitan Melbourne has an extensive road, tram and train network. However, existing public transport infrastructure will require significant investment and planning to offer improved capacity, accessibility, quality of experience, integration with other networks, security, reliability, cost of fares and frequency. Such changes would attract and accommodate increased patronage. Building these suggested changes for increased resilience into the transport system is vital to reduce the impacts of extreme climate events.

Overall, reducing transport GHG emissions requires an integrated systems approach covering all contributory elements. It is essential to engage all stakeholders including public transport, road authorities, port authorities, freight providers, vehicle manufacturers, energy providers, logistics planners, and fuel technology developers. In addition, sufficient numbers of consumers must take up or be encouraged to adopt greener vehicle technologies and transportation options.

Opportunities

Key opportunities have been identified to reduce Melbourne's land transport GHG emissions to 60% below 1990 levels by 2030. This will require significant changes as outlined below, and are consistent with the State Government's targets.

They include some measures that can be taken in the Melbourne region alone, while others require national action.

These actions will not only reduce GHG emissions, but also:

- Create a competitive advantage for Melbourne by increasing the efficiencies of freight transportation
- Increase the liveability and accessibility of Melbourne
- Become a world example of how to reshape a low-density metropolis into a low-emissions, highly accessible region
- Reduce the high cost of traffic congestion

Specific opportunities include:

1. Reduce the demand for motorised travel

Build an urban structure that reduces the distances needed to be travelled by high emissions modes and maximises walking and cycling accessibility. In order to have a significant impact there needs to be a 20% reduction on forecast car travel kilometres and a subsequent conversion of 25% of the remaining forecast car kilometres to walking or cycling. If these changes were observed they would contribute 30% of the emission reduction target[63].

2. Mode shift from cars to public transport

Increasing public transport's share of motorised personal travel kilometres to 35% (currently around 9%) would contribute 11% of the required emissions reductions[64].

3. Improve freight efficiency

Improve the emissions intensity of freight movements through:

- Shift from truck-only to intermodal freight movements
- Significantly increase freight efficiency by using larger vehicles and fewer small package movements (encouraged by pricing)
- Reducing total freight fuel usage per tonne-km to 40% below current forecasts could contribute 18% of the emission reduction target[65]

4. Improve car occupancy

Average car occupancies must increase by 36% to 1.9 persons per vehicle. If such an improvement were realised it would contribute 9% of the emission reduction target[66].

5. Reduce vehicle emissions intensity

This can be achieved by investing in and adopting more efficient vehicles, using alternative fuels that reduce full-fuel cycle emissions and have sustainable feed stocks, adopting intelligent transport systems and improved driving practices. These reductions need to apply to all classes of vehicles. Average fleet fuel intensity per vehicle kilometre needs to fall to 55% below 2007 levels and see 100% of public transport electricity supply sourced from renewable/green energy[67].

If these changes were implemented they would contribute 31% of the emissions reduction target[68].

A mode shift of cars to public transport means more people would utilise public transport, walking and cycling, instead of driving. The impact of this is illustrated, along with other key factors in reducing emissions, in the graph below.

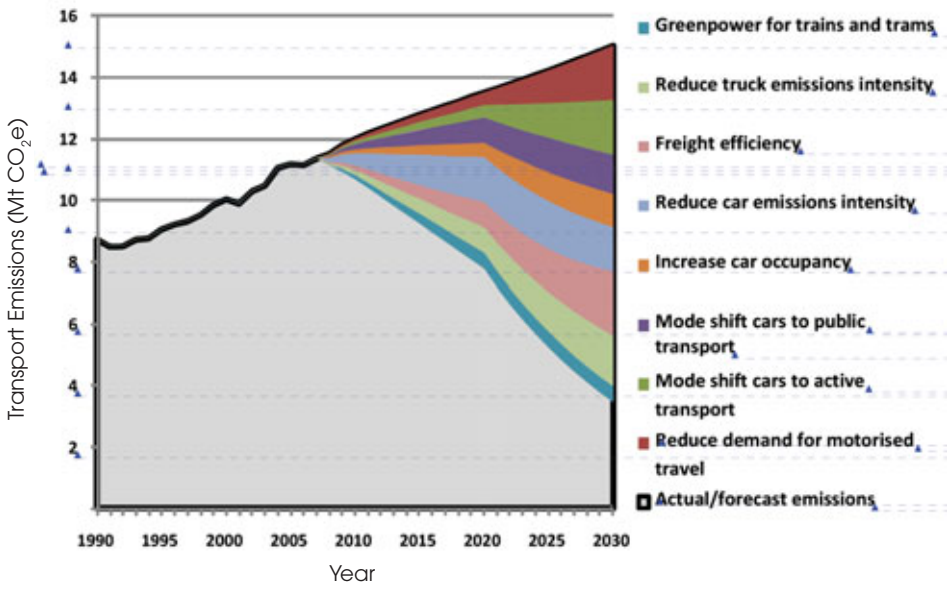


Figure 10: (Emission reduction measures by 2030) below shows how these measures would together deliver a 60% reduction in emissions on 1990 by 2030. Source: BusVic Modelling

Barriers

There are significant barriers to achieving reduction in GHG emissions from transport. These include:

- Pricing: Lack of externality pricing in transport does not provide incentives to reduce emissions
- Funding: Limited opportunities for private sector investment in low-emissions transport modes
- Planning: Current limitations on planning processes and controls to resolve conflicts
- Capacity: Capacity constraints on the rail system for both freight and passenger trains
- Urban structure: A low-density, car-orientated urban structure is not ideally suited to walking, cycling and public transport use
- Quality of experience: Many potential patrons of public transport are deterred by overcrowding, lack of cleanliness, security concerns and high cost, all of which contribute to an overall low quality of experience
- Tax: Presence of tax incentives (e.g. fringe benefits tax arrangements, large vehicle tax concessions)
- Contractual arrangement: current contractual arrangements don't allow for recovery of costs from reducing emissions from public transport

Enablers

Melbourne has several characteristics that will help ease the transition to a low-emissions transport future, including:

- Existing automated road charging technology
- Urban renewal opportunities in a number of principal activity centres
- Increased corporate and social awareness
- Developing recommendations and setting targets of average CO_2 ratings for new vehicle purchases would provide a mechanism to rapidly curb fleet emissions

KEY RECOMMENDATIONS

Action

1. **Encourage Melbourne organisations, particularly Members to introduce staff travel behavioural change programs**

Actions will include fuel efficiency training for professional drivers and implementing programs to assist people adopt lower emission modes of transport via partnerships with companies such as RACV, GreenFleet and LEV partnership. An option for salary packaging of public transport fares should be provided to employees, although it is not currently possible for employers to salary-package public transport fares tax efficiently as they are subject to fringe benefits tax (FBT). However, employers could still package public transport fares because discounts are available from Metlink for bulk purchases.

Advocacy

1. **Align our national vehicle emissions intensity targets[69] with the best practice benchmarks of the European Union**

Strong national targets set on a suitable timetable will allow manufacturers to adapt and supply more low-emissions vehicles. Targets should aim to bring Victoria in line with the European Union's average g/km emissions by 2015, with further cuts in following years.

2. **Reform federal tax arrangements to remove incentives that maximise car use and discourage public transport use[70, 71]**

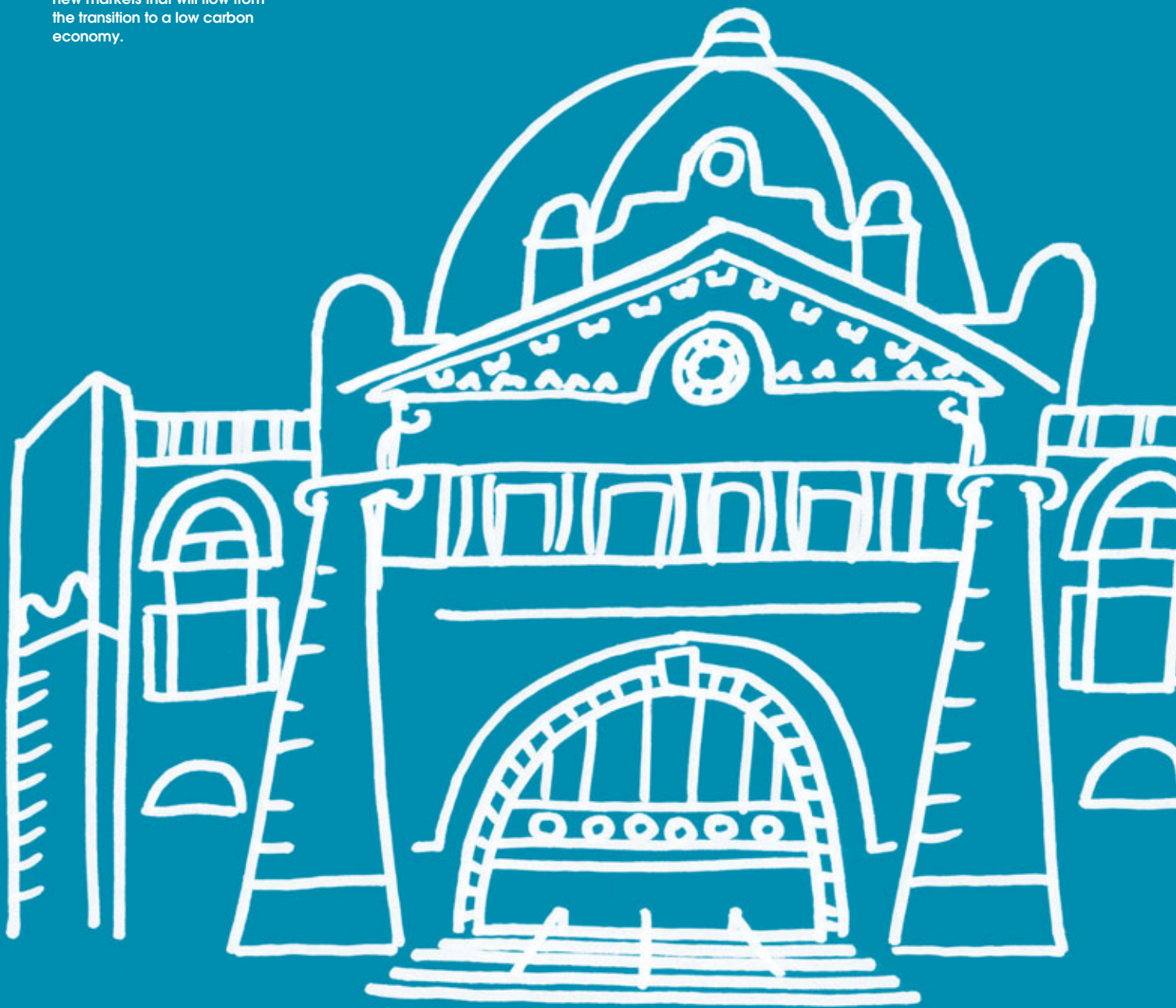
Current FBT concessions provide direct incentives to increase the distance travelled each year for employer-provided cars. Taxation arrangements should be revised to remove these concessions and introduce incentives to choose more sustainable transport modes, such as public transport.

3. **Advocate the State Government to include greenhouse gas performance targets in all tenders for the provision of public transport services**

4. **Advocate for increased Government investment in transport infrastructure which will assist in reducing emissions – particularly public transport**

Until there are viable alternatives to personal car travel people will not move onto public transport. Significant investment in public transport services and infrastructure, including improved coverage, span, frequency, speed and reliability.

Melbourne's industry sectors, including infrastructure such as wharves, airports and rail terminals, need to identify and quantify climate change risks to assets and investments. Melbourne's industry sectors should seek to capitalise on the new jobs, new technologies and new markets that will flow from the transition to a low carbon economy.



5.5 Social equity: Making responses to climate change feasible for all Australians

Background

Climate change is an issue for our whole society. Everyone contributes to it and collectively experiences its impacts, but some sectors of the community are more vulnerable to it than others[72]. Low income[c] households and communities face disadvantages arising directly from climate change and from policies aimed at mitigating climate change. Large scale measures to improve household energy efficiency provide an opportunity to reduce the threat of increased prices related to an ETS while curbing household emissions.

Despite Australia entering its 17th year of consecutive positive economic growth, a significant minority of Australians are in poverty and at risk of being excluded from mainstream society. Where poverty is defined as being below 50 per cent of the median household disposable income, an estimated 13.7 per cent of Australians were below the poverty line in 2005-06[72]. Poverty has been increasing over the past few years as income distribution has become more unequal[73]. Wealth distribution shows even greater disparity than income distribution in Australia. The 2006 census reveals that there are 1.8 million Australians aged 15 years and over in low-income/low-wealth households[74].

These Australians in poverty will have few resources with which to respond to adverse climate conditions, which could result in housing problems such as storm damage or heat stress. Similarly, they will have difficulty meeting the extra costs of carbon pricing and other expenses such as increasing food prices due to drought and changes in arable farming land.

If a carbon price is set at say, $25 per tonne, on average, a poor household in Victoria will experience an additional annual cost of $671, which amounts to 2.5% of their annual household expenditure. An average high income Victorian household will experience an additional cost of $1,530 per year or 0.4% of household expenditure. This higher proportional cost compared to a low income household occurs despite the fact that poorer households have a lower carbon footprint than high income households: 26.8 tonnes a year, compared with 61.2 tonnes a year[75].

The household categories most adversely impacted by carbon pricing, in relative terms, are low income households, unemployed households, aged pension households and households with children where government benefits exceed 30% of income. The risk is that, without policies which address equity, more Australians will be moved into poverty. A carbon tax of $25 per tonne, without ameliorating policies, is likely to move a further 470,000 Australians below the poverty line[76].

The Committee for Melbourne Utility Debt Spiral Project alerted us to the issue that many low income households already face difficulty paying utility bills. Climate change, with greater temperature extremes, and a price on carbon will exacerbate this problem. Lower income households also face difficulties related to transport affordability. These households are often located in outer Melbourne suburbs with less public transport and greater reliance on private vehicles. With rising petrol prices and associated peak oil costs, as well as the imposition of a carbon tax, these households will experience greater financial hardship[77, 78]. To counteract these price rises, planning for comprehensive measures of sufficient magnitude needs to be undertaken urgently.

c For purpose of this calculation, a low income household was defined as one where the average weekly expenditure is less than or equal to $559, representing about half the Victorian average weekly expenditure. A high income household is defined as one where the average weekly expenditure of greater than or equal to $1,925 is approximately double the expenditure of an average Victorian household.

It is vital that our responses to climate change avoid placing more people in poverty and at risk of social exclusion, potentially creating less social cohesion in Australia. Preventing increased social exclusion is desirable in its own right. Preventing increased social exclusion as a result of climate change mitigation is also essential for the political success of such programs. Successful measures will enable all Australians, including those with low incomes, to reduce their carbon footprint. Equity responses to climate change also present opportunities, as outlined below.

Opportunities

A significant opportunity exists to enable low income households to respond to climate change by increasing household energy efficiency. Such an approach combines adaptation to the impacts of climate change with mitigation of residential household emissions, which the State Government aims to reduce by 10% by 2010.

A well planned and integrated approach will improve the wellbeing of people living in poverty and lead to multiple benefits for householders, the economy and society. It would:

- Help low income households cut the cost of essential energy services without reducing liveability
- Restrict low income households' vulnerability to extremes of heat and cold
- Improve energy efficiency in public housing which, in addition to reducing GHG emissions, would cut energy bills for low-income households
- Reduce residential GHG emissions
- Decrease the number of households requiring support under hardship programs
- Enable economic and human capital growth by promoting an energy-efficient service industry

There is significant national and international knowledge and expertise to develop such approaches.

Barriers

Barriers to low income households improving their household energy efficiency are well understood. They include:

- The split incentive between landlord and tenant in rental properties
- The high, up-front cost of many measures
- The time it takes to install new energy saving measures
- The fact that most programs targeting equity issues in association with climate change overlook the needs of households with the lowest incomes. While a range of government grants are increasingly offered to low income households, most of these schemes still require a contribution from the household. This will prevent many low income households taking up these opportunities, as they would be unable to afford the initial capital contribution, even though they might save in the longer term. For example, the Federal Government offers $1,000 rebate for households with annual incomes under $100,000, for the purchase of a solar hot water system to replace an electric system. However, this leaves a considerable shortfall in relation to the cost of a solar hot water system which many households would not be able to fund[79]
- Current grant schemes only cover small numbers of households. Assistance to low income households needs to be greatly expanded and integrated into a coordinated and comprehensive approach. The present ad hoc system of grants gives no clear indication of coverage or the extent of assistance needed to prevent inequity
- Information needed by low-income people, in order to take advantage of available grants and to make the best choices to save money and reduce carbon emissions, is not readily available. Sales assistants are not trained to advise on these aspects. Additionally, marketing messages about a product in terms of carbon savings are not always clear or credible

Enablers

The following measures would facilitate energy efficiencies in low income households. Eligibility criteria for grant schemes should be prioritised to target households with the lowest levels of income to access larger grants. It might also be necessary to provide bridging grants for low-income households to facilitate uptake of other rebates[80].

A new program is needed to assist in the retrofit of all low income households. Such a program should include the following features:

- Education campaigns on the most effective means to achieving energy and water efficiency
- Home audits of energy and water use that result in recommendations for energy efficiencies and behaviour change, as well as referral to sources of assistance
- Financial and other assistance for low income households to implement measures that improve water and energy efficiency
- Improved labelling on products and appliances so that initial and second-hand purchasers can make informed decisions about energy efficiency and carbon content at the point of purchase
- Financial and taxation incentives to encourage landlords to retrofit properties to improve energy and water efficiency
- Improving energy and water efficiency in public housing
- Mandatory energy efficiency standards in all new buildings

KEY RECOMMENDATIONS

Action

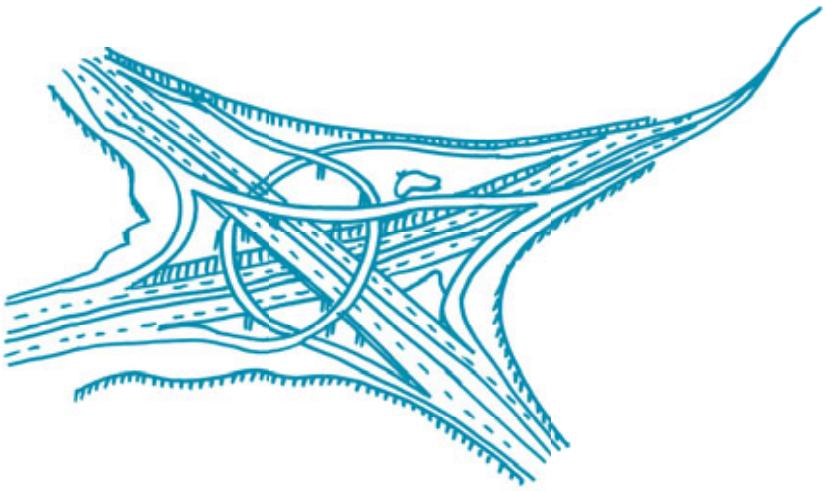
1. **Increased support for low-income renters**

Conduct a round table with private rental market investors, superannuation funds, industry associations, real estate agents, body corporates and financiers and NGOs to discuss measures to help low-income private renters adapt to climate change impacts. Measures could include installing insulation, solar, water and energy efficient measures in rental properties, and they could be facilitated via coordinated grants, building audits, and access to relevant products and services including low to zero interest green loans and incentives.

Advocacy

1. **Accelerate the availability of public funding for low income home owners to be made available to provide support through capital grants or rebates for the purchase of energy efficient products.**

It is important that the building sector undertakes GHG emission reduction at each stage of the supply chain in the construction of new buildings, as well as in the management of existing building stock. There are good opportunities to cost effectively improve buildings' energy performance and energy savings through targeted operational improvements, upgrades and retrofitting.



5.6 Urban Resilience – Reducing vulnerability to heat and flood

Background

In urban environments such as Melbourne, development often results in considerable changes to the local environment through changes to air, water, soil, disturbance regimes, night lighting and noise pollution, increased impermeable surfaces and invasions by non-indigenous species[81]. Through development, Melbourne's urban areas are becoming heat islands that are usually 1-2°C warmer than surrounding areas[82]. The main cause of the urban heat island (UHI) is modification of the natural land surface; waste heat generated by energy usage is a secondary contributor[83]. Radiant heat from the sun is absorbed by roads and buildings and warms the air around them more effectively than the plants and soil they have replaced[84].

The temperature difference of a UHI is usually greater at night than during the day and in winter than in summer. It is also most apparent when winds are weak.

As population centres grow they tend to modify a greater land area and cause a corresponding increase in average temperature.

City buildings have become higher. They modify wind flow, cast longer shadows and, via the thermal properties of newer building materials, change the daily patterns of heat flow[85]. Other factors, such as more motor traffic and increased use of air conditioning, have produced additional heat energy.

Increasing tree cover and vegetation in a city is a simple and effective way to reduce the UHI effect. Trees, rooftop gardens and other urban vegetation affect the urban environment in two ways. Firstly, vegetation uses moisture available to its root system to convert liquid water to vapour water, a process referred to as evapotranspiration. This cools both the plant's surfaces and the surrounding air. Secondly, the plants provide shade and reflect solar radiation[86].

Floods cause the most deaths and injuries of any natural disaster event. While riverine and coastal settlements are considered particularly vulnerable, research indicates that urban flooding has the potential to be an increasing problem in a growing city regardless of climate change. Bigger houses and more paved surfaces result in increased vulnerability to flooding as storm drains, water supply and waste management systems require more system capacity and technological sophistication to cope with intense rainfall events. The strength and height of retaining walls, the number of buildings above high flood levels and the capacity of drainage systems all contribute to the infrastructure's resilience and flood vulnerability.

Storm surge events present an additional risk in the bayside areas of Melbourne, with the added problem of saltwater intrusion. The risk of extreme sea levels is hard to define because current studies focus more strongly on gradual sea level rise rather than the implications of enhanced storm surges for optimal coastal protection.

The capacity of an urban stormwater system to handle intensive precipitation and storm surge events and maintain the integrity of water and sewage systems affects the extent of damage.

There are many approaches to adapting to flood events beyond the modification of planning and zoning requirements. The IPCC *Fourth Assessment Report* documents several examples, including participatory risk assessment and specialised insurance programs, retrofit of buildings to improved hazard standards, re-vegetation along shorelines and riverbanks, and hard barriers such as dykes and groynes.

Enhancement of green space can help manage floods as well as UHIs. Appropriately designed green space will limit the severity of flooding, as well as having important benefits for urban stream water health and carbon bio-sequestration.

Urban landscapes can be functional beyond providing spatial amenities. Our knowledge of the traditional values of open spaces and landscape features can be bolstered by understanding the ecological functioning of urban landscapes that utilise sustainable water management and micro-climate influences. Researchers have found that strategic planting of deciduous species around buildings is typically most effective for cooling buildings, especially if these trees shade windows, air conditioning condenser units and part of the building's roof[87]. However, depending on tree and building height and the distance between tree and building trees might block useful solar energy in the winter, when the sun is low in the sky, without providing much shade during the summer when the sun is high. Also, proper planting is important for providing shelter from winter winds without reducing the overall wind speeds that can help alleviate summer heat islands[88].

Street trees and bio-retention systems can be developed to harvest stormwater using distributed tanks to help an under-capacity sewerage system cope. Rehabilitation of degraded coastal zones to natural salt tolerant ecosystems can serve as an important buffer and filter for saltwater incursion during high sea level events.

Increasing vegetation coverage and the supporting infrastructure for flood management has multiple benefits[89]:

- Carbon emissions benefits due to lower energy demand: Hotter temperatures spur demand for air conditioning which lifts energy use when demand is already high. This contributes to power shortages and more GHG emissions[90]
- Air quality improvements: Hotter air in cities increases both the frequency and intensity of ground level ozone (the main ingredient in smog). Smog is formed when air pollutants such as nitrogen oxides and Volatile Organic Compounds are mixed with sunlight and heat. The rate of this chemical reaction increases with higher temperatures[91]. Better air quality means fewer respiratory ailments such as asthma
- Public health benefits: The UHI effect intensifies heat waves in cities, making residents and workers uncomfortable and unproductive, and putting them at increased risk of heat exhaustion, heat stroke and heart attack
- Water demand benefits: Water usage goes up on hotter days. Fewer UHIs will curb increases in water demand
- Ecological restoration of streams: Stormwater harvesting along with other treatments such as bioretention, can restore streams degraded by urban stormwater runoff
- More effective flood risk management: These approaches can make the management of flood risk more cost effective by alleviating to some extent the requirements of increased sewerage system capacity and expensive building retrofits

Opportunities

Managing and creating urban green spaces in the city has multiple benefits. It reduces the UHI effect, aids in carbon sequestration, improves flood management and conserves biodiversity and habitat for native species[92]. Good-quality, well-maintained networks of green spaces also play a role in providing land for biomass, food or wind energy production, recycling and composting schemes[93].

Opportunities to address green space include:

- Increasing vegetation coverage: This can be achieved through planning measures in greenfield developments, incentives for inner city biosequestration offset schemes, grants for local councils to retrofit biofiltration systems and assistance programs for residents to increase planting[94]
- Outdoor landscaping: Vegetation can be placed in outdoor landscaping schemes and used by councils, communities and businesses to uptake emissions and reduce the effects of UHI[95]
- Creating and enhancing parkland and open space: Well-vegetated open space can have a significant cooling impact including downwind areas[96]. Anticipated busy areas in the city should have parklands situated or created upwind in the dominant wind direction[97]. Abandoned industrial settings in coastal zones can be a particular target for revegetation
- Green roofs: Installing rooftop gardens can significantly reduce heat transfer into buildings as well as encourage evapotranspiration and biosequestration. Climbing varieties of plants can also have the same effect on walls, and have been used extensively in cities such as Singapore. Green roofs allow for greater water retention and decrease storm water intensity and nutrient loads

- Cool roofs: Replacing traditional roofing materials with material that has high solar reflectance (or albedo) can reduce summer peak temperatures by more than 30%[98]. Cool roofs on low-slope buildings should be smooth with a bright white surface to reflect solar radiation, reduce heat transfer to the interior and reduce summer air conditioning demand. Steeper roofs should be coloured white to reflect the sun's energy[99]
- Cool paving: Replacing hard, dark-coloured paving with materials which minimise the absorption of solar heat and the subsequent transfer of this heat to the surroundings to reduce the UHI effect. Recommended surfaces are permeable, porous pavement, and plastic lattice structures filled with soil, gravel, and grass which also allow water to filter into the ground, keeping the pavement cool when moist[100]
- Stormwater harvesting: Biofilters (including street trees and bioretention systems) and porous pavement filters can be developed further to treat harvested stormwater. Novel distributed underground tanks for storages can be developed and existing solutions such as aquifer storage and recovery should be further refined
- The core response will be the way in which all aspects of our Melbourne region are planned and developed in an integrated co-ordinated manner. Such planning and development only becomes more important as our region expands by 1000 people a week. It must encompass buildings, roads, energy, water, transport and all major infrastructure

Barriers

A range of barriers currently prevent the further development of resilience to climate change within our urban environment.

- Lack of integrated management of green spaces

  There is a lack of integrated management for Melbourne's green spaces. The multitude of green space owners, the scale and communication failures of green space management need to be addressed to create an integrated approach to identify, create and manage new green space[101]

- Lack of policy and legal framework

  There is little or no provision in the federal, state or local government legislation to encourage the creation of green space. In addition, there are no legal frameworks, instruments or mechanisms to engage or encourage public and private landholders to create green space opportunities[102]. Nor are there any legal frameworks to determine who has the right to harvest and re-sell stormwater, and under what circumstances. Policy and planning schemes need to be reviewed and amended to allow for the creation of green space. Stakeholders need to work with local government to support the creation of new green space, particularly in coastal zones, through the creation of policy and by amending current planning schemes across Melbourne, in support of *Melbourne 2030* and local settlement policies[103]

Enablers

Enabling actions which will facilitate the increased development of urban resilience include:

- Funding

  Securing funding sources and incentives from government, business and community will enable the creation of green space and supporting infrastructure[104].

  There is a lack of funding to establish urban green space. In addition there is vulnerability in funding for urban green space due to budget cuts and competition from other services within local, state and federal authorities[105]. Traditionally, funding has tended to focus on rural or regionally located green space or revegetation projects[106]

- Partnerships

  Establishing more green space across Melbourne will create partnerships within government, the community and other organisations. A partnership approach to green space creation and management would include interested parties jointly managing an area. Potential members of partnerships include local authorities, residents' groups, wildlife groups, landscape maintenance charities and groups of individuals with a common interest. A management committee which oversees the make up of partner groups could then manage the open space[107]

- Awareness

  Awareness of the UHI effect and the benefits of green space is low among key decision makers and funding sources. Awareness raising of these issues is predominantly limited to non-government organisations[108]

KEY RECOMMENDATIONS

Advocacy

1. **Incorporate vegetative roofs into building standards and promote the creation of 'green' roof credits.**
2. **Modification of Melbourne metropolitan planning and zoning to include mandatory standards for more green space.**

There is scope to increase the green space cover across Melbourne. This will be achieved through a variety of methods, such as financial contributions from developers, grant funding, partnership agreements and management plans. There needs to be a clear plan of action that identifies roles and responsibilities, defines the structure, relationships and responsibilities of supporting bodies and individuals. A green space action plan for Melbourne would require the commitment of all cross-sector stakeholders from the outset, including land owners, industry, government and researchers. It would be imperative that all new developments have appropriate green space that services the community and ecosystem. Melbourne's urban design and development strategies should be reviewed, seeking to initiate and promote ways to help limit UHIs, and create green space.

Identifying potential or existing areas, using geographic information system mapping, should be a first step to integrated protection and maintenance. The strategy would identify biologically diverse linkage zones.

5.7 Business procurement to reduce greenhouse gas emissions

Background

Every year, Victorian businesses spend billions of dollars procuring goods and services.

The scale of this activity and the embedded GHG emissions associated with each transaction, mean there is vast potential for governments, business and individuals to review everyday procurement activities and minimise overall GHG emissions[109].

Sustainable procurement balances business needs with economic development, social development and environmental protection[110]. It includes techniques such as:

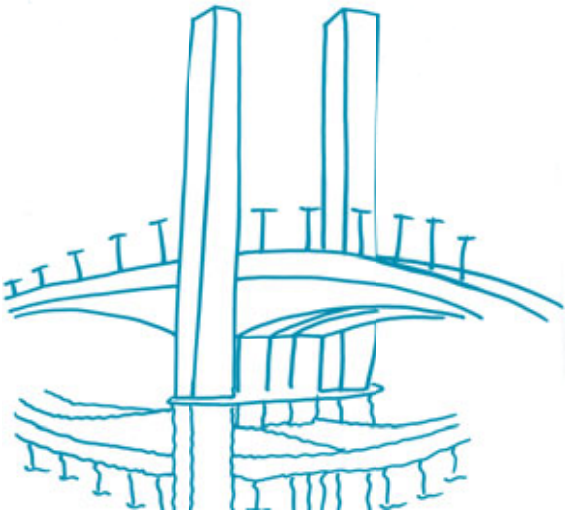
- Minimising environmental impacts and maximising value for money over the whole-of-life of the goods and services
- Supporting suppliers' socially responsible practices, including compliance with legislative obligations to employees[111]

Opportunities

A key opportunity exists for businesses to satisfy a growing demand from consumers for purchase decisions to include environmental as well as financial considerations. This can be achieved through sustainable procurement programs.

Sustainable procurement programs aim to deliver products and services which reduce ecological damage and emissions from consumed products along their lifecycle (production, consumption and disposal stages)[112]. A properly structured sustainable procurement system allows businesses to buy goods and services that have a substantially lower impact on the environment, while maintaining quality, functionality and cost competitiveness[113]. Sustainable procurement can offer resource effectiveness and cost savings by minimising what is used in the first place[114]. Key aspects of a sustainable procurement program that can be implemented by an organisation include specifications reflecting performance needs, analyses of alternatives, bulk purchasing, competitive bidding and whole-of-life costing[115]. Sustainable products and appliances are often cheaper to run, energy- and resource-efficient, and can offer ongoing cost savings on utilities, (energy and water bills)[116].

Changing which products and services are purchased and used by an organisation can reduce an organisation's emissions and improve resource efficiency.



Currently, there exists a sustainable purchasing program targeting Victorian local government, state government agencies and business, known as ECO-Buy. ECO-Buy is a not-for-profit company supported by Sustainability Victoria and the Department of Sustainability and Environment, which has grown out of a previous joint initiative of the Municipal Association of Victoria, EcoRecycle Victoria and the Victorian Greenhouse Strategy. It operates as a centre of excellence in sustainable purchasing. It encourages increased supply, demand and use of environmentally preferred products and services[117].

Barriers

There are many barriers to implementing sustainable procurement strategies including:

- Higher perceived costs of sustainable products: The price of sustainable products is often regarded as a barrier to sustainable purchasing[118]. The cost of some sustainable products and services might be higher in the initial stages of procurement, however, the cost over the lifecycle of the product or service might well prove to be cheaper, and reduce costs in the longer term[119]
- Lack of information: A critical barrier for implementing sustainable procurement strategies is communication. One of the major barriers to buying sustainable products and services is that purchasers are generally unaware that the products and services have an environmental impact or that alternative, 'greener' versions of the products exist. A way to overcome this is to implement awareness programs within organisations to regularly remind staff about buying 'green'[120]
- Lack of education: The lack of education and professional development opportunities within the public and private sectors are a major barrier to implementing sustainable procurement[121]

Enablers

There are currently many enablers for sustainable procurement. These include:

- Awareness raising and information provision: Integrating training and awareness programs will establish sustainable procurement in the public and private sector. Organisations should be made aware that consumers are increasingly demanding products to be manufactured and delivered in an environmentally responsible way, and that implementing sustainable purchasing can raise an organisation's corporate profile and help win new business[122]
- Partnerships: Partnerships between suppliers and purchasers will see sustainable procurement strategies for business and government developed and implemented[123]
- New markets: Investment stimulates local and global markets to innovate and produce more sustainable products and services for public and private organisational purchasers[124]

KEY RECOMMENDATIONS

Actions

1. **Development of educational curricula and training activities**

Facilitate broad-scale guidance and decision support about sustainable procurement for Members through a partnership with ECOBuy. An 'Introduction to Sustainable Procurement' training course would be facilitated for Members to provide professional development for organisations wishing to implement sustainable procurement policies and practices.

2. **Create an index of sustainable procurement organisations**

Create an index of sustainable procurement organisations in Victoria to promote the model among Melbourne organisations including Members. This index will be broad enough to include government and non-government contributors, vendors, consultants, groups, organisations and trainers, and how they can help – for example, listing available resources such as databases of sustainable products and training.

5.8 Overarching Recommendations

Overarching recommendations

1. **All new and proposed amendments to government legislation should require a climate change impacts assessment including measures to accommodate resilience and adaptation to effects of climate change, such as:**

- Impacts of extreme events: Storm surges, intense storms and increased frequency of flooding and bushfires
- Water: Efficient and sustainable approaches including storm water capture and use, water recycling and reuse and desalination
- Ecosystem services: Land-use management, green space protection and enhancement, biodiversity conservation, and ecosystem benefits such water and air quality must be safeguarded by co-ordinated planning and decision-making at all levels of government
- Health: There must be provision for health services to be able to respond rapidly to events such as extended heat waves, or the appearance of previously absent vector-borne diseases

2. **Advocate substantial amendments to the planning schemes to include:**

- Mandatory standards for the sustainable retrofit of existing buildings
- Mandatory standards for minimum levels of urban green space
- 'As-of-right' six-storey/30m height development[125] along high frequency public transport routes, subject to local green space and heritage considerations

3. **Utilise the Asia Pacific Institute for Sustainable Cities to facilitate the co-ordinated uptake of existing funding schemes across Victoria:**

- In Australia, 80% of the population lives in cities. Ours is therefore the world's most urbanised continent
- The Institute would engage with industry, academia, civil society and government to facilitate projects which will aid Australia's and other Asia Pacific nation's mitigation and adaptation to sustainability
- The focus on urban issues would encompass a resilient water supply, low emission development of clean energy, sustainable building design, regional planning, and public transport

5.9 What's next

The Climate Change Taskforce has created the foundation for recommending a platform of ideas for actions or advocacy which would benefit Melbourne in our response to climate change.

It is now time for the Climate Change Taskforce to lead us into the outcomes we seek in our *FutureMap*. Accordingly, smaller action groups will be formed to drive each recommendation. If the idea requires direct action to be taken, we will look to our Members to participate in guidance and decision support programs, set targets and then take a leadership role in implementing the actions.

We acknowledge the time and expertise of our Climate Change Taskforce members in defining our ideas on opportunities for Victoria arising from climate change.

We now need the commitment of our Members to take those ideas and make them positive outcomes for Melbourne.

6 EXTRAS

6.1 Glossary

Throughout this *FutureMap* the terms mitigation and adaptation are regularly used. These terms are defined below as are others which are defined in this report.

Adaptation

Refers to measures to reduce the vulnerability of natural and human systems to the impacts of climate change, be they presently observed impacts, unavoidable future impacts, or the possible dangerous impacts that will occur if mitigation is unsuccessful or slow.

CO_2e

Equivalent carbon dioxide describes how much global warming a given type of greenhouse gas may cause, using the functionally equivalent amount or concentration of carbon dioxide as the reference.

CSIRO

Australian Commonwealth Scientific and Industrial Research Organisation.

Decadal-scale

A timescale greater than ten years.

Deciles

Refers to categories for (typically) rainfall totals. Decile 1 refers to totals that are within the lowest 10% of all recorded values. Decile 10 refers to totals that fall within the top 10% of all recorded values.

GHG emissions

Greenhouse Gas Emissions.

IPCC

Refers to the Intergovernmental Panel on Climate Change. The IPCC is a scientific intergovernmental body, set up by the World Meteorological Organisation (WMO) and by the United Nations Environment Programme (UNEP). The IPCC was established to provide the decisions-makers and others interested in climate change with an objective source of information about climate change.

Kt

Kilotonne

Mitigation

Refers to the implementation of policies that reduce GHG emissions or enhance carbon sinks. Underpinning the actions recommended in this *FutureMap* is the assumption that an ETS will be implemented in Australia in 2010, with accompanying national targets for reducing GHG emissions. Included in mitigation, then, are the actions that are required to respond to a carbon price.

NETS

National Emissions Trading Scheme.

NGO

Non Government Organisation.

6.2 Climate change mitigation assumptions

There is now considerable modelling evidence to support the need to reduce greenhouse gas emissions and prepare for a changing climate[126].

Climate change mitigation activities fundamentally require assumptions to be made about the predicted magnitude, timing and impacts of climate change based on estimated future emissions growth. Future GHG emissions are the product of very complex dynamic systems, determined by driving forces such as demographic and socio-economic development and technological change. As there are an infinite number of possibilities to describe future emissions growth, a range of scenarios have been developed that reflect plausible states of the future world. The possibility that any single emissions path will occur as described in such scenarios is highly unlikely.

The set of emissions scenarios most commonly used are the Special Report on Emission Scenarios (SRES) and are used by the IPCC. The SRES scenarios do not include climate change mitigation policies but represent different demographic, social, economic, technological, and environmental developments, which might be viewed positively by some people and negatively by others. The SRES scenarios were used by the IPCC in its recent Fourth Assessment Report to determine that, by 2100, global emissions will have led to CO_2 carbon dioxide concentrations in the atmosphere of between 600-1550ppm, causing temperature increases of between1.1 and 6.4°C above 1990 levels.

Recent analysis of observed global emissions has shown that GHG emissions over the past decade have been growing faster than the highest growth projections of the SRES. The Garnaut Climate Change Review in its recent interim report noted that between 2000 and 2006 global emissions grew by 3.1% per year, compared with emissions growth of only 1.1% during the 1990s (when the SRES was developed), and are likely to continue to grow rapidly.

Stabilisation scenarios are becoming more widely used to show what the world needs to achieve, to limit temperature increases to certain thresholds. Significantly it has now been formally recognised by parties to the Kyoto Protocol[127] that developed countries need to make cuts to emissions of 25-40% on 1990 levels by 2020 to ensure that global average temperature does not increase by more than 2.4°C from pre-industrial levels.

Current and future climate change assumptions made within this *FutureMap* are based on the most recent climate change data presented by the Australian and Victorian governments, Victorian Government Department of Sustainability and Environment, CSIRO and IPCC. Climate change assumptions and predictions are presented in chapters 2 and 3.

Other assumptions include:

- An Australian ETS will be implemented in 2010
- The regulatory framework in Australia relating to GHG emissions, energy, water and waste will increase in scope and requirement
- The Victorian population will increase significantly
- Energy and resource consumption in Victoria will increase significantly
- The benefits of avoided climate change damages are sufficiently large to offset the costs

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