The Senate

Environment and Communications References Committee

Current and future impacts of climate change on housing, buildings and infrastructure

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Abbreviations

ABCB	Australian Building Codes Board
ABR	Australian Business Roundtable
ABS	Australian Bureau of Statistics
ACCA	Australian Coastal Councils Association
ACCARNSI	Australian Climate Change Adaptation Research Network for Settlements and Infrastructure
ACCC	Australian Competition and Consumer Commission
ACCU	Australian Carbon Credit Unit
ALGA	Australian Local Government Association
AMA	Australian Medical Association
APEEL	Australian Panel of Experts on Environmental Law
ARC	Australian Research Council
ARR	Australian Rainfall and Runoff Guidelines
ASBEC	Australian Sustainable Built Environment Council
BASIX	Building Sustainability Index
Breakthrough	Breakthrough National Centre for Climate Restoration
CBD	Central Business District
C-FAST	City based Flood Adaptation Solutions Tool
COAG	Council of Australian Governments
CRISP	Climate Risk Information and Services Platform
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEA	Doctors for the Environment Australia
DI	Discomfort Index
EAGA	Eastern Alliance for Greenhouse Action
EIANZ	Environment Institute of Australia and New Zealand
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)

EUA	Environmental Upgrade Agreement
FFDI	Forest Fire Danger Index
Finkel Review	Independent Review into the Future Security of the National Electricity Market, chaired by Dr Alan Finkel AO (2017)
FMA	Floodplain Management Australia
GBRMPA	Great Barrier Reef Marine Park Authority
HIA	Housing Industry Association
IGCC	Investor Group on Climate Change
IPCC	Intergovernmental Panel on Climate Change
LGAQ	Local Government Association of Queensland
MWh	Megawatt hour
NABERS	National Australian Built Environment Rating System
NAGA	Northern Alliance for Greenhouse Action
NatHERS	Nationwide House Energy Rating Scheme
NCC	National Construction Code
NCCARF	National Climate Change Adaptation Research Facility
NDRRA	Natural Disaster Relief and Recovery Arrangements
NEM	National Electricity Market
NEXIS	National Exposure Information System
NIBA	National Insurance Brokers Association of Australia
PACE	Property Assessed Clean Energy
PC	Productivity Commission
PV	Photovoltaic
QTIC	Queensland Tourism Industry Council
RCP	Representative Concentration Pathway
RDA South West	Regional Development Australia – South West
SECCCA	South East Councils Climate Change Alliance
TCAP	Tasmanian Coastal Adaptation Pathways
TCRM	Tropical Cyclone Risk Model
UHI	Urban heat island

UK	United Kingdom of Great Britain and Northern Ireland
UNSW	University of New South Wales
US	United States of America
WALGA	Western Australian Local Government Association
WBGT	WetBulb Globe Temperature
WSAA	Water Services Association of Australia

Chapter 1

Introduction

1.1 On 9 May 2017, the Senate referred the following matter to the Environment and Communications References Committee for inquiry and report:

> The current and future impacts of climate change on housing, buildings and infrastructure, accounting for the full range of projected climate scenarios, having regard to matters, including:
>
> (a) recent and projected changes in sea level rises, and storm surge intensity;
>
> (b) recent and projected changes in temperature and precipitation;
>
> (c) recent and projected changes in extreme weather, including heatwaves, bushfires, floods, and cyclones;
>
> (d) recent and projected changes in natural coastal defence systems including coral reefs, kelp and mangrove forests;
>
> (e) the impact of these changes on the vulnerability of infrastructure in coastal areas;
>
> (f) the impact of these changes on water supply and sewage treatment systems;
>
> (g) the impact of these changes on transportation, including railways, roads and airports;
>
> (h) the impact of these changes on energy infrastructure, including generators and transmission and distribution lines;
>
> (i) the impact of these changes on health, education and social services infrastructure, including hospitals, schools and aged care;
>
> (j) the impact of these changes on private and public housing;
>
> (k) the impact of these changes on public recreation and tourism facilities;
>
> (l) the impact on financing and insurance arrangements for housing, buildings and infrastructure;
>
> (m) the adequacy of current state and Commonwealth policies to assess, plan and implement adaptation plans and improved resilience of infrastructure; and
>
> (n) any other related matters.[1]

1 *Journals of the Senate*, 9 May 2017, p. 1305.

1.2 The committee was initially required to report by 23 November 2017. However, on 16 October 2017, the Senate granted an extension of time to report until 27 March 2018. On 13 February 2018, the Senate granted a further extension of time to report until 27 June 2018. A final extension to 13 August 2018 was granted by the Senate on 25 June 2018.[2]

Conduct of the inquiry

1.3 In accordance with its usual practice, the committee advertised the inquiry on its website and wrote to relevant individuals and organisations inviting submissions. The date for receipt of submissions was 16 August 2017, although the committee received and considered submissions after that date.

1.4 The committee received 65 submissions, which are listed at Appendix 1.

1.5 The committee held three public hearings for this inquiry, as follows:

- Sydney, 23 November 2017;
- Melbourne, 15 March 2018; and
- Canberra, 22 March 2018.

1.6 A list of witnesses who appeared at the hearings is at Appendix 2. The public submissions and transcripts of evidence are available on the committee's website at www.aph.gov.au/senate_ec.

Acknowledgement

1.7 The committee thanks all of the individuals, organisations and governments that contributed to the inquiry.

Structure of the report

1.8 Chapter 1 of this report has outlined introductory matters about this inquiry. Chapters 2 to 10 provide an overview of the evidence provided to the committee. Members of the committee have expressed their views in additional comments attached to this report.

1.9 An outline of the matters examined in Chapters 2 to 10 is below:

- Chapter 2 provides background information about the recorded and projected changes in the Australian climate that are of particular relevance for the built environment.
- Chapter 3 considers how improved understanding of climate risks can support risk management and effective climate change adaptation.

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2 *Journals of the Senate*, 17 October 2017, p. 2084; 13 February 2018, p. 2690; 25 June 2018, p. 3271.

- Chapter 4 examines the implications of climate change for approaches to urban and coastal planning, including planning for sea level rise, addressing the urban heat island effect and managed retreat.
- Chapter 5 discusses how climate change is influencing developments in the markets for insurance and property finance.
- Chapter 6 focuses on the risks climate change presents relating to residential and commercial buildings, including the resilience of buildings to extreme weather events and heat stress from unsafe internal temperatures.
- Chapter 7 addresses the implications of climate change for transportation infrastructure and the infrastructure used for water supply, sewage treatment and energy.
- Chapter 8 considers the implications of climate change for the buildings and infrastructure relied on for health care, aged care, education, tourism and public recreation.
- Chapter 9 discusses the overall approaches taken by the Australian, state and territory governments regarding adaptation planning and policies to improve the resilience of infrastructure to climate change. Whether current legislative and institutional arrangements within government are appropriate for responding to climate change risks, the coordination of government policies on climate change, and the approach taken to increasing the resilience of infrastructure following natural hazard events are particular areas of focus.
- Chapter 10 outlines specific issues local governments face in responding to the threats climate change presents to buildings and infrastructure.

Note on references

1.10 Many submissions to this inquiry cited published research extensively. This report cites the evidence presented to the committee in the submissions, however, where the author of a submission refers to original research, the citation is generally omitted from this report. Readers should refer to the submissions for details of the research relied on for the evidence presented to the committee (as noted above, the public submissions are available on the committee's website).

Chapter 2

Australia's changing climate and its implications for the built environment

2.1 Australia has a significant amount of residential dwellings, other buildings and infrastructure. As the Australian Sustainable Built Environment Council (ASBEC) explained, 2015 figures indicate that there are almost 8 million buildings across the country, and that these buildings have a replacement cost of approximately $5.7 trillion. These buildings include:

- over 7.5 million residential buildings with a replacement value of $3.5 trillion;
- around 215,000 commercial buildings worth $1.8 trillion; and
- around 139,000 industrial buildings worth $0.3 trillion.[1]

2.2 Other essential infrastructure networks are also extensive and of high value, such as roads, railways and energy infrastructure.

2.3 These buildings and other infrastructure assets need to withstand the Australian climate. Australians are already familiar with extreme events such as heatwaves, cyclones, bushfires and floods that have caused extensive damage to cities and infrastructure and resulted in deaths and injuries. Due to climate change, however, many types of extreme events are expected to become more frequent or more intense. Coastal areas are also experiencing rising sea levels and more intense storm surges.

2.4 Damage from extreme events can already be significant, both in terms of human life and economic cost. To understand the implications for Australia's infrastructure, this chapter highlights the evidence received about recent changes to the climate system, terrestrial environment and the marine environment that are relevant when considering future challenges for housing, buildings and infrastructure.

2.5 Available evidence about projected changes is also discussed, noting that there is uncertainty about such projections and that future changes are dependent on the emissions pathway taken. In doing so, the report refers to the four emission pathways adopted in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The following extract from CSIRO's submission provides a useful explanation of the IPCC's emissions pathways framework:

> The magnitude and nature of multi-decadal to centennial climate change that the world is likely to experience depends strongly on actions to reduce the emissions of greenhouse gases. The Intergovernmental Panel on Climate Change's Fifth Assessment Report (IPCC AR5) adopted four Representative Concentration Pathways (RCPs) to span the range of

1 Australian Sustainable Built Environment Council (ASBEC), *Submission 26*, p. 2.

> possible future trajectories in terms of the resulting greenhouse gas concentrations in the atmosphere. The four RCPs are RCP2.6, RCP4.5, RCP6, and RCP8.5; these are named technically after future radiative forcing values, but basically range from very low to high emissions pathways, and include the effects of burning fossil fuels as well as greenhouse gas emissions from land use change and industrial processes such as concrete manufacturing. The Paris Agreement goals are consistent with a future concentration pathway that falls between RCP2.6 and RCP4.5; whereas current commitments by countries are more consistent with the RCP4.5 trajectory at least until 2030 or so…RCP4.5 is often referred to as an 'intermediate emissions scenario'. A continuation of historical emissions is more consistent with the RCP8.5 trajectory. Given there is not yet any certainty that the world will meet the Paris Agreement commitments, good risk management should consider this whole range of future climates.[2]

Sea level rises and coastal erosion

2.6 Sea levels have risen over the 20th century as a result of ocean thermal expansion[3] and an increase in water entering the ocean from melting glaciers and ice caps.[4] CSIRO submitted that between 1966 and 2009, the average rate of relative sea level rise from observations along the Australian coast was 1.4 ± 0.2 millimetres per year.[5] Globally, sea levels increased between 1993 and 2016 at 'an average rate of 2.6 to 2.9 millimetres per year, amounting to a total increase in the order of 7 centimetres over that period'.[6]

2.7 A joint submission from several Australian Government departments and agencies added that the overall trend in sea level rise is affected by variability, such as El Niño and La Niña events. The submission noted:

> A strong event, such as the 2015-16 El Niño or the 2010-11 La Niña, can result in fluctuations of 5 to 10 millimetres in global sea level over periods

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2 CSIRO, *Submission 45*, p. 7 (citation omitted).

3 As the ocean warms, its density decreases resulting in an increase in volume. See JA Church and JM Gregory et al, 'Changes in Sea Level' in *Climate Change 2001: The Scientific Basis: Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, JT Houghton and Y Ding et al (eds), 2001, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 644.

4 CSIRO, *Submission 45*, p. 7; Climate Council of Australia, *Submission 40*, p. 3. For a detailed analysis of sea level change, see JA Church and PU Clark et al, 'Sea Level Change' in *Climate Change 2013: The Physical Science Basis—Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, TF Stocker and D Qin et al (eds), 2013, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

5 CSIRO, *Submission 45*, p. 7.

6 Department of the Environment and Energy, Bureau of Meteorology, Great Barrier Reef Marine Park Authority, Attorney-General's Department, Department of Agriculture and Water Resources, and Geoscience Australia, *Submission 39*, p. 13.

> of 6 to 12 months, with larger shifts on individual coastlines. (Sea levels in the western Pacific, including eastern and northern Australia, are generally lower during El Niño events and higher during La Niña events).[7]

2.8 Nevertheless, it is expected that by 2020 the Australian sea level will, on average, be 0.06 to 0.19 metres above the 1986–2005 level. The rate of increase is expected to be faster than that experienced over the 20th century, due to continued ocean thermal expansion and melting glaciers and ice caps, as well as the loss of mass from ice sheets, and changes in the mass of water stored on land.[8]

2.9 CSIRO added that whether a low or high emissions pathway is taken is expected to have only a limited impact on the committed amounts of sea level rise 'over the next decade or so'. However, CSIRO emphasised that future sea level rises later in this century will be sensitive to the amount of global greenhouse emissions. CSIRO submitted:

> By 2090, intermediate global emissions (RCP4.5) are likely to lead to a global sea-level rise of 0.27 to 0.66 m. High global emissions (RCP8.5) are likely to lead to a rise of 0.38 to 0.89 m. However, a collapse of the marine-based sectors of the Antarctic ice sheet could add several tenths of a metre to sea-level rise late in the century…[9]

2.10 It is widely accepted that climate change could result in increased numbers of coastal properties being damaged or lost due to storm surges, increased coastal erosion and higher sea levels. The ASBEC submitted that the impacts of these climate change-related developments 'are being seen already in many Australian coastal settlements'.[10] Local governments advised that coastal assets are already being affected, and that the cost to protect, upgrade and repair such assets is expected to increase with climate change and sea level rise.[11]

2.11 The Climate Council of Australia advised that the exposure of coastal assets to sea level rise 'is very large and the risks are set to increase'. The Climate Council submitted that, across Australia, more than $226 billion (2008$) in commercial, industrial, road and rail, and residential assets are potentially exposed to flooding and erosion hazards at the high-end scenario of 1.1 metres of sea level rise by 2100. This figure includes 5800 to 8600 commercial buildings, with an estimated replacement value of $58 billion–$81 billion; 3700 to 6200 light industrial buildings,

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7 Department of the Environment and Energy et al, *Submission 39*, p. 13.

8 CSIRO, *Submission 45*, pp. 7–8.

9 CSIRO, *Submission 45*, p. 8.

10 ASBEC, *Submission 26*, p. 2.

11 See Hobsons Bay City Council, *Submission 7*, p. 6.

with an estimated replacement value $4.2 billion–$6.7 billion; and 27,000 to 35,000 kilometres of roads and rail, with a replacement value of $51 billion–$67 billion.[12]

2.12 In 2006, it was estimated that approximately 3 per cent of addresses in Australia are within three kilometres of the shoreline in areas less than five metres above mean sea level.[13]

2.13 The committee received evidence of how sea level rises are expected to affect individual cities and communities. Examples include:

- Darwin—the Northern Territory Government advised that around 180 residential buildings in Greater Darwin are estimated to be at risk from a 1.1-metre sea level rise. In addition, '190 buildings within 110 metres of the high tide mark…are at risk from erosion'.[14] The Government added that the threat is particularly evident around Darwin 'because Darwin's coastal cliffs are comprised of erodible, soft rock necessitating continual remediation and reinforcement by local government'.[15]
- Collaroy-Narrabeen Beach—the committee was advised that this beach is the most vulnerable to erosion from coastal storms in northern Sydney (and is considered be the third most at risk area from coastal processes in Australia). The Environment Institute of Australia and New Zealand noted that in 2016 an estimated $30 million in damage was caused by severe storms that eroded away about 50 metres of beach and caused extensive property damage.[16]
- City of Lake Macquarie—the local council informed the committee that a 0.9-metre increase in relative sea level is expected to result in the permanent inundation of over 93 hectares of residential zoned land, along with the loss of public land and facilities.[17]

2.14 The National Climate Change Adaptation Research Facility (NCCARF) at Griffith University has published maps indicating how sea level rise place areas of Australia potentially at risk of inundation. The maps are indicative only, and do not take into account storm surge or wave height, nor do they take into account sea walls,

12 All dollar figures are 2008$. Climate Council of Australia, *Submission 40*, p. 4 (citation omitted).

13 K Chen & KJ McAneney, 'High-resolution estimates of Australian coastal population', *Geophysical Research Letters*, 33, 2006; cited in B Cechet, P Taylor, C Griffin and M Hazelwood, 'Australia's coastline: adapting to climate change', *AusGeo News*, no. 101, March 2011, Geoscience Australia, www.ga.gov.au/ausgeonews/ausgeonews201103/climate.jsp (accessed 5 January 2018).

14 Northern Territory Government, *Submission 17*, p. 2.

15 Northern Territory Government, *Submission 17*, p. 2.

16 Environment Institute of Australia and New Zealand, *Submission 36*, p. 4.

17 Lake Macquarie City Council, *Submission 29*, p. 2.

barriers or erosion. Noting the limitations, the maps provide an accessible means for understanding the potential risks of sea level rise for particular communities.

2.15 The maps for Brisbane and the Gold Coast for 2100 under a low emissions scenario follow at Figure 2.1 (on page 10) and Figure 2.2 (on page 11).

Changes in temperature and extreme heat events

2.16 Along with sea level rises, change in temperature is perhaps the consequence most readily associated with climate change. The Climate Council provided the following explanation of how greenhouse gas emissions from human activities affects temperature and precipitation:

> As greenhouse gases increase in the atmosphere, primarily carbon dioxide from the combustion of fossil fuels (coal, oil and gas), the climate system is warming because these gases are trapping more heat. The oceans are also warming, especially at the surface, and this is driving higher evaporation rates that, in turn, increases the amount of water vapour. In addition, a warmer atmosphere can hold more water vapour, leading in turn to more intense rainfall. The 1°C temperature rise that has already occurred, together with increasing evaporation, has led to an increase of about 7% in the amount of water vapour in the atmosphere.[18]

Temperature

2.17 CSIRO submitted that Australia's mean land surface air temperature and surrounding sea surface temperature have both increased by around 1°C since 1910. CSIRO added that:

> In recent decades, months warmer than average occur more often than months colder than average. And since 2001, the number of heat records in Australia has outnumbered extreme cool records by about 3 to 1 for daytime maximum temperatures, and about 5 to 1 for night time minimum temperatures.[19]

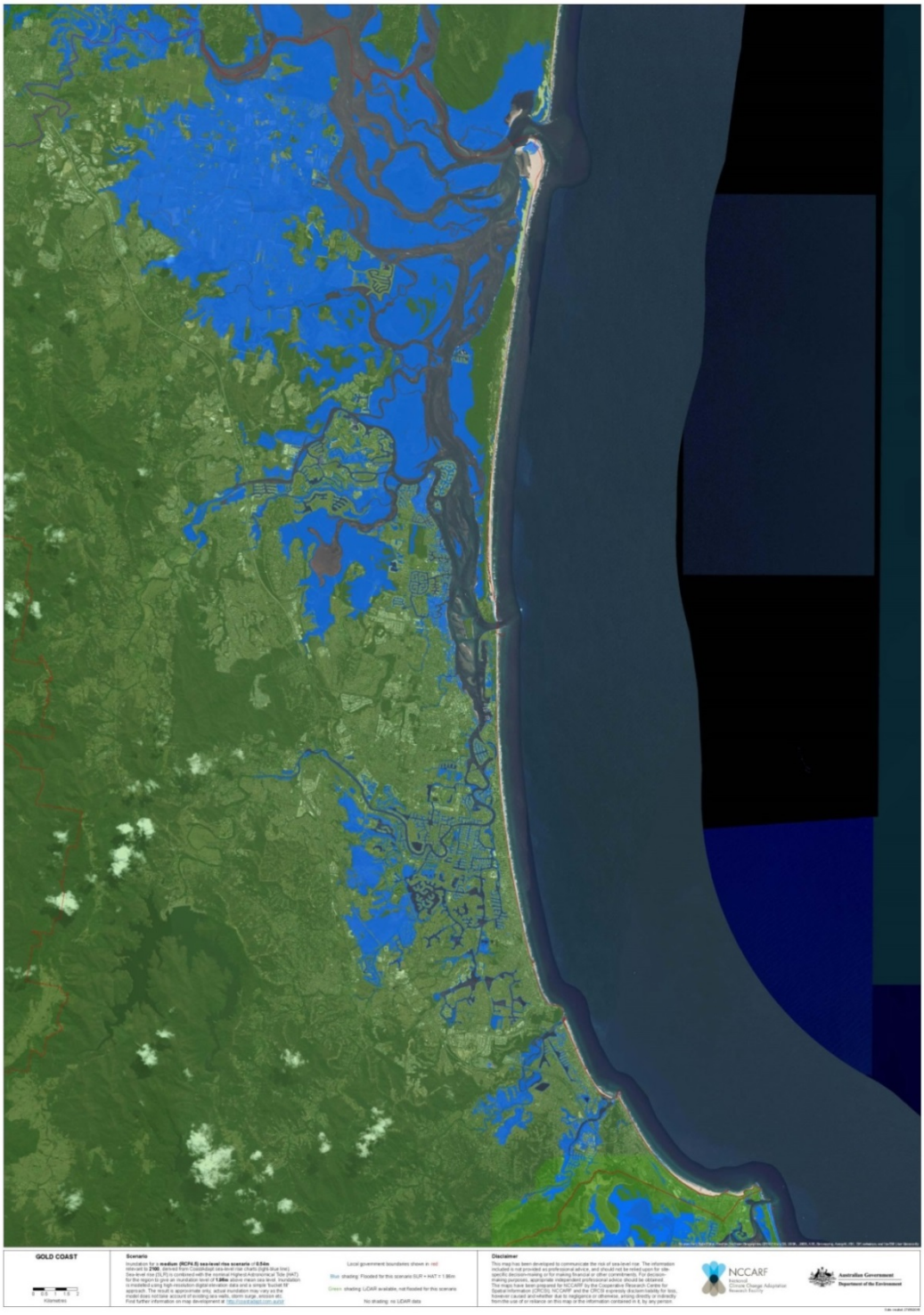
2.18 Recorded temperature changes by region are depicted at Figure 2.3 (on page 12).

18 Climate Council of Australia, *Submission 40*, p. 8.

19 CSIRO, *Submission 45*, p. 8.

Figure 2.1: Brisbane, potential inundation in year 2100 under low greenhouse gas scenario (RCP4.5)

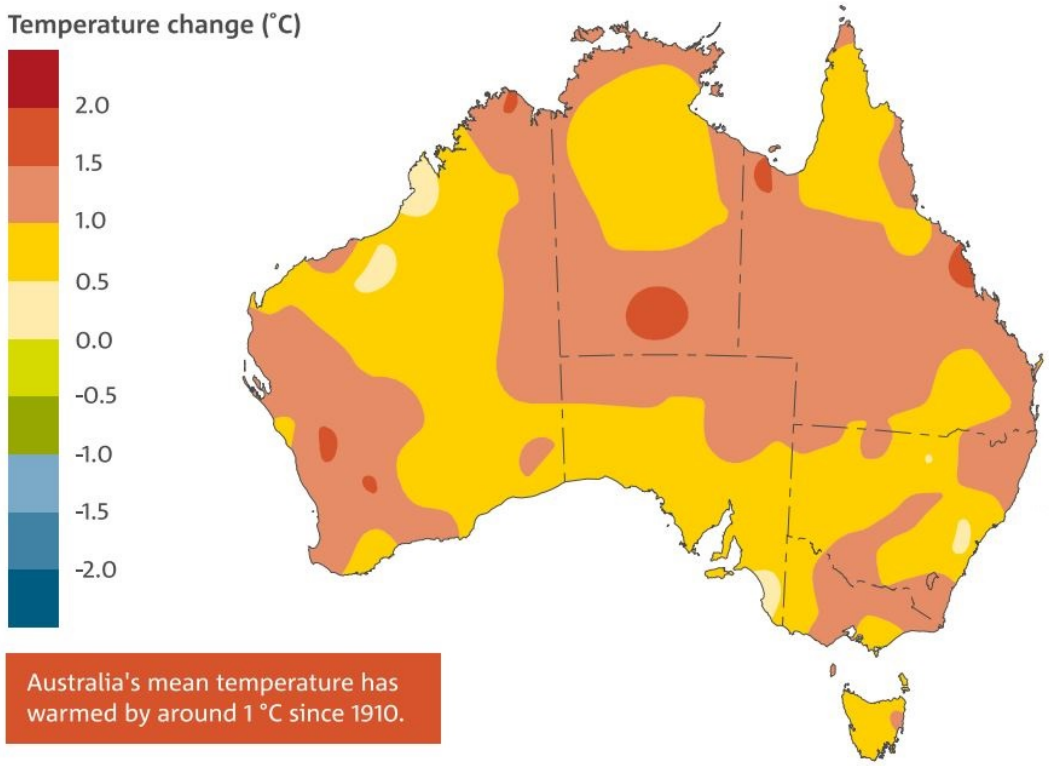
Figure 2.2: Gold Coast, inundation in year 2100 under low greenhouse gas scenario (RCP4.5)



Note: These maps illustrate a sea-level rise scenario of 0.54 metres relevant to 2100, derived from CoastAdapt sea-level rise charts, combined with the nominal highest astronomical tide that gives an inundation level of 1.96m above mean sea level. Inundation has been modelled using high-resolution digital elevation data and a simple 'bucket fill' approach. As noted above, the model does not take account features such as sea walls. Further information on how the maps have been developed is available at https://coastadapt.com.au/slr.

Source: NCCARF, 'Sea-level rise and future climate information for coastal councils', CoastAdapt, https://coastadapt.com.au/slr (accessed 9 January 2018).

Figure 2.3: Annual mean temperature changes across Australia since 1910



Source: Bureau of Meteorology; published in CSIRO and Bureau of Meteorology, 'Report at a glance' in *State of the Climate 2016*, www.bom.gov.au/state-of-the-climate/index.shtml (accessed 9 January 2018).

2.19 When considering future changes, CSIRO warned that there are two key uncertainties: future anthropogenic emission trajectories of greenhouse gases and the response of the Earth's climate system to those emissions.[20]

2.20 Notwithstanding this, CSIRO submitted that regional climate projections indicate that 'mean, daily minimum and daily maximum temperatures will continue to increase throughout this century for all parts of Australia'. CSIRO continued:

> The magnitude of the warming later in the century will depend on global emissions. By around 2030, Australian annual average temperature is projected to increase by 0.6-1.3 °C above the climate of 1986-2005 under intermediate global emissions (RCP4.5), with little difference in warming between different emission (i.e. RCP) scenarios. The projected temperature range by 2090 is 0.6 to 1.7 °C for low emissions, 1.4 to 2.7 °C for intermediate emissions and 2.8 to 5.1 °C for high emissions. Inland areas are likely to warm more than coastal areas.[21]

20 CSIRO, *Submission 45*, p. 9.

21 CSIRO, *Submission 45*, p. 9.

Heatwaves

2.21 A heatwave event is a period of abnormally hot weather that lasts several days.[22]

2.22 Overall, the evidence received by the committee during this inquiry noted that the duration, frequency and intensity of heat events have increased significantly. For example, CSIRO submitted that attribution studies have identified that the 2013 and 2014 heatwave events in Australia were influenced by climate change.[23] Similar evidence was provided in the Climate Council's submission, which provided the following comments on the trend in extreme heat events:

> The incidence of extreme temperatures has increased markedly over the last 50 years, and heatwaves have become hotter, are lasting longer and occur more often…Ground-breaking scientific research that tells us how much influence climate change has on a single heatwave or heat record has shown that many of the most extreme weather events, such as Australia's record hot year in 2013, were virtually impossible without climate change…The 2016/2017 summer has been described as the "Angry Summer", highlighting the extraordinary number of weather records broken…This follows the long-term trend of rising global average temperature since the 1970s, increasing at a rate 170 times faster than the background rate over the past 7,000 years…[24]

2.23 Submissions commented on a wide range of projected changes in Australia's climate and extreme events. On temperature-related changes, CSIRO explained that projections indicate that heatwaves will 'become more frequent, hotter, and longer across Australia by the end of the 21st century'. More frequent and hotter hot days are expected, with the degree of change dependant on the emissions pathway taken.[25]

2.24 Projections for individual cities were provided, such as the following evidence from CSIRO regarding expected changes in Sydney's climate:

> Sydney currently has around 27 days each year where the maximum temperature exceeds 30°C. By 2090, under intermediate global emissions of greenhouse gases (RCP4.5), there are likely to be approximately 51 days each year exceeding 30°C; under high emissions (RCP8.5), this is projected to rise to 84 days. The average longest run of Sydney days with maximum temperature exceeding 30°C is currently around four per year. By 2090, under moderate (RCP4.5) emissions this will rise to around six days and under high (RCP8.5) emissions, nine days.[26]

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22 Bureau of Meteorology, 'Glossary', www.bom.gov.au/lam/glossary/hpagegl.shtml (accessed 9 January 2018).

23 CSIRO, *Submission 45*, p. 9.

24 Climate Council of Australia, *Submission 40*, p. 1 (citation omitted).

25 CSIRO, *Submission 45*, p. 9.

26 CSIRO, *Submission 45*, p. 9.

2.25 CSIRO and the Bureau of Meteorology have undertaken analysis to project how the number of hot days in Australian capital cities will increase over time under different emissions pathways. Results of this analysis are at Table 2.1.

Table 2.1: Actual and projected average number of days per year with the maximum temperature above 35°C for Australian capital cities

City	1995	2030	2090	
		RCP4.5	*RCP2.6*	*RCP8.5*
Adelaide	20	26	32	47
Brisbane	12	18	27	55
Canberra	7.1	12	13	29
Darwin	11	43	52	265
Hobart	1.6	2.0	2.0	4.2
Melbourne	11	13	14	24
Perth	28	36	37	63
Sydney	3.1	4.3	4.5	11

Note: The 1995 figures are averages of observations for 1981–2010. The 2030 and 2090 figures are from climate model projections under different RCP scenarios.

Source: CSIRO and Bureau of Meteorology, *Climate Change in Australia – Technical Report, 2015*; cited in Climate Council of Australia, *Submission 40*, p. 6.

2.26 In urban areas, rising temperatures and a greater number of hot days per year due to climate change could exacerbate the 'urban heat island'[27] effect that city residents already experience. The following evidence received during a previous inquiry into stormwater management illustrates how heat can be significantly higher in built areas compared to nearby green areas:

> …on an early March morning at break of dawn, the temperature over Adelaide's city centre was 10 degrees warmer than it was over the Parklands. That is because of the hard surface, the heat sink and everything else like that. That relates back to a suburban environment. If you have all house and hard space—all impervious area—in an urban environment, that one park at the end of every three or four streets, no matter how well it is manicured or preserved, is not going to provide that cooling effect. It needs to be done street by street.[28]

27 The urban heat island effect describes the situation when an urban area is significantly warmer than the surrounding rural area. One of the explanations for this is because greenery, which provides a cooling effect, has been replaced with urban infrastructure to a significant extent. Waste heat from other human activities and a range of factors regarding the design of buildings and the urban environment also contribute to the heat island effect.

28 Mr Andrew King, Chair, Stormwater South Australia, *Committee Hansard*, 26 August 2015, p. 30; Senate Environment and Communications References Committee, *Stormwater management in Australia*, December 2015, p. 17.

2.27 Several submitters commented on the urban heat island effect during this inquiry. For example, the Northern Territory Government advised that it is aware that the Darwin central business district 'is consistently hotter than surrounding areas, largely due to planning outcomes and building designs that collectively contribute to the creation of a significant heat sink and source in today's climate'.[29]

2.28 The urban heat island effect is discussed further in Chapter 4. Heatwaves also have implications for the health of building occupants, which is discussed in Chapter 6.

Bushfires

2.29 Submissions commented on fire weather. Since the 1970s, longer fire seasons across large parts of Australia have been encountered.[30] CSIRO added:

> Projected warming and drying in southern and eastern Australia will lead to fuels that are drier and readier to burn, with increases in the average forest fire danger index and a greater number of days with severe fire danger…[31]

2.30 It was emphasised, however, that the influence of climate change on the amount and condition of the fuel needed for bushfires is 'complex'. To illustrate, the Climate Council noted that 'increases in rainfall may dampen the bushfire risk in one year by keeping the fuel load wetter, but increase the risk in subsequent years by enhancing vegetation growth and thus increasing the fuel load in the longer term'. Notwithstanding the complexity in assessing the implications of a changing climate for bushfire risk, the Climate Council observed that 'it is clear…that climate change is driving up the likelihood of dangerous fire weather'. The Climate Council explained:

> At higher temperatures, fuel is 'desiccated' and is more likely to ignite and to continue to burn…In addition, fires are more likely to break out on days that are very hot, with low humidity and high winds—that, is high fire danger weather…Heatwaves are becoming hotter, longer and more frequent, which is contributing to an increase in dangerous bushfire weather. Also, over the past several decades in the southeast and southwest of Australia, there has been a drying trend characterised by declining rainfall and soil moisture. Contributing to this drying trend is a southward shift of fronts that bring rain to southern Australia in the cooler months of the year…In very dry conditions, with relative humidity less than around 20%, fuel dries out and becomes more flammable…Jolly et al. 2015 and

29 Northern Territory Government, *Submission 17*, p. 3.

30 CSIRO, *Submission 45*, p. 8. Fire weather is measured using the Forest Fire Danger Index (FFDI), which estimates the fire danger on a given day based on observations of temperature, humidity, wind speed and rainfall. The 'annual 90th percentile of daily FFDI points has increased since 1974 across Australia, especially in southern and eastern Australia, and the fire season has lengthened'. CSIRO and Bureau of Meteorology, 'Australia's changing climate' in *State of the Climate 2016*, www.bom.gov.au/state-of-the-climate/australias-changing-climate.shtml (accessed 9 January 2018).

31 CSIRO, *Submission 45*, p. 10.

> Williamson et al. 2016 highlighted that the combination of droughts and heatwaves contribute significantly to particularly bad fire seasons in Australia's southeast. A study into forested regions of Australia found that, in the majority of cases, years with drought conditions resulted in a greater area of burned land…[32]

2.31 The implications of bushfires for infrastructure are already significant under current conditions. The Climate Council submitted that Deloitte Access Economics has estimated that bushfires result in annual costs of approximately $380 million on average.[33] Australia's worst bushfire disaster—the 2009 Black Saturday bushfires in Victoria—caused the loss of 173 lives and resulted in estimated damage totalling $4.4 billion.[34]

2.32 Victoria has been particularly susceptible to damage from bushfire, sustaining around 50 per cent of economic damage despite only comprising 3 per cent of Australia's total landmass.[35]

2.33 Like other natural disasters, bushfires can damage a wide range of infrastructure, including water supplies, roads and bridges, and electricity infrastructure. The Climate Council provided the following overview of how bushfires can affect essential infrastructure:

> Large-scale, high intensity fires that remove vegetation expose top soils to erosion and increased runoff after subsequent rainfall…This can increase sediment and nutrient concentrations in nearby waterways, potentially making water supplies unfit for human consumption…During the Black Saturday fires in 2009, 10 billion litres of Melbourne's drinking water were pumped to safer storage locations because of fears it would be contaminated…These bushfires affected about 30% of the catchments that supply Melbourne's drinking water. Melbourne Water estimated the post-fire recovery costs, including water monitoring programs, to be more than $2 billion…The 2016 Tasmanian wilderness fire caused more than $130 million in damages to roads, hydro-electric infrastructure and bridges…[36]

32 Climate Council of Australia, *Submission 40*, pp. 6–7 (citations omitted).

33 Climate Council of Australia, *Submission 40*, p. 7.

34 ASBEC, *Submission 26*, p. 4.

35 Climate Council of Australia, *Submission 40*, p. 7 (citation omitted).

36 Climate Council of Australia, *Submission 40*, p. 7 (citations omitted).

Precipitation, storms, cyclones and flooding

2.34 This section examines the implications of climate change for precipitation and a variety of storm and water-related risks to coastal and non-coastal areas.

Precipitation

2.35 CSIRO advised that rainfall patterns have changed. Examples put forward by CSIRO include:

- the 19 per cent reduction of May–July rainfall in the south-western region of Western Australia since 1970;
- reductions in rainfall during April–October (the growing season) in the continental south-east of Australia;
- increases in rainfall since the 1970s in parts of northern Australia; and
- decreases in average snow depths 'at a number of Australian sites since the 1950s'.[37]

2.36 In their contribution to the joint departmental and agency submission, the Bureau of Meteorology and the Great Barrier Reef Marine Park Authority (GBRMPA) explained that 'evidence for significant observed changes in extreme high rainfall is mostly inconclusive'. Notwithstanding this, it was noted that in the decades since the 1950s some parts of Australia 'do show a tendency…towards a higher proportion of rainfall falling from extreme events'.[38]

2.37 On future projections for precipitation, the joint submission explained that climate models 'generally indicate a higher proportion of total rainfall coming from extreme events, with more extreme rainfall events projected even in those regions where total rainfall is expected to decrease'.[39] CSIRO provided the following summary of expected precipitation changes based on information currently available:

> In southern Australia, winter and spring rainfall is projected to decrease, though increases are projected for Tasmania in winter…The winter decline may be as great as 50 per cent in south-western Australia under high emissions by 2090. The direction of change in summer and autumn rainfall in southern Australia is uncertain, but there is medium confidence in a decrease in south-western Victoria in autumn and in western Tasmania in summer. There is medium confidence in a winter rainfall decrease across eastern Australia by 2090. In northern Australia and northern inland areas, there is low confidence in the direction of future rainfall change by 2090,

37 CSIRO, *Submission 45*, p. 8.

38 Department of the Environment and Energy et al, *Submission 39*, p. 14.

39 *Submission 39*, p. 14.

> but substantial changes to wet-season and annual rainfall cannot be dismissed.[40]

2.38 As a result of the projected precipitation changes, southern Australia is expected to encounter increased time in drought 'with a greater frequency of severe droughts'. This is related to 'the southward shift of the fronts from the Southern Ocean that bring rain across southern Australia during the cool months of the year (winter and spring)'.[41]

Storm surges and tropical cyclones

2.39 Storm surges[42] and tropical cyclones attracted significant comment. These can be interlinked, as storm surges 'accompany tropical cyclones as they make landfall'[43] and 'the most extreme storm surges are normally associated with cyclones'.[44] However, storm surges 'can also be formed by intense low pressure systems in non-tropical areas, such as east coast lows in the Tasman Sea'.[45]

2.40 In modern Australian history, Tropical Cyclone Tracy, which devastated Darwin in 1974, is the standout example of the destruction cyclones can cause in Australia. Sixty-six people died from Cyclone Tracy (53 on land and 13 at sea) and approximately 35,000 residents (out of a population of 48,000) were evacuated in its aftermath.[46]

2.41 Cyclones that have occurred more recently have also caused significant damage. The ASBEC noted that Cyclone Yasi (2011) 'was estimated to have caused over $3.5 billion in damage and lost business in Queensland'.[47] Cyclone Debbie (2017) resulted in estimated insurance losses of over $1.6 billion.[48]

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40 CSIRO, *Submission 45*, p. 9. See also Climate Council of Australia, *Submission 40*, p. 8.

41 Climate Council of Australia, *Submission 40*, pp. 1, 10. See also CSIRO, *Submission 45*, p. 10.

42 Storm surges are 'a rise above the normal sea level resulting from strong, mainly onshore winds and/or reduced atmospheric pressure'. They can result in extensive flooding of coastal areas, particularly in low-lying areas. Climate Council of Australia, *Submission 40*, p. 3.

43 Climate Council of Australia, *Submission 40*, p. 3.

44 Department of the Environment and Energy et al, *Submission 39*, p. 13.

45 Climate Council of Australia, *Submission 40*, p. 3.

46 Department of Tourism and Culture (NT), 'Cyclone Tracy', https://dtc.nt.gov.au/arts-and-museums/northern-territory-library/nt-history/cyclone-tracy (accessed 9 January 2018).

47 ASBEC, *Submission 26*, p. 4.

48 National Insurance Brokers Association of Australia, *Submission 8*, p. 2.

2.42 Modelling work commissioned by the Northern Australia Insurance Premiums Taskforce estimated that the long-term future losses from cyclones in northern Australia are expected to be, on average, around $285 million per year.[49]

2.43 It was acknowledged that trends in tropical cyclone frequency and intensity 'are difficult to discern for the Australian region due to the short observational records, as well as high year-to-year variability'.[50] Nevertheless, it is projected that tropical cyclones will 'become less frequent with a greater proportion of high intensity storms (those with stronger winds and greater rainfall)'.[51] The Climate Council provided the following overview of the implications of climate change for tropical cyclones:

> Climate change is likely to affect tropical cyclone behaviour in two ways. First, the formation of tropical cyclones most readily occurs when there are very warm conditions at the ocean surface and when the vertical gradient is strong. As the climate continues to warm, the difference between the temperature near the surface of the Earth and the temperature higher up in the atmosphere, is likely to decrease as the atmosphere continues to warm. As this vertical gradient weakens, it is likely that fewer tropical cyclones will form…Second, the increasing temperature of the surface ocean affects the intensity of cyclones (along with changes in upper atmosphere conditions), both in terms of maximum wind speeds and in the intensity of rainfall that occurs in association with the cyclone. This is because the storms draw energy from the surface waters of the ocean, and as more heat (energy) is stored in these upper waters, the cyclones have a larger source of energy on which to draw…[52]

2.44 As noted in another of the committee's reports on climate change, in the southern Great Barrier Reef region the incidence of strong tropical cyclones is projected to increase from one every 25 or more years at present to one every 6–12 years. Between the Pilbara and southern Kimberley regions, the incidence of strong cyclones is projected to increase from one every 10 years to one every 7.5 years.[53]

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49 The Treasury, *Northern Australia Insurance Premiums Taskforce: Final Report*, November 2015, p. 30.

50 Climate Council of Australia, *Submission 40*, p. 9. See also Department of the Environment and Energy et al, *Submission 39*, p. 15.

51 CSIRO, *Submission 45*, p. 10. See also Department of the Environment and Energy et al, *Submission 39*, p. 15.

52 Climate Council of Australia, *Submission 40*, p. 9 (citations omitted).

53 Senate Environment and Communications References Committee, *In hot water: the impacts of climate change on marine fisheries and biodiversity*, December 2017, p. 14 (based on evidence from the Australian Institute of Marine Science).

2.45 Storm surges were also discussed extensively during this inquiry, with stakeholders focused on the relationship between storm surges and the sea level in particular. CSIRO submitted that the rising sea level 'amplifies the effects of high tides and storm surges'.[54] To illustrate, CSIRO discussed a preliminary assessment of the implications of sea level rise in southeast Queensland. Two key findings of the assessment are as follows:

- Without taking into account an expected population increase, the number of buildings in the area at risk of inundation from a 1-in-100-year storm tide could increase from 227,000 at present to 245,100 by 2030 and to 273,000 by 2070. CSIRO noted that the population in the region is expected to increase to 4 million by 2030, which would compound climate change effects 'if the population remains at its current pattern of settlement'.
- With an additional 0.2 metre rise in sea level and unchanged planning and building regulations, by 2030 it is projected that the number of residential buildings at risk from a storm tide of 2.5 metres will increase from 35,200 to about 61,500 (and approximately 121,000 residential buildings by 2070).[55]

2.46 The Climate Council commented:

> As the sea level continues to rise, these storm surges are riding on a higher base sea level and thus becoming more damaging as they are able to penetrate further inland. Some of the most devastating coastal flooding events are caused by a "double whammy" of concurrent high sea-level events and heavy rainfall events in the catchments inland of coastal settlements. That is, coastal settlements can be inundated by water from both i) a storm surge, a high tide and a higher sea level, and ii) flooding rivers from the catchments behind the settlements.[56]

2.47 Likewise, the Bureau of Meteorology and the GBRMPA noted that, even if the severity of storm surges does not change, rising sea levels would result in increased frequency of flooding from storm surges. This is because 'an increase in the baseline sea level component will lead to an increase in sea levels at any specific time even if all other components are constant'.[57]

2.48 Given the relationship between cyclones and storm surges, and the projection regarding the increased intensity of cyclones due to climate change, it is considered there will be a greater risk of extreme storm surges.[58] In considering the implications of these events, the Australian Local Government Association (ALGA) emphasised that inland communities can also be affected by these coastal events. ALGA noted that

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54 CSIRO, *Submission 45*, p. 7.

55 CSIRO, *Submission 45*, pp. 11–12 (citation omitted).

56 Climate Council of Australia, *Submission 40*, pp. 3–4.

57 Department of the Environment and Energy et al, *Submission 39*, p. 13.

58 Department of the Environment and Energy et al, *Submission 39*, p. 13.

'much of the flooding from Cyclone Debbie was experienced beyond the coastal zone'.[59]

Extreme rainfall events and flooding

2.49 The Climate Council of Australia submitted that a 2°C increase in average temperatures globally 'could result in a 10–30% increase in extreme downpours'.[60] It is expected that extreme rainfall events (the wettest day of the year and the wettest day in 20 years) will increase in intensity in Australia.[61] As noted at paragraph 2.36, it is expected that a higher proportion of total rainfall will come from extreme events, even in regions where total rainfall is expected to decrease.

2.50 Flooding from heavy rainfall is another area of concern. Flood events have caused significant damage previously: notable examples include the floods in 2010–11 in southeast Queensland, Victoria, and Tasmania, which were calculated to have caused $5.6 billion damage.[62] The Climate Council provided the following summary of the damage caused by the 2010–11 floods in Brisbane and elsewhere in southeast Queensland:

> The economic impacts of heavy rainfall can be devastating. One of the worst flooding events in recent times in Australia as a result of heavy rainfall was the Queensland 2010/2011 floods. Extreme and extended rainfall over large areas of Queensland from a strong La Niña event in the latter part of 2010 led to record breaking and very damaging flooding in Queensland in December 2010 and January 2011. December 2010 was Queensland's wettest December on record…Approximately 2.5 million people were affected and 29,000 homes and businesses experienced some form of flooding. The economic cost of the flooding was estimated to be in excess of $5 billion…with 18,000 homes inundated, damage to 28% of the Queensland rail network and damage to 19,000 km of roads and 3 ports…Around 300,000 homes and businesses lost power in Brisbane and Ipswich at some stage during the floods…[63]

2.51 As noted above, although precipitation levels may decrease in many parts of the country, the intensity of extreme rain events is projected to increase. This has particular implications for urban areas, where impervious surfaces and significant amounts of runoff are typical features of the built environment. As noted in the committee's 2015 report on stormwater management, future growth in Australia's urban centres and more frequent extreme weather events due to climate change may increase volumes of runoff in urban areas that will need to be absorbed in the

59 Australian Local Government Association, *Submission 12*, p. 4.

60 Climate Council of Australia, *Submission 40*, p. 8 (citation omitted).

61 Climate Council of Australia, *Submission 40*, p. 8.

62 ASBEC, *Submission 26*, p. 4.

63 Climate Council of Australia, *Submission 40*, p. 8 (citations omitted).

environment or managed by stormwater infrastructure, or will otherwise result in flooding.[64]

2.52 The committee received evidence discussing analysis of flood risk in particular areas. For example, Lake Macquarie City Council submitted there are around 18,500 properties in its jurisdiction that are subject to lake and catchment flooding in a 1 per cent flood event. The Council provided the following evidence of the consequences of this in the face of climate change:

> Recent climate change projections for the region indicate that there will be an increase in the frequency of extreme rainfall events (95^{th} percentile) in summer and autumn. Other projections for the region indicate that the maximum intensity of extreme rainfall events will increase by up to 20% by 2050 for a 24 hour event and by greater amounts for shorter duration events in the longer term (2080).
>
> As a consequence, greater numbers of people and infrastructure will be exposed to the direct impacts of flooding in the future and communities and systems that are already exposed to flooding will be exposed more frequently. Within the broader Hunter region, vulnerable groups including elderly and low socio-economic groups are disproportionately represented in areas subject to flooding.
>
> Infrastructure within the City that is exposed to flood hazards includes residential dwellings, public infrastructure including road and nationally significant transport links, utilities, community facilities, commercial and industrial areas. Intangible damages associated with flood hazards include impacts on mental and physical health, disruption of services, and disruption of economic activity.[65]

Natural defences

2.53 Certain types of ecosystems and natural features such as coral reefs, sand dunes, mangroves and wetlands can help protect Australia's coast from the worst impacts of extreme weather events. How climate change is affecting coral reefs, kelp and mangrove forests, and the marine environment generally, were discussed extensively in the committee's 2017 report on the impacts of climate change on marine fisheries and biodiversity.[66]

2.54 In summary, there is substantial evidence that warming ocean temperatures and ocean acidification have had significant ecological impacts in the Great Barrier Reef and in Western Australian reefs, such as coral bleaching and reductions in coral

64 See Senate Environment and Communications References Committee, *Stormwater management in Australia*, December 2015.

65 Lake Macquarie City Council, *Submission 29*, p. 3 (citations omitted).

66 See Senate Environment and Communications References Committee, *In hot water: the impacts of climate change on marine fisheries and biodiversity*, December 2017.

calcification and reproduction rates. Mangrove and kelp forest dieback has also occurred, such as the severe dieback of mangroves in the Gulf of Carpentaria.[67]

2.55 From an infrastructure perspective, the health of these natural coastal defence systems can be significant, particularly during extreme weather events. As Professor Damien Burrows noted during the committee's marine fisheries and biodiversity inquiry:

> Mangroves protect the coast by absorbing the energy of storm-driven waves and wind. The only two yachts undamaged by Cyclone Tracy in Darwin in 1974 were sheltered in a mangrove creek. In 2006, mangroves protected vessels and the coastline during Cyclone Larry in far north Queensland. The damage bill would have been much higher if it wasn't for the existence of intact mangrove forests.[68]

Need for a strong mitigation response

2.56 This report generally focuses on adaptation measures required in response to climate change. It is important, however, to address the need to reduce and curb greenhouse gas emissions, including the actions needed to meet Australia's obligations under the Paris Agreement.[69]

2.57 Several submitters emphasised the need for more action to be taken to address the consequences of human activities for the climate system. The Investor Group on Climate Change (IGCC) commented:

> Ultimately, the best defense against rising costs and the physical impacts of climate change is to meet the goals of the Paris Agreement and limit global warming to less than 2°C.[70]

2.58 To achieve this, the IGCC argued that Australia needs to be 'working to facilitate an economically efficient transition to a net zero emissions[71] economy in line

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67 Senate Environment and Communications References Committee, *In hot water: the impacts of climate change on marine fisheries and biodiversity*, December 2017, pp. 29, 32.

68 Senate Environment and Communications References Committee, *In hot water*, p. 36.

69 The Paris Agreement is an international agreement reached in 2015 in response to the threat of climate change. The agreement seeks to keep global temperature rise in the 21st century 'well below' 2°C above pre-industrial levels and 'to pursue efforts to limit the temperature increase even further' to 1.5°C. In response to the Paris Agreement, in August 2015 the Australian Government committed to reduce emissions by 26 to 28 per cent below 2005 levels by 2030. United Nations Framework Convention on Climate Change, 'The Paris Agreement', http://unfccc.int/paris_agreement/items/9485.php (accessed 20 February 2018); Australian Government, *National Climate Resilience and Adaptation Strategy*, 2015, p. 13.

70 Investor Group on Climate Change, *Submission 55*, p. 15. See also IAG, *Submission 56*, p. 9.

71 An organisation, region or country can achieve net zero emissions by reducing greenhouse gas emissions and offsetting or sequestering other emissions so that their net emission reach zero.

with global commitments under the Paris Agreement', including by managing carbon risk as an economic and financial risk (this is discussed in Chapter 3).[72]

2.59 Governments and other stakeholders called on the Australian Government to strengthen its mitigation and adaptation efforts. For example, the Queensland Government submitted that it:

> …strongly advocates for the Australian Government to strengthen its climate change policy response in terms of its emissions reduction targets and a credible suite of mechanisms to achieve these targets, and its efforts in relation to climate adaptation.[73]

2.60 The need for a carbon pricing mechanism to change existing economic models and otherwise support the transition to a low-carbon economy was noted.[74]

2.61 Effective mitigation is critical due to the limits on the ability to adapt. Professor Lesley Hughes from the Climate Council of Australia warned that although Australia, as a developed country, is adapting to climate change 'reasonably well' at present, the ability to adapt 'even in a country like Australia, will become a larger and larger challenge'. Professor Hughes commented:

> Really, we need to fix the root cause of the problem so that we don't get a situation to which we simply cannot adapt. It's very clear from the climate science that we're heading for at least two degrees, probably more. We are not reducing emissions strongly enough to only get two degrees, so we're looking at more than two degrees in the second half of this century. The influence of that on extreme climate events will be massive. There will be many to which adaptation becomes increasingly unlikely.[75]

2.62 Professor Hughes added that the climate system has 'a very big lag time'. Professor Hughes explained that once 2°C of warming is reached, sea level rise will continue 'for centuries if not millennia'. The professor stated:

> When we get to two degrees, we are probably still in the range of adapting, but, beyond that, sea level rise is going to keep going up at least for centuries after that. So it really depends on the timescale at which you are thinking your infrastructure needs to adapt by. It's like turning off a tap, but the water keeps running for a few hundred years and you still have an overflowing bath tub.[76]

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72 Investor Group on Climate Change, *Submission 55*, p. 5.

73 Queensland Government, *Submission 58*, p. 1.

74 See Mr Andrew Petersen, Chief Executive Officer, Sustainable Business Australia, *Committee Hansard*, 23 November 2017, pp. 12, 13.

75 Professor Lesley Hughes, Councillor, Climate Council of Australia, *Committee Hansard*, 23 November 2017, p. 30.

76 Professor Lesley Hughes, Climate Council of Australia, *Committee Hansard*, 23 November 2017, p. 31.

Chapter 3

Understanding risk and informing decisions

3.1 A theme in much of the evidence received during this inquiry is the need to ensure decision-makers at all levels, ranging from individual property owners to governments, have access to the reliable information necessary to make informed decisions about managing climate risks. Furthermore, it is reasoned that collecting and publicising further information about climate risks will facilitate more timely action that will reduce the costs which will inevitably be faced in the future. For example, the Investor Group on Climate Change (IGCC) observed:

> The longer Australia waits to implement effective adaptation planning and infrastructure solutions the more expensive it will become to adapt. Currently the economic costs are not being adequately assessed or consistently measured.[1]

3.2 When considering the implications of climate change for infrastructure, it was also emphasised that there are unique considerations. These relate to the interconnectivities and interdependencies between different types of infrastructure assets and the significant flow on effects associated with disruption. For example, as Dr Lauren Rickards observed in her submission, 'transportation services cannot operate without energy'. Dr Rickards argued that infrastructure networks 'with critical interdependencies are at an increased risk of failure from external shocks or stresses', and that it is important 'to understand the extent of interdependencies and climate related risks faced by infrastructure systems so that adaptation solutions can be developed or tailored accordingly'.[2]

3.3 Ms Emma Herd, Chief Executive Officer, IGCC, provided similar observations about the interdependences between business assets and essential utilities and transportation networks. Ms Herd commented:

> This question of interdependency is so key in terms of effective adaptation and resilience planning. For a lot of businesses, their key physical climate change risk may not be in the asset that they have direct control over. When I say 'key climate change risk', I mean their financial impact might be in an associated value chain or supply chain area. For example, if you're a data centre and you're in an area subject to heatwave conditions, your biggest vulnerability is in the resilience of the electricity network. If you think that through, if you're a financial institution which has data centres concentrated in areas of increased heatwave conditions, potentially one of the banks' biggest vulnerabilities in terms of physical risk is in the resilience of their data centre. Alternatively, if you're a property asset, you may have invested significantly in resilience measures on site, but in fact your biggest

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1 Investor Group on Climate Change (IGCC), *Submission 55*, p. 3.

2 City of Melbourne, *Submission 43*, p. 2.

> physical risk is then associated with the arterial roads to get to your asset, public transport infrastructure to bring your employees in, or precinct-level measures to protect from increased flooding or inundation if you're in a coastal area.[3]

3.4 This chapter considers the evidence received about how decision-makers could be better informed, such as by conducting analysis that considers worst-case climate projections, identifying the most at-risk infrastructure, undertaking further research and through the public disclosure of climate risks.

Planning for worst-case scenarios

3.5 The previous chapter summarised some of the climate change projections currently utilised by Australia's key research institutions and government agencies. The analysis and emissions pathways framework developed by the Intergovernmental Panel on Climate Change (IPCC) was also briefly outlined.

3.6 These projections are based on scientific data and rigorous analysis, however, they reflect scientific understanding at a point in time. Advances in scientific understanding of changes in the climate system have been achieved, yet knowledge gaps remain. Future emissions levels also cannot be predicted with certainty.

3.7 There is some concern that the existing approach to developing climate projections is overly conservative. The Breakthrough National Centre for Climate Restoration (Breakthrough) argued that IPCC assessments have taken an excessively cautious approach to climate change projections and have 'underplayed high-end possibilities'. Breakthrough partly attributed this to the consensus approach taken to compiling the IPCC's reports, which it argued results in insufficient attention being given to low-probability, high-impact risks that are 'greater than we would expect under typical statistical assumptions'.[4]

3.8 Breakthrough presented several arguments as to why it considers the global climate models are deficient. One of the reasons is that the models do not adequately account for carbon cycle feedback.[5] Another is that the rate of polar ice-mass loss is underestimated. Alternative studies were cited indicating that, even if just the Antarctic ice sheets are considered, there is the potential for multi-metre sea level rises this century rather than the up to 1.5 metre average rise referred to in Chapter 2.[6]

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3 Ms Emma Herd, Chief Executive Officer, IGCC, *Committee Hansard*, 23 November 2017, p. 16.

4 Breakthrough – National Centre for Climate Restoration, *Submission 62*, pp. 23.

5 Breakthrough – National Centre for Climate Restoration, *Submission 62*, p. 7.

6 D Spratt and I Dunlop, *What lies beneath: The scientific understatements of climate risk*, September 2017, p. 19; provided in Breakthrough – National Centre for Climate Restoration, *Submission 62*, p. 34.

3.9 Professor Ross Garnaut AO, who in 2007 was appointed to undertake a comprehensive climate change review by the state and territory governments, and then the Australian Government, has also discussed the potential for climate risks to be understated. In a 2011 paper, Professor Garnaut commented that there is a possibility of such an outcome due to scholarly reticence and publications lags, with the pattern of increasing concerns in the scientific community about climate risks supporting this conclusion. Professor Garnaut wrote:

> It is remarkable that the review of developments in the science—new observations and results of new research—have all either confirmed established scientific wisdom, or shifted the established wisdom in the direction of greater concern. This continues a pattern that has been present for some time. As noted earlier in this paper, the fourth assessment by the IPCC embodied more concern than the third, the third than the second and the second than the first.[7]

3.10 Professor Garnaut argued that the possibility of risks being understated is 'not a reason to clutch for knowledge outside the mainstream wisdom'; he emphasised that 'if our discussion ceases to be grounded in the established science, we have no firm, common ground from which to work on the most difficult policy problem of our times'. However, the professor concluded that when considering measures for climate change mitigation and adaptation, there is likely merit in taking stronger action. Professor Garnaut concluded:

> We should…be alert to the possibility that the reputable science in future will suggest that it is in Australians' and humanity's interests to take much stronger and much more urgent action on climate change than might seem warranted from today's peer-reviewed published literature. We have to be ready to adjust expectations and policy in response to changes in the wisdom from the mainstream science.[8]

3.11 Given the possibility of climate projections being overly cautious, Breakthrough argued that a prudent risk management approach requires 'a tough and objective look at the real risks to which we are exposed'. Breakthrough added that there is a particular need to consider:

> …those high-end events whose consequences may be damaging beyond quantification, and which human civilization as we know it would be lucky to survive. It is important to understand the potential of, and plan for, the worst that can happen, and be pleasantly surprised if it doesn't. Focusing on "middle of the road" outcomes, and ignoring the high-end possibilities, may result in an unexpected catastrophic event that we could and should have seen coming.[9]

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7 R Garnaut, *The science of climate change*, Garnaut Climate Change Review – Update 2011, Update Paper No. 5, March 2011, www.garnautreview.org.au/update-2011/update-papers/up5-the-science-of-climate-change.pdf (accessed 2 May 2018), p. 53.

8 R Garnaut, *The science of climate change*, p. 55.

9 Breakthrough – National Centre for Climate Restoration, *Submission 62*, p. 3.

3.12 Dr Craig James from CSIRO suggested that there is a problem with people becoming 'relaxed' about climate change reaching a certain level, such as the consequences of the world warming by a global average of 2°C. Dr James remarked that this is 'a dangerous space to be in, quite frankly'. Dr James noted that a global average increase of 2°C presents significant problems for all nature-based systems and that there is 'a lot of necessary adaptation between here and two degrees, let alone anything beyond that'.[10]

3.13 The committee also received evidence indicating that the private sector does not comprehend the risk climate change presents to their activities. Mr Andrew Petersen, Chief Executive Officer, Sustainable Business Australia, provided the following comments about this:

> Warren Buffett, that well-known raconteur, has built a fortune on that interface between risk and reward. One of his most famous quotes was that risk comes from not knowing what you are doing. The evidence suggests, from the private sector at least, that it doesn't actually fully understand the complexity of the risks that it faces and therefore does not know yet how to respond. A recent review of corporate disclosure reports revealed that 72 per cent of suppliers say that climate risk could actually significantly impact their business operations through revenue or expenditure yet only half of those are currently managing that risk.[11]

Assessment of existing and emerging risks to infrastructure

3.14 To help understand the implications of climate change and to enable decision-makers to focus on the most at-risk infrastructure assets, it was suggested that a national assessment or audit of existing infrastructure could be undertaken. Essentially, the evidence received identified two areas in which a national study could add value:

- by calculating the overall total anticipated cost of climate change and the investment in adaptation measures that will be required; and
- by identifying the most at-risk assets to enable adaptation responses to be prioritised.

3.15 A vocal advocate for undertaking a national assessment of the anticipated cost of climate change and the necessary investment in adaptation measures is the IGCC. Ms Emma Herd, Chief Executive Officer of the IGCC, explained that despite climate change already affecting infrastructure and resulting in additional costs for business

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10 Dr Craig James, Research Program Director, CSIRO, *Committee Hansard*, 22 March 2018, p. 7.

11 Mr Andrew Petersen, Chief Executive Officer, Sustainable Business Australia, *Committee Hansard*, 23 November 2017, p. 9. Similarly, Breakthrough argued that '[s]uccessful risk management requires thinking "outside the box" to avoid a failure of imagination, but not doing so is widespread at the senior levels of government and global corporations'. Breakthrough – National Centre for Climate Restoration, *Submission 62*, p. 4.

and government, 'no comprehensive estimate seems to exist on the cost of climate change impacts on Australia and the likely level of investment required for adaptation measures'. Ms Herd noted that an accurate understanding of the potential exposure of investments to climate risks and the ways in which business assets can be managed to reduce exposure are key concerns for investors. Ms Herd explained, however, that the absence of comprehensive information about the overall risk 'makes cost benefit analysis of climate change adaptation at an aggregated level impossible to quantify'.[12]

3.16 Ms Herd provided the following further comments in support of developing rigorous estimates about the costs associated with implementing the adaptation measures that are likely required:

> No matter which way you look at it, climate change has a cost. So, the question then becomes: do you want to invest in mitigation to reduce the absolute cost of adaptation, or do you want to defer investment in mitigation and just pay the bill for adaptation on the other side? And at the moment we're having a policy discussion whereby we're calculating only half of that equation, which is the cost of mitigation. We're not actually calculating the full cost–benefit analysis of climate change for Australia, which is: which side of that ledger will we pay more on, and where do we get the most economic benefit in terms of increasing our investment?[13]

3.17 Ms Herd continued:

> …the Paris Agreement sets out quite ambitious goals of limiting global warming to two degrees or less—we're not currently anywhere near meeting two degrees. At best, we're at 2.6, but that's if everybody does everything that they currently say they're going to do. We're more likely, currently, to hit three-plus. That has huge cost implications for Australia, and we don't know what the bill is for that current projected change. We don't even know what the bill is for two degrees of change at the moment. So, it definitely feels as though we're having a policy discussion with only half the information we need, and part of the need for that national assessment of value at risk is the need to have a fully informed public policy discussion.[14]

3.18 Ms Herd added that businesses are undertaking assessments to understand the potential consequences for their assets; however, they 'have to pay an awful lot of money for it…and it's not publicly available and it's not added up at a national level to

12 Ms Herd added that the last available estimate (undertaken in 2011) found that the replacement cost of coastal buildings and infrastructure at risk from climate change was estimated to be at least $226 billion (in 2008$) under a 1.1 metre sea level rise scenario. Ms Herd observed that science 'has advanced considerably in the years since, while new proprietary risk assessment tools and integrated datasets have also become available and are currently being applied but on an ad hoc basis'. Ms Emma Herd, IGCC, *Committee Hansard*, 23 November 2017, p. 15.

13 Ms Emma Herd, IGCC, *Committee Hansard*, 23 November 2017, p. 18.

14 Ms Emma Herd, IGCC, *Committee Hansard*, 23 November 2017, p. 18.

give a view of the macroeconomic impacts'. Accordingly, Ms Herd argued there is a preference for a whole-of-economy approach to obtaining this information.[15]

3.19 Professor Lesley Hughes from the Climate Council of Australia similarly drew the committee's attention to the absence of an up-to-date national assessment of climate change risks.[16] The Queensland Tourism Industry Council argued that a risk assessment to examine the overall consequences of climate change should be undertaken that considers the 'costs for defending buildings and infrastructure, environmental issues, and associated socio-economic benefits'.[17]

3.20 Others focused on how a national audit could inform the prioritisation of adaptation work by identifying the assets most at-risk from climate change. The Australian Sustainable Built Environment Council (ASBEC) submitted:

> There would be great benefit in a comprehensive national audit project to identify the core assumptions and technical parameters used in the design and delivery of infrastructure. This should fundamentally inquire as to whether climate change predictions have been incorporated into these assumptions.[18]

3.21 During the inquiry, the committee sought details about the information currently available to government about the climate risks to infrastructure. Dr Russell Wise from CSIRO explained that the National Exposure Information System (NEXIS) operated by Geoscience Australia provides 'a reasonably good understanding of current infrastructure and their exposure to coastal inundation'. However, Dr Wise acknowledged that further work would be useful. In particular, Dr Wise observed that scenarios regarding socio-economic development (such as population size and the location of infrastructure assets in the future) are not as advanced as climate change projections.[19] Other CSIRO representatives similarly agreed that a national audit of at-risk infrastructure would be of value to assist further research and planning about climate change adaptation.[20]

3.22 In considering a national assessment, it is evident that the scale of the task could potentially be overwhelming. For example, CSIRO's evidence suggested that studies of infrastructure would identify that 'enormous numbers of houses and dollar values of structures are going to be affected'.[21]

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15 Ms Emma Herd, IGCC, *Committee Hansard*, 23 November 2017, p. 17.

16 Professor Lesley Hughes, Councillor, Climate Council of Australia, *Committee Hansard*, 23 November 2017, p. 31.

17 Queensland Tourism Industry Council, *Submission 10*, p. 6.

18 Australian Sustainable Built Environment Council (ASBEC), *Submission 26*, p. 3.

19 Dr Russell Wise, Senior Research Scientist, CSIRO, *Committee Hansard*, 22 March 2018, p. 2.

20 Dr Craig James, CSIRO, *Committee Hansard*, 22 March 2018, p. 8.

21 Dr Craig James, CSIRO, *Committee Hansard*, 22 March 2018, p. 2.

3.23 The IGCC acknowledged that a national assessment of adaptation costs would be 'complicated'. To approach it successfully, the IGCC suggested it could be undertaken as part of each IPCC cycle; that is, after the IPCC's work has been undertaken and peer-reviewed, a national study could be undertaken with private sector participants to take the IPCC's analysis 'down to the level where it's investable and workable and plannable'.[22] Ms Herd referred the committee to New Zealand where a regularly updated report on projected climate change implications is prepared on a cyclical basis alongside the IPCC's work cycle. Ms Herd added that this report is supplemented by other reports focusing on specific risks, such as the implications for coastal infrastructure, natural capital reserves, forestry and the agriculture sector.[23]

3.24 Ms Kirsty Kelly from the ASBEC suggested that a national assessment of at-risk infrastructure would not need to involve testing assets. Rather, the assessment could add value by reviewing the standards applied in the construction of those assets and considering 'whether those standards are based on the frequency and intensity of weather events that we are seeing now'.[24]

3.25 International approaches to undertaking national risk assessments could be instructive. Recently, researchers have considered how an appropriate framework for undertaking a national assessment of climate risks to infrastructure could be developed for the United Kingdom. In a paper published in April 2018, they argued that due to the interconnectivities and interdependencies of infrastructure sectors, 'collective consideration' of the multiple infrastructure sectors is warranted. The paper identified the following approach for undertaking a national assessment to prioritise adaptation actions:

> A starting point will be agreement of a common baseline, some standardized socio-economic and adaptation scenarios to provide common reference points (but not limit development of other scenarios), and improved records and metadata about adaptation actions. However, to fully tackle the issues…a national capability needs to go further and must ultimately provide a common and internally coherent analytical framework that enables different risks to be fairly compared. It must be able to analyse the impact of 'persistent' events (e.g. repeated sequence of storms or floods, in the same or multiple locations) and simultaneous hazards (e.g. wind storm coupled with flooding). This can only be achieved by producing a national database of the location, function, design and condition of assets, and a record of any adaptation to these assets in order to provide a reliable assessment of current and future infrastructure performance.[25]

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22 Ms Emma Herd, IGCC, *Committee Hansard*, 23 November 2017, p. 18.

23 Ms Emma Herd, IGCC, *Committee Hansard*, 23 November 2017, p. 16.

24 Ms Kirsty Kelly, Representative, ASBEC, *Committee Hansard*, 23 November 2017, p. 45.

25 RJ Dawson et al, 'A systems framework for national assessment of climate risks to infrastructure', *Philosophical Transactions of the Royal Society A*, vol. 376: 20170298, 2018, http://rsta.royalsocietypublishing.org/content/376/2121/20170298 (accessed 2 May 2018), p. 16.

Research and data

3.26 Stakeholders generally agreed that a key role for government, particularly the Australian Government, is to ensure that adequate and reliable data, analysis and guidance is available to guide responsible decision-making. For example, the Climate Council of Australia submitted that:

> In order to climate proof infrastructure, the design, building, financing and maintenance of infrastructure must use the best available climate science and adaptation information available from premier agencies such as CSIRO and [the Bureau of Meteorology].[26]

3.27 Generally, comments from local governments and other stakeholders about the need to be informed about how they can adapt to climate change called for information to be updated more regularly, widely disseminated and publicised, and utilised consistently by all levels of government. For example, Hobsons Bay City Council submitted:

> To effectively plan for and manage extreme weather events, climate projections are needed that are based on the best available science and are relevant to the local area. This information should be widely disseminated and readily accessible to inform emergency management planning. It should also inform minimum legislative standards and planning decisions to ensure houses, buildings and infrastructure are designed and built to reduce the risk to human life and wellbeing.[27]

3.28 Corporate Australia also uses data collected by Australian Government agencies to guide decision-making. Wesfarmers explained that it uses CSIRO data to inform climate resilience planning and to improve its 'understanding of the material climate change issues that face our divisions', including physical, regulatory, reputational and competitive risks.[28] Sydney Airport referred to its participation in workshops presented by the Australian Climate Change Adaptation Research Network for Settlements and Infrastructure (ACCARNSI), which is hosted by the National Climate Change Adaptation Research Facility (NCCARF) and funded by the Australian Government.[29]

3.29 Mr Andrew Petersen, Chief Executive Officer, Sustainable Business Australia, emphasised there is a need for the Australian Government to provide ongoing financial support for research institutions, as well as sharing of the data collected to assist companies and governments to make decisions about the need for, and location of, future infrastructure. Mr Peterson argued that continually collecting

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26 Climate Council of Australia, *Submission 40*, p. 12.

27 Hobsons Bay City Council, *Submission 7*, p. 5.

28 Wesfarmers, *Submission 20*, p. 3.

29 Sydney Airport, *Submission 33*, p. 3.

data and maintaining datasets and making them available to all decision-makers in the economy would help build 'resilience into our economic system'.[30]

3.30 This section examines government support for climate research generally. This is followed by a discussion of the evidence from stakeholders that called for research to be used to develop specific products to assist with planning or for existing guidelines to be updated more frequently. This discussion is based on the evidence received during this inquiry. Relevantly, however, the Australian Research Council (ARC) recently provided funding for a new centre for excellence relating to climate change. The ARC Centre for Excellence for Climate Extremes at the University of New South Wales opened in April 2018.[31] As this occurred after submissions to this inquiry were received, the evidence outlined below does not consider this development.

Australian Government support for the National Climate Change Adaptation Research Facility

3.31 Submitters highlighted changes made by the Australian Government to the funding of climate change research. In particular, submitters referred to funding reductions for the NCCARF at Griffith University.

3.32 The NCCARF was established by the Australian Government and commenced operating in 2008. Since it was created, the Australian Government has provided $56 million in funding.[32] However, based on current funding announcements, from 2018–19 the Australian Government will not be directly funding the NCCARF.[33]

3.33 Submitters commended the work undertaken by the NCCARF and other research organisations such as CSIRO that provided resources to assist communities, businesses and governments to adapt to climate change effectively. For example, Mr Andrew Petersen, Chief Executive Officer, Sustainable Business Australia, commented that, over the last decade, this work has been 'instrumental to a number of

30 Mr Andrew Petersen, Chief Executive Officer, Sustainable Business Australia, *Committee Hansard*, 23 November 2017, p. 11.

31 Australian Research Council, 'ARC Centre of Excellence for Climate Extremes', *Media release*, 10 April 2018, www.arc.gov.au/news-media/media-releases/arc-centre-excellence-climate-extremes (accessed 2 May 2018).

32 Department of the Environment and Energy, Bureau of Meteorology, Great Barrier Reef Marine Park Authority, Attorney-General's Department, Department of Agriculture and Water Resources, and Geoscience Australia, *Submission 39*, p. 2.

33 The last funding announcement made by the Government was the provision of $0.6 million to the NCCARF and CSIRO in 2017–18. See Australian Government, *Budget 2017–18: Budget Measures—Budget Paper No. 2*, May 2017, p. 94.

businesses' in various sectors, including finance, insurance, infrastructure and construction.[34]

3.34 The Local Government Association of Queensland (LGAQ) also highlighted the importance of the work undertaken by the NCCARF. It submitted:

> While the Climate Council and a few other not for profit organisations undertake pieces of research and prepare publications about the implications of climate change on the matters of concern to this inquiry, there is currently only one organisation, the…NCCARF…that provides peer reviewed and credible synthesis of research outcomes specifically for practitioners.
>
> This service is vitally important to facilitating the uptake of leading thinking by time poor practitioners who are not climate change specialists, but have content expertise e.g. coastal engineers, urban and regional planners and policy and regulation makers.[35]

3.35 The Australian Coastal Councils Association (ACCA) and Professor Lesley Hughes from the Climate Council of Australia called on the Government to provide further funding to support the NCCARF and for funding for climate change adaption generally to be stable and ongoing.[36] Sydney Airport also submitted that it would 'encourage the ongoing work' of ACCARNSI and the NCCARF.[37]

3.36 The ACCA focused on the CoastAdapt tool to illustrate the importance of the work undertaken by the NCCARF and the need for the Australian Government to provide the NCCARF with ongoing funding. The Association submitted:

> The cut in funding means that NCCARF will be unable to continue its adaptation research activities including research to further develop the CoastAdapt web tool, which was launched in September 2016 to assist coastal councils respond to rising sea levels and other climate impacts.
>
> The CoastAdapt web tool quickly became established as a vital source of information and guidance for coastal councils attempting to minimise the impacts of a changing climate on their local communities and environment. The decision to cut funding for climate adaptation research was a major disappointment to coastal councils and other agencies attempting to deal with the imminent threat of a changing climate.[38]

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34 Mr Andrew Petersen, Sustainable Business Australia, *Committee Hansard*, 23 November 2017, p. 11. See also Ms Emma Herd, IGCC, *Committee Hansard*, 23 November 2017, p. 17.

35 Local Government Association of Queensland, *Submission 11*, p. 7.

36 See Professor Lesley Hughes, Climate Council of Australia, *Committee Hansard*, 23 November 2017, pp. 32, 34; Australian Coastal Councils Association (ACCA), *Submission 61*, p. 4; Mr Alan Stokes, Executive Director, ACCA, *Committee Hansard*, 15 March 2018, p. 24.

37 Sydney Airport, *Submission 33*, p. 3.

38 ACCA, *Submission 61*, p. 4.

3.37 The LGAQ expressed concern that the CoastAdapt could become obsolete without ongoing funding to maintain and update the tool. The LGAQ called on the Government to provide funding to maintain the tool and to expand it to include modules on bushfire, heatwave and flooding.[39]

Australian Rainfall and Runoff Guidelines

3.38 Concerns were expressed about the approach taken to updating the Australian Rainfall and Runoff guideline (ARR). The ARR is prepared by Geoscience Australia and is used by designers and engineers 'for the estimation of design flood characteristics in Australia'.[40]

3.39 The ARR was first published in 1987 and was not updated until 2016. While submitters welcomed the 2016 update, there was general concern about the time that elapsed between updates, particularly as climate change was not considered in the original version. For example, a joint submission from a group of engineers and scientists stated:

> The 1987 edition of ARR did not address potential impacts of climate change at all, so approaches to incorporating climate change prior to the release of the 2016 edition of ARR varied considerably between studies, where climate change was considered at all.[41]

3.40 To help ensure that infrastructure can be designed to be resilient to the effects of climate change, Consult Australia called for the Australian Government to ensure that Geoscience Australia has adequate resources to update documents such as the ARR more regularly.[42] Consult Australia also suggested that resources should be made available to Geoscience Australia and other relevant bodies to develop material similar to the ARR for other climate-related matters, such as temperature, wind and bushfires.[43]

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39 Local Government Association of Queensland, *Submission 11*, p. 7.

40 Consult Australia, *Submission 44*, p. 10.

41 Dr Phillip Jordan, Mr Michael Wrathall, Dr Richard Cresswell, Dr Katherine Daniell, Ms Penelope Springham, Dr William Glamore and Mr Andrew Herron, *Submission 48*, p. 7.

42 Similarly, Hobsons Bay City Council, which described the recent update to the ARR as being an 'important first step', submitted that 'further work is needed to strengthen the process for considering climate impacts in flood modelling and make it business as usual'. Hobsons Bay City Council, *Submission 7*, p. 4.

43 Consult Australia, *Submission 44*, p. 10.

Mapping and other datasets of at-risk areas

3.41 High-level projections and simulations of flooding and coastal inundation were identified in Chapter 2. Other examples of tools developed to assist local governments to gain a more detailed understanding of the interactions between flooding and different management measures were provided, including a tool developed by CSIRO to assist local governments located along the Port Phillip coastline.[44]

3.42 Floodplain Management Australia (FMA) highlighted the importance of useful flood risk information compiled by a respected source for informed decision-making. The FMA submitted:

> Having access to flood risk information underpins effective flood management and our ability to reduce the flood vulnerability of communities. Educating and engaging the broader community on their vulnerability to the impact of flooding and other natural hazards is also essential to building resilience. FMA supports transparency and education around flood risk.[45]

3.43 Mapping information is also valuable for the insurance sector.[46]

3.44 Overall, it was acknowledged that governments have undertaken work to gather data and to ensure that relevant data are available to businesses and communities.[47] It was also noted that large amounts of data have already been collected. Given this, Ms Megan Motto from Consult Australia indicated that there is a need to identify 'what we need, how to make use of it, how to make sense of it [and] how to analyse it in a way that's useful for us in designing the buildings and roads and rail of the future'.[48]

3.45 However, local governments and other owners of infrastructure need more detailed and tailored information to consider and plan for risks. For example, the committee was advised that the publication of risk mapping at a local level would help inform decision-making. By ensuring reliable information was freely available, it was suggested that governments could then require investors to take responsibility for any subsequent decisions to build in at-risk areas, enabling future governments to resist future pressure for resources to protect such properties.[49]

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44 Hobsons Bay City Council, *Submission 7*, p. 3.

45 Floodplain Management Australia, *Submission 35*, p. 5.

46 The implications of climate change for the insurance sector are examined in Chapter 5.

47 Mr Andrew Petersen, Sustainable Business Australia, *Committee Hansard*, 23 November 2017, p. 11.

48 Ms Megan Motto, Chief Executive Officer, Consult Australia, *Committee Hansard*, 23 November 2017, p. 25.

49 Regional Development Australia – South West, *Submission 15*, p. 5.

3.46 CSIRO submitted that there is 'insufficient data for sophisticated urban modelling', and suggested that there 'may be benefits from having standardised nationwide high-resolution information, including tide, rainfall and terrain data'.[50] Dr Russell Wise from CSIRO advised that Emergency Management Australia is 'exploring the development of a national capability on disaster risk information to understand what's required now and into the future and the changing nature of the natural hazards that will be causing disasters'. Dr Wise suggested that this work, which is focused on natural hazards, 'could be much more broadly applied to other forms of the more insidious chronic changes caused by climate change'.[51]

3.47 Hobsons Bay City Council submitted that, in its view, at present there is 'a significant gap in information available for coastal planning and sea level rise'. The Council detailed its concerns and suggestions for improvement as follows:

> The national first pass assessment of sea level rise is at a high resolution with limited usefulness for land use planning. Effective mapping that shows likely sea level rises over a range of time periods is needed at a scale that can inform land use decisions. It is most effective to undertake this mapping at a federal or state level due to the scale of the problem and to ensure a consistent approach between regional agencies and include local councils.
>
> Mapping should be refreshed at regular intervals (e.g. every decade) and incorporate the latest scientific information. Mapping should clearly communicate the probability of the risk occurring in a way that is clear to the community. For example: 'based on the best available science at the time there is a 10 per cent chance that sea level rise will be less than this and a 90 per cent chance it will be greater than this.' Such an approach will enable the community to understand the risk and will limit the temptation for modelling to be based on lower level risks due to political pressure.[52]

3.48 Hobsons Bay City Council advised that the continued funding of key projects, such as the CSIRO modelling of coastal and land-based flooding around Port Phillip referred to in paragraph 3.41, 'is a priority to coastal communities'.[53] Similarly, Lake Macquarie City Council called on the Australian Government to continue to invest in science that contributes to improved climate change projections regarding sea level rises and associated coastal hazards'.[54] It was also suggested that existing

50 CSIRO, *Submission 45*, p. 12.

51 Dr Russell Wise, CSIRO, *Committee Hansard*, 22 March 2018, pp. 2–3.

52 Hobsons Bay City Council, *Submission 7*, p. 3.

53 Hobsons Bay City Council, *Submission 7*, p. 3.

54 Lake Macquarie City Council, *Submission 29*, p. 2.

work undertaken to better understand the effects of climate change in particular regions should be better publicised.[55]

3.49 The Climate and Health Alliance also urged increased 'investment in vulnerability mapping programs to identify and map vulnerable populations and infrastructure to inform climate adaptation strategies and emergency response plans'.[56]

3.50 In addition to calls for continued investment in risk mapping, including the development of more detailed maps tailored to particular regions, broader concerns about the need for coordination and government leadership were put forward. The FMA argued for the development of a national approach to how information about flood risk associated with climate change should be prepared and published. The FMA argued that a national approach would be useful to overcome resistance in some locations about how the public release of such information could affect property values. The FMA explained:

> We acknowledge that many of our Local Government members face political and public pressure due to perceptions—warranted or otherwise—about the impact of releasing flood risk information about property values, development opportunities and insurance premiums. A national approach to how climate change flood risk information should be prepared and publicly disseminated, and how such information should be applied in the planning of existing and new areas, would go a long way to diffusing parochial reluctance in dealing with the issue.[57]

3.51 Ms Megan Motto, Chief Executive Officer, Consult Australia, commented that there are also issues with the interoperability of the systems that store data.[58]

3.52 Although several stakeholders commented on the value of information being make public, it was argued that enhancements to how public information is released are also necessary in some instances to maximise the utility of the information. For example, Mr Mark Leplastrier, Senior Manager, Natural Perils, IAG, referred to the Australian Tropical Cyclone Database managed by the Bureau of Meteorology. Mr Leplastrier commented:

> Every man and his dog is basically picking up that dataset and trying to make sense of it to understand cyclone risk. If we could put much more

55 RDA South West explained that Geoscience Australia and the Western Australian Department of Planning have undertaken work on coastal risk in the south west of Western Australia but that although this work is publicly available, RDA South West considers it is not publicised. See Regional Development Australia – South West, *Submission 15*, p. 5.

56 Climate and Health Alliance, *Submission 16*, p. 8.

57 Floodplain Management Australia, *Submission 35*, p. 5.

58 Ms Megan Motto, Consult Australia, *Committee Hansard*, 23 November 2017, p. 25.

> scientific effort into establishing a much better source of truth there, we'll start being able to have aligned views of risk and what to do about it.[59]

3.53 Mr Leplastrier added, however, that Geoscience Australia is developing a Tropical Cyclone Risk Model (TCRM) that is 'basically digesting historical cyclone tracks' and has the ability to produce a risk model that could be used in insurance or planning. Mr Leplastrier explained that a key feature of the TCRM is that it has been set up to enable researchers to 'contribute to the model and improve on it'. Mr Leplastrier observed that this model:

> …might be an interesting thing to take forward, if we can actually really focus scientific attention into that model. It's a bit like a local government flood study, which is a very good set of scientific information. If we could do that with these other important hazards and then have that available for people like insurers or engineers to pick up, that would be very, very good.[60]

3.54 Mr Neil Plummer from the Bureau of Meteorology commented that, although there is 'a lot of data and information available with which to make better decisions…there is a need for more accessible, nationally integrated datasets'.[61]

3.55 Despite it being acknowledged that governments understand the need for publicly available data, there are apparent issues with proprietary data. Mr Karl Sullivan from the Insurance Council of Australia explained that the insurance sector has struggled to access certain datasets at a reasonable price. Mr Sullivan stated:

> There are a number of datasets, even some residual flood datasets, where we are still negotiating, after a decade, to try to obtain those datasets at a reasonable cost and reasonable price, considering that anything you purchase has to be passed on to your customers at some point.[62]

3.56 Mr Dwayne Honor from the FMA noted that it is difficult to get information from all infrastructure asset owners that is needed to 'understand the interconnected nature of our critical infrastructure', such as the information held by local governments and telecommunications providers. Mr Honor explained that the information can be obtained, but 'sometimes it is not an easy process'. Mr Honor continued:

> It depends on the resources of the other asset owners, and then whether they want to share it with you. Some of them are pseudo-private organisations

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59 Mr Mark Leplastrier, Senior Manager, Natural Perils, IAG, *Committee Hansard*, 23 November 2017, p. 53.

60 Mr Mark Leplastrier, IAG, *Committee Hansard*, 23 November 2017, p. 53.

61 Mr Neil Plummer, General Manager, Community Forecasts, Bureau of Meteorology, *Committee Hansard*, 22 March 2018, p. 8.

62 Mr Karl Sullivan, General Manager, Policy Risk and Disaster, Insurance Council of Australia, *Committee Hansard*, 23 November 2017, p. 53. Ms Kirsty Kelly from the ASBEC also identified that access to proprietary data is a key issue: see *Committee Hansard*, 23 November 2017, p. 39.

> and aren't as willing to share information as government agencies can be. Oftentimes it is just ignored because it is too hard to get the information…[63]

3.57 Mr Honor suggested that a protocol could be developed to which relevant organisations could sign up that would enable information sharing and address concerns about sensitive information being disclosed.[64]

3.58 Mr Sullivan emphasised that the public release of previously cost-prohibitive datasets in the past has also resulted in beneficial and innovative outcomes. Mr Sullivan noted that the release of the geocoded national address file, which previously cost around $20,000 a year for each individual licence, resulted in 'a huge amount of innovation not just from the insurance industry, who were suddenly able to access it more freely, but from small start-up companies, innovators and app developers'.[65]

3.59 Ms Megan Motto, Chief Executive Officer, Consult Australia, also noted that there is an issue with data being 'held in disparate locations and places and by different authorities', such as local, state and the Australian governments, as well as private businesses. Ms Motto noted that this issue is receiving attention with the cities reference group established in 2017 by the Australian Government reviewing how to bring together data from both the public and private sectors.[66]

3.60 Finally, another issue when considering data is the potential for confusion about the various types of datasets available. Mr Neil Plummer from the Bureau of Meteorology commented that 'I think there is, at times, uncertainty amongst planners and other agencies about just what datasets are available and the best ones to use'. In particular, Mr Plummer noted that there is a danger in solely relying on historical data given the current trends in climate variables.[67]

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63 Mr Dwayne Honor, Queensland Director, Floodplain Management Australia, *Committee Hansard*, 23 November 2017, p. 6.

64 Mr Dwayne Honor, Floodplain Management Australia, *Committee Hansard*, 23 November 2017, p. 6.

65 Mr Karl Sullivan, Insurance Council of Australia, *Committee Hansard*, 23 November 2017, pp. 53–54.

66 Ms Megan Motto, Consult Australia, *Committee Hansard*, 23 November 2017, p. 25.

67 Mr Neil Plummer, Bureau of Meteorology, *Committee Hansard*, 22 March 2018, p. 8.

Disclosure and management of climate risk by corporate Australia

3.61 The committee received evidence discussing the importance of disclosure by companies about their exposure to climate change to enable accurate pricing of risk. In particular, the findings of the Taskforce on Climate-related Financial Disclosures established by the G20's Financial Stability Board and chaired by Michael Bloomberg were noted.[68]

3.62 The IGCC noted that it is increasingly recognised that Australian businesses have 'an obligation to identify and manage material climate change impacts for their operations and disclose material risks and impacts to the market'.[69] The IGCC argued that investors are forcing change by reviewing their investments and expecting that 'ASX300 companies which they invest in (or are currently assessing with a view to potentially invest), to have developed climate change adaptation strategies'.[70]

3.63 In addition, the need for directors and boards to consider climate risks carefully was noted. The legal opinion provided by Mr Noel Hutley SC and Mr Sebastian Hartford-Davis in 2016 that climate change risks should be considered by company directors and that these risks may be relevant to a director's duty of care and diligence was referred to in several submissions.[71]

3.64 The Senate Economics References Committee recently considered carbon risk disclosure practices within corporate Australia. In its April 2017 report *Carbon risk: a burning issue*, that committee concluded that 'carbon risk reporting was not sufficiently prevalent amongst Australian firms, and that when information was provided it was often of variable quality'. The committee recommended that the Australian Government 'commit to implementing the recommendations of the Financial Stability Board Task Force on Climate-related Financial Disclosures where appropriate, and undertaking the necessary law reform to give them effect'.[72]

3.65 In its March 2018 response to the report, the Government welcomed the release of the final report of the Financial Stability Board Task Force on Climate-related Financial Disclosures and encouraged stakeholders to consider the recommendations. However, the Government argued that law reform is not required

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68 IGCC, *Submission 55*, p. 6. The Taskforce was established to develop 'voluntary, consistent climate-related financial risk disclosures for use by companies in providing information to investors, lenders, insurers, and other stakeholders' (see www.fsb-tcfd.org/about/). The final recommendations of the Taskforce can be viewed here: www.fsb-tcfd.org/wp-content/uploads/2017/06/FINAL-TCFD-Report-062817.pdf

69 IGCC, *Submission 55*, p. 6.

70 IGCC, *Submission 55*, p. 10.

71 For example, see Environment Institute of Australia and New Zealand, *Submission 36*, pp. 7–8.

72 Senate Economics References Committee, *Carbon risk: a burning issue*, April 2017, p. 28.

because the *Corporations Act 2001* is principles-based and does not stop stakeholders from implementing the recommendations.[73]

73 Australian Government, *Response to Senate Economics References Committee report—Carbon risk: a burning issue*, March 2018, p. 3.

Chapter 4

Urban and coastal planning

4.1 Chapter 2 provided a high-level overview of how warming of the climate system is projected to result in various changes, such as changes in temperature, precipitation, sea level and the frequency and intensity of extreme weather events. This chapter will consider how managing these risks through appropriate planning frameworks and decisions can support effective climate change adaptation.

Examples of responses

4.2 In response to the threats climate change presents for coastal regions, various state governments have revised coastal planning strategies, policies and programs to help improve the resilience of coastal communities. For example:

- In New South Wales, the state government is reforming planning arrangements for coastal communities, and the object of the *Coastal Management Act 2016* (NSW) specifically notes the need to 'mitigate current and future risks from coastal hazards, taking into account the effects of climate change'.[1] The Government has released a draft Coastal Management State Environmental Planning Policy and a draft coastal management manual and toolkit.[2] In addition, between 2014 and 2016, Local Government NSW and the NSW Office of Environment and Heritage administered the Building Resilience to Climate Change grants program designed 'to address identified climate change risks and vulnerabilities facing NSW councils'.[3]
- In Victoria, the *Victorian Coastal Strategy 2014* outlines the Government's policy on managing coastal environments, which includes benchmark requirements to plan for sea level rise of not less than 0.8 metres by 2100 and to plan for not less than 0.2 metres over current 1 in 100 year flood levels by 2040 for urban infill areas.[4] A ministerial direction and planning practice note specifically address planning to manage coastal hazards and the coastal

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1 *Coastal Management Act 2016* (NSW), s. 3(f).

2 Office of Environment and Heritage (NSW), 'Coastal reforms', www.environment.nsw.gov.au/coasts/coastreforms.htm (accessed 21 February 2018).

3 Local Government NSW, 'Building Resilience to Climate Change', www.lgnsw.org.au/policy/climate-change/building-resilience (accessed 3 April 2018). An example of a project funded by the program is outlined in Institute of Public Works Engineering Australasia and Northern Beaches Council, *Submission 14*, p. 2.

4 Victorian Coastal Council, *Victorian Coastal Strategy 2014*, www.vcc.vic.gov.au/assets/media/menu_files/VCS_2014.pdf (accessed 21 February 2018), p. 52.

impacts of climate change.[5] Evidence given by multiple Victorian local governments indicated that their planning activities are based on the 0.8 metres by 2100 and 0.2 metres by 2040 sea level rise scenarios.[6]

- In Queensland, the state government and the Local Government Association of Queensland (LGAQ) have developed programs to improve how local governments manage climate change. The Queensland Climate Resilient Councils program seeks to strengthen internal council decision-making processes to improve climate change responses. The QCoast2100 grants program provides assistance to identify vulnerabilities and risks associated with future coastal hazards.[7]
- In Western Australia, the state government issued the WA Coastal Zone Strategy in August 2017. On managing coastal erosion and inundation, the Strategy notes that planning policy seeks to avoid development in at-risk areas, identifies the need to consider planned retreat, envisages design approaches to accommodate risks and outlines when coastal protection works could be considered.[8]

4.3 The Tasmanian Government provided the following evidence regarding its adaptation and resilience efforts for communities in coastal areas:

> Since 2011, the Tasmanian Government has been working with communities vulnerable to coastal hazards through the Tasmanian Coastal Adaptation Pathways (TCAP) project. The key aim of TCAP is to raise awareness of coastal hazards and partner with communities to manage risks into the future.
>
> Through TCAP, the Government has worked in partnership with councils in 11 of the communities at risk from coastal erosion and inundation including, most recently, the municipalities of Hobart City, Huon Valley, Kingborough and Glamorgan Spring Bay.
>
> Following on from TCAP, the Government is committed to providing further guidance and support to coastal managers on understanding and managing coastal hazards to build Tasmania's climate resilience.[9]

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5 Department of Environment, Land, Water and Planning (Victoria), 'The coast and planning in Victoria', www.planning.vic.gov.au/policy-and-strategy/coastal-planning-in-victoria (accessed 27 April 2018).

6 See *Committee Hansard*, 15 March 2018, p. 26.

7 The LGAQ explained that the program is intended to 'facilitate the identification of impacts to coastal communities (including housing, buildings and infrastructure) and the identification of response options for the short, medium and long term'. Funds available under the program total $12 million over three years. See Local Government Association of Queensland, *Submission 11*, p. 4.

8 Western Australian Government, *WA Coastal Zone Strategy*, 2017, www.planning.wa.gov.au/dop_pub_pdf/WA_Coastal_Zone_Strategy.pdf (accessed 6 April 2018) p. 14.

9 Tasmanian Government, *Submission 4*, pp. 3–4.

4.4 The Environment Institute of Australia and New Zealand (EIANZ) referred to the Sydney Coastal Councils Group's mapping of areas of risk of coastal inundation. The EIANZ submitted that these maps use 'sophisticated modelling together with Councils' own information sources (e.g. LiDAR technology) to determine risk and develop consistent model planning and management responses in consultation with relevant state government agencies and the broader community'.[10]

4.5 At Collaroy-Narrabeen Beach in northern Sydney, which is considered to be the beach most vulnerable to erosion from coastal storms in northern Sydney and where severe storms were experienced in 2016, EIANZ note that actions to preserve and protect the beach have been undertaken. These actions include 'ensuring that development along Collaroy-Narrabeen Beach considers current and future hazards of wave impact and coastal erosion'.[11]

4.6 The committee was also advised of a 16-kilometre seawall being built by the Gold Coast City Council to protect its beaches.[12]

4.7 Public works as part of flood risk management have also been undertaken. The committee was referred to a levee constructed in Deniliquin which, for an investment of $15.8 million, is expected to 'avoid $85 million in flood damages in a 1 in 100 year flood'.[13] However, flood mitigation efforts can encounter opposition; the committee was also informed of instances where the construction of levees have been opposed on amenity or heritage grounds.[14]

4.8 The evidence received during this inquiry provides a sample of the climate change adaptation projects being undertaken. The committee is also aware of other examples, such as the local government projects supported by the Victorian Government intended to build community capacity and resilience in the face of climate change.[15]

4.9 An innovative approach to helping inform the community about the risk of rising sea levels is the Witness King Tide Program. Green Cross Australia submitted that this program centres on king tides, which are the highest tides of the year that occur twice annually due to astronomical and gravitational factors. The program uses king tides as an 'opportunity for the public to understand what sea level rise

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10 Environment Institute of Australia and New Zealand (EIANZ), *Submission 36*, p. 2.

11 EIANZ, *Submission 36*, p. 4.

12 Mr Alan Stokes, Executive Director, Australian Coastal Councils Association (ACCA), *Committee Hansard*, 15 March 2018, p. 25.

13 Floodplain Management Australia, *Submission 35*, p. 4.

14 Mr Paul Grech, Director, Land Use Planning, Floodplain Management Australia, *Committee Hansard*, 23 November 2017, p. 7.

15 For a list of these projects, see Department of Environment, Land, Water and Planning (Victoria), 'Climate change: Working with Local Government', www.climatechange.vic.gov.au/local-government/working-with-local-government (accessed 4 April 2018).

projections might mean for their local community'. Green Cross Australia explained how the program operates as follows:

> When king tides hit, we ask coastal communities around Australia to head out and snap pictures of local landmarks during the very high tide. These photos capture what our coastal communities may look like in the future, as global sea levels rise. Together, these images build a picture of the threat posed by sea level rise across Australia and help track the future impact of climate change. This Citizen Science program has been very successful with over 6,000 photos shared on an interactive map…[16]

4.10 Other resources are also available to assist individuals, businesses, communities and governments to prepare for the impacts of climate change in coastal areas. Of particular note is the CoastAdapt website developed by the National Climate Change Adaptation Research Facility (NCCARF), which highlights the risks coastal areas face from climate change and sea level rise, and provides advice regarding effective responses to those risks.[17] Other sources include:

- inundation risk mapping using the Google Earth engine published by digital mapping service provider NGIS;[18] and
- the interactive map published by the Australian Government that provides data for different locations across Australia on projected changes in sea level rise and other climate risks.[19]

4.11 Green Cross Australia explained that it has 'run a series of hypotheticals where we have engaged with business, industry and communities to consider the implications of storm surge in important areas around Australia and how we might respond to them'. An example that Green Cross Australia highlighted is modelling of how a hypothetical storm surge would affect Townsville. This modelling, which was undertaken with CSIRO and Townsville City Council, demonstrates 'how quickly water can move and how soon it reaches low lying homes and businesses'.[20]

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16 Green Cross Australia, *Submission 38*, pp. 1–2. Photos and further details about the Witness King Tide Program is at witnesskingtides.org/.

17 See coastadapt.com.au/.

18 See www.coastalrisk.com.au/.

19 See www.climatechangeinaustralia.gov.au/en/climate-projections/coastal-marine/marine-explorer.

20 Green Cross Australia, *Submission 38*, p. 2. The simulation is available at www.greencrossaustralia.org/our-work/disaster-and-community-resilience/townsville-stormsurge-simulation.aspx.

4.12 Mapping work undertaken elsewhere has also assisted governments to understand how low lying areas are at risk from 'more frequent and dramatic inundation and erosion'. The Tasmanian Government acknowledged that 'these events and their impacts could have serious implications for both public and private assets in vulnerable coastal areas'.[21]

4.13 Work undertaken by the CSIRO for local and state governments was also highlighted during this inquiry, such as the sea level rise projections commissioned by the Tasmanian Government and the City of Port Phillip.[22] CSIRO has also developed tools to assist decision-making, such as an integrated adaptation framework called C-FAST (City based Flood Adaptation Solutions Tool) and the Climate Risk Information and Services Platform (CRISP).[23]

4.14 On the latter program, CSIRO advised that it 'aims to support business-as-usual workflows in decision-making by Commonwealth agencies'.[24] To do this, CRISP promotes a stress-testing approach that prompts the user 'to consider a higher end change so that when they make their decision, they know it is robust to a worst-case scenario'.[25]

Land-use planning

4.15 Evidence received from some state governments indicated that work is being undertaken to ensure planning systems are appropriate for climate change. For example, the Queensland Government explained that a recent review of the planning system to 'better integrate climate change mitigation and adaption measures into the planning framework' has resulted in the following:

- in relation to new development, all local planning schemes in Queensland are required to contain provisions to avoid or mitigate the risks of natural hazards (including floods, bushfires, inundation and erosion);
- a requirement that climate change projections (including a projected sea level rise of 0.8 metres by 2100) must now be considered when planning new development near the coastline, and that new development in erosion prone areas along the coast must be avoided; and
- the 'promotion of effective and energy efficient design and siting of buildings, the integration of transport and land use planning, and the delivery of quality urban design'.[26]

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21 Tasmanian Government, *Submission 4*, p. 2.

22 Tasmanian Government, *Submission 4*, p. 3; Hobsons Bay City Council, *Submission 7*, p. 3.

23 CSIRO, *Submission 45*, pp. 12, 20.

24 CSIRO, *Submission 45*, p. 20;

25 A detailed explanation of how CRISP works was provided by Dr Russell Wise from CSIRO: see *Committee Hansard*, 22 March 2018, p. 7.

26 Queensland Government, *Submission 58*, p. 4.

4.16 One of the objectives of the Western Australian Government's coastal planning policy is 'to avoid future development within areas identified to be at risk from coastal hazards during a 100 year planning timeframe'.[27]

4.17 Nevertheless, evidence received from several stakeholders expressed concerns with planning arrangements and indicated that divergent approaches between different states and territories are developing. For example, Regional Development Australia – South West (RDA South West) informed the committee that construction near 'high value but exposed beaches and coastline is continuing in the south west [of Western Australia] despite a general acceptance of the inevitability of sea level rises'. RDA South West continued:

> Some of the infrastructure building is by local government on ground that is 1m or less above sea level. It is not expected that sea walls will be constructed, although some have [been] created as basic in-beach sea defences to mitigate against storm events. Foreshore infrastructure projects have been funded by both State and Federal Governments.
>
> Whether this is deemed reasonable social and economic development for medium term gain is another question, but there is little doubt that the projects are publicly popular and will very likely succumb to sea level rises before the end of the century.[28]

4.18 The Western Australian Local Government Association (WALGA) argued that the planning system in Western Australia 'has not been altered sufficiently to take into account climate change issues'. Despite climate risks being evident across the state, WALGA expressed concern that 'to date the only genuine policy response or control adopted to ensure that the future supply of housing is appropriate to its environment in WA is the bushfire planning and building controls adopted in December 2015'. WALGA argued that local governments and landowners need greater guidance and clarity from the state government to understand the risk of coastal inundation and other potential climate change-related risks.[29]

4.19 The insurance company IAG argued that current planning and zoning requirements 'do not reflect the level of risk communities will face in the future'. IAG argued that a 'thorough review' is needed of planning and zoning requirements to 'ensure they are changed to reflect the range of scenarios and forecasts in risk exposure that will occur with climate change'. IAG argued that 'current land planning and zoning requirements are misaligned with insurance risk', and that this places pressure on the affordability of insurance (this is discussed further in Chapter 5).[30]

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27 Western Australian Government, *WA Coastal Zone Strategy*, p. 14.

28 Regional Development Australia – South West, *Submission 15*, p. 5.

29 Western Australian Local Government Association, *Submission 57*, pp. 5, 8.

30 IAG, *Submission 56*, p. 7.

4.20 The Housing Industry Association (HIA) called for what it termed 'truth in zoning' so that landowners and the housing industry can confidently make decisions about future development. Mr Michael Roberts provided the following explanation of the HIA's position:

> …if land is identified as suitable for residential or urban development, it should be free from the need to undertake additional costly and exhaustive studies after the fact. Equally, land should not be zoned for residential or urban purposes if an ongoing high level of risk has been identified and the issue remains unresolved.[31]

4.21 The Australian Sustainable Built Environment Council (ASBEC) commented that there is a need to reconsider the current approach where planning is based on historical information, such as the use of '1 in 100 year events' as a benchmark for planning decisions. The ASBEC argued that this approach 'poses a significant impediment to climate change adaptation'. The ASBEC called on governments to make 'a greater commitment to ensuring planning systems are regularly updated'.[32]

4.22 Floodplain Management Australia (FMA) also commented on land use planning. It provided the following observations:

> Land use planning will need to factor in future climate change related risks when determining where existing facilities such as hospitals, schools and aged care facilities should be located. Overly harsh policies will restrict the opportunities to provide these facilities, while no restrictions can generate unmanageable risks. Land use planning could also address future risks associated with climate change by encouraging redevelopment to more flood compatible uses. Land use planning is, of course, only one element of a comprehensive flood risk management strategy and needs to be considered in conjunction with other measures such as structural mitigation measures.[33]

4.23 The FMA also argued that differences between the approaches taken by state, territory and local governments are unhelpful and, in some cases, it again asserted that these differences were due to concerns about highlighting risks to property. The FMA submitted:

> There are inconsistencies in benchmarks for sea level rise and rainfall intensity changes applied by the different State/Territory and Local Government jurisdictions in Australia. While there is, understandably, the potential for local variations the inconsistencies are often related to parochial concerns with identifying future risks to private property.

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31 Mr Michael Roberts, Executive Director, Planning and Environment, Housing Industry Association, *Committee Hansard*, 22 March 2018, p. 9.

32 Australian Sustainable Built Environment Council (ASBEC), *Submission 26*, Attachment 1, p. 31.

33 Floodplain Management Australia, *Submission 35*, p. 3.

> For example, over recent years in NSW here has been a regrettable retreat from definitive policies about sea level rise predictions to be adopted for 50 and 100 year horizons. Further, a scattering of state based policies dealing with climate change across related NSW agencies such as the Office of Environment and Heritage and Department of Planning and Environment make it difficult to access and understand the totality of the State Government's direction.[34]

4.24 The FMA argued that these inconsistences and the lack of a 'definitive and nationally consistent policy' on sea level rise and rainfall intensive benchmarks are 'a significant barrier to facilitating orderly and efficient planning to manage the effects of climate change into the future'.[35]

4.25 The HIA similarly argued that Australian, state and territory governments 'need to show more leadership' to address the uncertainties around planning for sea level rise. Mr Michael Roberts from the HIA stated:

> There is currently no well-established approach to incorporating climate change issues such as sea level rise into the land use decision-making process. Planning for sea level rise needs a more sophisticated approach than has traditionally been employed to deal with other natural hazards. The long-term solutions for sea level rise cannot simply be dealt with in the same way as flooding. There is a need for a staged strategy that provides flexibility to adapt to updates in the science over time.
>
> It should also be remembered that most current land use strategic plans only have a 25-year horizon. The strategy needs to recognise the average life of buildings and the redevelopment churn that is highly likely to occur in the coastal areas over the next 50 to 70 years. Now is not the last chance governments will get to direct built form outcomes.[36]

4.26 Stakeholders also called for greater coordination of various government policies. For example, the South East Councils Climate Change Alliance suggested that the *Local Government Act 1989* (Vic) should include overarching principles regarding climate risk planning and mitigation, as well as specific references linking it to the *Climate Change Act 2017* (Vic).[37]

4.27 Finally, other approaches to land-use planning informed by international experience could be considered. During the committee's public hearing in Melbourne, the concept of 'sponge cities' was discussed. This is where public areas in cities are planned to detain stormwater, where these areas are 'robust enough to drain and then

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34 Floodplain Management Australia, *Submission 35*, p. 2. See also Mr Paul Grech, Floodplain Management Australia, *Committee Hansard*, 23 November 2017, p. 1.

35 Floodplain Management Australia, *Submission 35*, p. 2.

36 Mr Michael Roberts, Housing Industry Association, *Committee Hansard*, 22 March 2018, p. 9.

37 Ms Dominique La Fontaine, Executive Officer, South East Councils Climate Change Alliance, *Committee Hansard*, 15 March 2018, p. 20.

be used for public open space', rather than being areas lost for permanent stormwater management. The committee was referred to examples of Copenhagen, Denmark and Hafencity in Hamburg, Germany,[38] although sponge city projects are also being pursued in China where 16 cities have the goal that by 2020, 80 per cent of their urban areas should absorb and reuse at least 70 per cent of rainwater.[39] The City of Melbourne and City of Port Phillip are examining stormwater management options based on these techniques.[40]

Urban heat island effect

4.28 Evidence was received about how the design of the urban environment can mitigate other climate change-related risks, such as heat effects in urban areas. For example, the Northern Territory Government submitted that a study is underway to identify the causes of heat accumulation in the Darwin central business district and to investigate possible policy options. The Government added:

> Early analysis suggests there are a range of options that could collectively reduce the average temperature across the entire CBD by up to 3°C, but localised temperature reductions could be significantly greater around options such as water features. This study has progressed to a point where cost–benefit analysis of a range of options is underway. The major benefit of implementing these options is to make the CBD a more accommodating and attractive place to live work and visit, with potential flow-on benefits in better infrastructure utilisation, and lower energy consumption because buildings and roads should remain cooler, radiate less heat, and therefore generate lower ambient temperatures so that air conditioning does not need to work as hard.[41]

4.29 Evidence received by the committee indicated options available to address urban heat are available and increasingly well understood. The committee was referred to strategies and projects in Melbourne to increase the amount of greenery in public areas. Witnesses representing the City of Melbourne and the City of Port Phillip explained that, given local governments have limited resources for such efforts, this work has been informed by canopy and health island mapping to ensure that hotspots requiring the most urgent attention are targeted effectively.[42]

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38 Mr Brett Walters, Manager, Sustainability and Transport, City of Port Phillip, *Committee Hansard*, 15 March 2018, p. 27.

39 A Biswas and K Hartley, 'China's "sponge cities" aim to re-use 70% of rainwater – here's how', *The Conversation*, https://theconversation.com/chinas-sponge-cities-aim-to-re-use-70-of-rainwater-heres-how-83327 (accessed 26 April 2018).

40 Mr Brett Walters, City of Port Phillip; Mr Gavin Ashley, Team Leader, Climate Resilience, City of Melbourne, *Committee Hansard*, 15 March 2018, p. 27.

41 Northern Territory Government, *Submission 17*, p. 3.

42 Mr Gavin Ashley, City of Melbourne, *Committee Hansard*, 15 March 2018, p. 28; Mr Steven McKellar, Senior Project Manager, Climate Adaptation and Sustainability, City of Port Phillip, *Committee Hansard*, 15 March 2018, p. 32.

4.30 The New South Wales Government recently announced a program to plant five million new trees in Sydney by 2030 to lower urban heat. It is expected that this measure will result in the tree canopy in Sydney doubling from 16.8 per cent to 40 per cent.[43] The Greater Sydney Commission's Western City District Plan identifies extending the urban tree canopy as a key planning priority.[44]

4.31 The committee also heard how 'green' infrastructure supported by 'blue' infrastructure can help address the urban heat effect and benefit individual building owners. Hobsons Bay City Council provided the following overview of green and blue infrastructure and how these types of projects can benefit local areas:

> Green infrastructure includes trees, gardens, creepers and vegetated walls and roofs throughout urban areas. For example refrigerated warehouses may benefit from green roofs to provide insulation and mitigate the [urban heat island (UHI)] effect, reducing energy costs and reducing the risk of heat stress to workers. Blue infrastructure includes using rainwater, stormwater, recycled water and other water sources to maintain the green infrastructure…These techniques to reduce the UHI effect are applicable to all projects, from large scale (e.g. major roads) to small scale (e.g. individual dwellings). These techniques need to become business as usual to reduce the risk of heat stress and associated health issues.[45]

4.32 The Water Services Association of Australia also noted the link between green infrastructure and blue infrastructure. It argued that the economics of providing irrigated green open space and other green infrastructure 'are favourable when using alternative water sources such as recycled water or stormwater'.[46]

4.33 The utilisation of green infrastructure is the focus of the New South Wales Government's draft Greener Places strategy. One of the draft strategy's aims is to 'create a healthier, more liveable and sustainable urban environment by…improving the resilience of urban areas'. The draft strategy identifies that this can be achieved through 'co-ordinated planning and design of green cover strategies including street

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43 The Hon Gladys Berejiklian MP, Premier of New South Wales, 'Tree-mendous – Sydney to get five million new trees', *Media release*, 11 April 2018, www.nsw.gov.au/your-government/the-premier/media-releases-from-the-premier/tree-mendous-sydney-to-get-five-million-new-trees/ (accessed 12 April 2018).

44 Greater Sydney Commission, *Western Sydney District Plan*, March 2018, https://gsc-public-1.s3-ap-southeast-2.amazonaws.com/s3fs-public/western-district-plan-0318.pdf (accessed 15 May 2018).

45 Hobsons Bay City Council, *Submission 7*, p. 3.

46 Water Services Association of Australia, *Submission 54*, p. 3. This was a key focus of the committee's 2015 inquiry into stormwater management.

trees, green walls and roofs, canopy trees, cool pavements and water sensitive urban design'.[47]

4.34 Although examples of efforts to reduce urban heat are readily apparent, a common theme in evidence is that further work in required. In particular, local governments were critical of state government support for reducing the urban heat island effect. For example:

- Hobsons Bay City Council submitted that buildings and the urban environment can be designed in ways to reduce the urban heat island effect; however, there 'is currently no legislation, standards or guidelines that provide a minimum standard for managing this issue'. Furthermore, the Council argued that 'there is also a knowledge deficit, through lack of training or capacity building, to enable the design and construction sector to increase their capacity to reduce the UHI effect'.[48]
- WALGA submitted that local governments are attempting to address the loss of tree canopy cover through urban forest plans, however, it considers that there is a lack of 'appropriate planning mechanisms' to support local governments. In particular, WALGA criticised 'inconsistent' Western Australian government policies, the lack of revegetation requirements for new developments, and inadequate protections for existing trees, and the lack of funding for the urban forest plans. WALGA also observed that a further challenge is the 'lack of knowledge (from community, staff and councillors) regarding the benefits of an urban forest'.[49]

4.35 It was suggested that addressing the urban heat island effect requires reconsideration of where populations are based and how greenfield developments are planned. Professor Tor Hundloe noted that most population growth in Sydney and Brisbane is occurring inland in the western districts of these metropolitan areas. Professor Hundloe observed that the temperatures in those areas are generally several degrees Celsius higher than in urban areas closer to the coast. Professor Hundloe suggested that greater consideration needs to be given to addressing urban heat in the areas where population growth is being facilitated, such as through the provision of green space.[50] Recently, it has been suggested that the most vulnerable residents in cities such as Sydney are generally the most exposed to heat risks, creating a

47 Government Architect New South Wales, *Greener Places: Establishing an urban green infrastructure policy for New South* Wales, 2017, www.governmentarchitect.nsw.gov.au/policies/greener-places (accessed 15 May 2018), pp. 10, 40.

48 Hobsons Bay City Council, *Submission 7*, p. 4.

49 Western Australian Local Government Association, *Submission 57*, p. 7.

50 Professor Tor Hundloe, Chair, Climate Change Special Interest Section, EIANZ, *Committee Hansard*, 15 March 2018, p. 11.

'heat inequality' component of the social inequality already experienced between different geographical areas.[51]

4.36 The Western City District Plan and the Greener Places draft strategy (see paragraphs 4.30 and 4.33) indicate that this issue is receiving policymakers' attention in some parts of Australia.

4.37 The HIA also argued that public spaces in greenfield development will need to provide greenery to address urban heat. Mr Michael Roberts, a HIA representative, noted that block sizes in new developments have decreased in size, reflecting policy preferences relating to housing affordability as well as the recognition that 'large trees aren't the best cohabitant of houses'. Accordingly, it was argued that 'we need to look more towards the public realm as the space that provides vegetation cover'. Mr Roberts commented, however, that local governments have delivered 'mixed messages' about this aspect of planning, with concerns about the need to protect natural assets generally being the focus of local government policy rather than addressing climate risks or natural hazards.[52]

4.38 On identifying preferred areas for population growth, it was suggested that the facilitation of population growth in areas near cities that have cooler climates could be supported by the Australian Government through finance for projects such as fast rail.[53]

4.39 CSIRO suggested that green infrastructure 'could potentially be considered alongside built infrastructure assets managed by councils' to help reduce the impacts of extreme heat, particularly the health-related consequences. CSIRO observed that to assist these efforts, it would be useful to determine 'a value on vegetation in cities (through the benefits of reducing heating/cooling requirements, reduced hospital emissions, etc.)'. CSIRO argued that such information could enable more informed cost–benefit analyses to 'build the business case for climate adaptation'.[54]

4.40 Other techniques to address urban heat were noted. Professor Jon Barnett advised that the use of light coloured roofing and road surfacing materials 'is a practical solution' to reducing the urban heat island effect. Along with the use of green and blue infrastructure, Professor Barnett argued that the use of light coloured

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51 N Frost, 'Heat inequality creates "ecological enclaves" while putting Sydney's most vulnerable residents at risk', *Domain*, www.domain.com.au/news/heat-inequality-creates-ecological-enclaves-while-putting-sydney8217s-most-vulnerable-residents-at-risk-20180508-h0zrrd/ (accessed 14 May 2018). The article reports comments made by several academics at a panel on spatial inequality and Australian cities in a warming world held recently at the University of Sydney.

52 Mr Michael Roberts, Housing Industry Association, *Committee Hansard*, 22 March 2018, p. 13.

53 Professor Tor Hundloe, EIANZ, *Committee Hansard*, 15 March 2018, p. 11.

54 CSIRO, *Submission 45*, p. 18.

materials 'need to become business as usual to reduce the risk of heat stress and associated health issues'.[55]

Coastal defences

4.41 As noted elsewhere in this report, local governments have invested in defences such as sea walls to protect properties and important natural assets.[56] Policies for coastal defences have also been developed—the Western Australia Government has specified that coastal protection works 'should only be considered after all options for avoiding and adapting to coastal hazards have been fully explored'. In addition, coastal protection works can only proceed if they meet certain conditions, such as the primary benefit of the works being for the public benefit (and that this public benefit and a positive return to the state is supported by a cost–benefit analysis).[57]

4.42 Submitters suggested that greater attention to protecting natural coastal defences is required. Lake Macquarie City Council called on the Australian Government to support programs designed to 'maintain the function of dune ecosystems as a natural defence to coastal infrastructure and private property, including ongoing community involvement in dune restoration projects'. In addition, the Council argued that the Australian Government should support the further development of remote sensing techniques and ensure data are made available 'to support high resolution monitoring of coastal recession and changes in natural coastal defence systems'.[58]

4.43 Hobsons Bay City Council argued that there is a need for 'research, knowledge sharing and capacity building to better understand the interface between land and water, and the suitability of techniques to protect different land uses', particularly in relation to coastal protection techniques. The Council submitted:

> …long term monitoring and evaluation of different coastal protection techniques is required to determine success and understand any unintended consequences. Techniques such as mangrove trees may prove to be very successful in reducing erosion, however when applied to areas of coastal saltmarsh the mangroves may significantly change the habitat and biodiversity of an area. Only through long term monitoring and evaluation will there be the capacity for coastal managers to learn and improve their techniques for coastal protection.[59]

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55 Professor Jon Barnett, *Submission 6*, p. 1.

56 Such as the sea walls being constructed by the City of Gold Coast. See City of Gold Coast, 'Seawall Construction Project', www.goldcoast.qld.gov.au/seawall-construction-projects-20762.html (accessed 26 April 2018).

57 Western Australian Government, *WA Coastal Zone Strategy*, pp. 14–15.

58 Lake Macquarie City Council, *Submission 29*, p. 5.

59 Hobsons Bay City Council, *Submission 7*, p. 6.

Planning for built areas becoming uninhabitable

4.44 As outlined in this report, climate change presents a wide range of challenges for built infrastructure. For example, modelling has identified areas in Australia at risk of inundation due to climate change. This could result in damaged or destroyed properties, or buildings that are contaminated and deemed uninhabitable.[60] Other developments, such as increased frequency of bushfire weather, may result in a greater number of bushfire events.

4.45 Despite this knowledge and the use of modelling to identify the areas at greatest risk, new development is continuing to occur in those high risk areas. Individuals may also not be taking actions to protect their properties, and either do not choose, or are unable to afford, appropriate levels of insurance cover.

4.46 This section builds on the issues discussed in this report up to this point—particularly land-use planning and the information available to guide decisions—to consider the evidence received regarding appropriate responses if properties known to be at risk today are threatened in the future.

Views on the need to consider planned retreat

4.47 The NCCARF noted that whether private house owners will respond to climate change risks is influenced by 'financial capacity, support networks, and knowledge and understanding of risk'. It argued that homeowners, once well informed, might undertake building alternations, particularly if they experience an extreme event. Nevertheless, they might encounter various challenges in doing so, including 'cost, design and construction of the existing home, insurance limitations, and government restrictions'.[61]

4.48 Despite the ability for well-informed homeowners to take action to improve the resilience of their property, the NCCARF noted that some housing will face a greater risk than what can be offset through design, such as houses at risk due to sea level rise. In situations where owners have to consider abandoning their houses, the NCCARF envisaged that owners would 'likely…look to legal redress and/or government compensation'.[62]

60 ASBEC, *Submission 26*, p. 2.

61 The National Climate Change Adaptation Research Facility (NCCARF) commented that insurance policies often do not cover repairs that improve resilience; consequently, 'homeowners must consider the value of financing any improvements themselves'. NCCARF, *Submission 28*, p. 5.

62 NCCARF, *Submission 28*, p. 5.

4.49 The potential for this outcome attracted comment from other submitters. RDA South West noted that there is a need to ensure informed decisions can be made, such as by publicising mapping of at-risk areas. It also argued that a 'framework should be developed so that infrastructure in "at risk" zones is built with a view to removal and/or planned retreat'. Beyond these actions, given what is known about climate change, RDA South West argued there is a need for individuals to take responsibility for their actions. It argued:

> Construction decisions need to become the full responsibility of the investor. Anyone who builds in 'at risk' zones cannot expect government (at any level) to construct coastal defence systems to protect private investment ie there should be an assumption that protective infrastructure will not be provided at public cost.[63]

4.50 It also appears unlikely that state governments would be obliged to compensate existing landowners for coastal erosion. The committee has not examined this in detail, however, a report prepared by an engineering consultancy for a Western Australian local government explained that, in Western Australia:

> …landowners own the rights to develop and use land as granted by land use regulations; they do not own the land itself. There is no law requiring the government (at any level) to provide protection of private property from natural hazards, nor compensation when land is lost to the sea. There are, however, several laws that allow the intervention of governments to enforce eviction if private property becomes uninhabitable, or removal of property if it constitutes a public risk. In the event of coastal erosion causing a property to "fall into the sea", and the land to disappear below the high water mark, the loss is to be borne by the property owner.[64]

4.51 During this inquiry, the committee became aware of preliminary work being undertaken regarding planned retreat. Councillor Richard Ellis of East Gippsland Shire Council advised that planned retreat of the commercial areas of Lakes Entrance and the prevention of future development in coastal areas have been discussed within Council. Councillor Ellis commented, however, that the costs that would be involved are 'quite remarkable'.[65]

4.52 Councillor Ellis added that, as a general observation, state governments do not appear to be discussing options for retreat.[66] A government that has, however, is the Western Australian Government. Its coastal zone strategy stipulates that planned or managed retreat 'should be used for existing development where possible', with efforts

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63 Regional Development Australia – South West, *Submission 15*, p. 5.

64 Cardno, Shire of Gingin: Draft Coastal Hazard Risk Management and Adaption Plan, January 2018, www.gingin.wa.gov.au/Profiles/gingin/Assets/ClientData/Document-Centre/Forms_and_brochures/59917806_RevC_Gingin_CHRMAP_Draft.pdf (accessed 11 May 2018), p. 5.

65 Councillor Richard Ellis, Committee Member, ACCA, *Committee Hansard*, 15 March 2018, p. 24.

66 Councillor Richard Ellis, ACCA, *Committee Hansard*, 15 March 2018, p. 24.

to accommodate the risk through design approaches to be pursued 'where it can be demonstrated that retreat is not possible'.[67] Local governments in Western Australia are currently developing plans to give effect to the state government's policy.

4.53 Mr Walters from the City of Port Phillip agreed that retreat in the urban environment has 'been talked about', however, he added that it is 'very difficult to imagine' given it would 'involve acquisition of some of the most valuable land in the country'. Mr Walters also noted that local governments have not undertaken work to assess how land values might be affected due to climate change that could identify the point at which land might become less valuable due to threats about habitability—Mr Walters described this as being the 'elephant in the room'.[68]

4.54 Dr Russell Wise, Senior Research Scientist, CSIRO, observed that local governments would find it difficult to plan for retreat effectively, and in any case the constituents of local governments would likely find planning for retreat unpalatable. Dr Wise explained:

> One of the things that's quite clear is that a lot of the people that are responsible for making these types of decisions in the local government often don't have the capabilities or the resources to undertake these kinds of assessments. One of the other issues, I think, is that there's an expectation on local government to be able to act on some of these options. So the option of retreat is not really an option that any local government could entertain.[69]

4.55 To give effect to the Western Australian Government's coastal planning policy, which has acknowledged that retreat will need to be considered, local governments are developing coastal hazard plans. In response to the draft plan prepared for the Shire of Gingin, a recent media article has highlighted local residents' concerns that the final plan will cause their land to have no value and that compensation might not be available despite the government deeming the land suitable for development since the 1960s.[70]

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67 Western Australian Government, *WA Coastal Zone Strategy*, p. 14.

68 Mr Brett Walters, City of Port Phillip, *Committee Hansard*, 15 March 2018, p. 24.

69 Dr Russell Wise, CSIRO, *Committee Hansard*, 22 March 2018, p. 5.

70 E Young, "'Valued at zero": WA coastal dwellers face financial ruin as sea rises', *The Age*, 9 May 2018, www.theage.com.au/national/western-australia/valued-at-zero-wa-coastal-dwellers-face-financial-ruin-as-sea-rises-20180508-p4ze3z.html?csp=fb031e22c7945089732ecaf2926933e3 (accessed 11 May 2018).

Proposals for improvement

4.56 Several stakeholders argued that there is a need for the Australian Government to have a leadership role in guiding how to manage the risk of coastal inundation, including how the issue of retreat should be approached.

4.57 Mr Paul Grech from the FMA argued that there is a need for nationally consistent guidance on, among other things, how to manage the 'gradual and, ultimately, permanent inundation of low-lying coastal communities due to sea-level rise'. Mr Grech commented that this is 'probably the most significant' issue on which national guidance on managing climate change related flood risks is needed.[71]

4.58 The HIA argued that the Australian Government needs to provide 'clear leadership and direction about the necessary first step in identifying coherent response strategies' regarding expected sea level rise, including as to whether and how developed areas will be defended. In addressing this issue, the HIA argued that the Australian Government needs to:

- evaluate potential defensive measures and examine how they could be funded; and
- resolve who is responsible for managing the legal risks arising from planning decisions affecting existing individual property owners, including by determining who will bear the costs if land is rendered unbuildable or buildings are damaged or lost.[72]

4.59 The HIA provided the following explanation as to why national leadership is required to address these issues:

> The current practice of leaving this issue to local government to solve will result in local governments in potentially affected areas attempting to address the issue on a site-by-site, development-application-by-development-application basis. This only serves to create significant uncertainty for everyone. It will be costly for those brave enough to have a go and will undoubtedly lead to a range of expensive and perverse outcomes.[73]

4.60 The suggestion for policy options to ensure a planned retreat in areas where the risk cannot be mitigated was also supported by the NCCARF.[74]

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71 Mr Paul Grech, Floodplain Management Australia, *Committee Hansard*, 23 November 2017, p. 2.

72 Mr Michael Roberts, Housing Industry Association, *Committee Hansard*, 22 March 2018, p. 10.

73 Mr Michael Roberts, Housing Industry Association, *Committee Hansard*, 22 March 2018, p. 10.

74 NCCARF, *Submission 28*, p. 5.

4.61 Finally, the ASBEC argued that improvements in Australia's planning systems and greater availability of data would support governments to 'anticipate and deal with the effects of climate change', including with respect to decision-making regarding retreat. In particular, the ASBEC argued that 'rigorous consultation' as part of the process for amending planning systems:

> …would ensure that any amendments are both appropriate and strongly supported and form the basis of discussion with the community about attitudes towards accommodation, acceptance, and retreat measures as solutions to climate change.[75]

Who pays for resilience works?

4.62 As with many public policy issues, the question of 'who pays' for actions to improve the resilience of housing, buildings and infrastructure to climate change is critical. Many types of resilience measures provide wider public benefits—accordingly, individuals and the private sector likely do not have a sufficient incentive to invest in these actions. The following evidence from Mr Michael Roberts of the HIA regarding sea walls illustrates this predicament:

> …if you…need to build a sea wall, you cannot generate a return on a sea wall so there will be zero private sector incentive to build a sea wall. But at the same time, the whole area will benefit from increased resilience to storm surge. So then how do you build an economic model which incentivises investment into public infrastructure, which then creates private sector incentives?[76]

4.63 It was noted that identifying who is responsible for managing adaptation risks is clear in some cases, such as for roads.[77] There are also examples of state governments that provide councils with funding to build resilience to climate risks.[78]

4.64 Nevertheless, even in cases where ownership is clear and the owner has an incentive to defend their asset, others still benefit from that asset being made more resilient. This could raise questions of equity. For example, Mr Roberts from the HIA noted that the Brisbane City Council is responsible for the Port of Brisbane, however, as the Port provides significant economic benefits for a large region, Mr Roberts posed the question: 'Is it fair to lump the responsibility of defending the port wholly and solely on Brisbane City Council?' Mr Roberts concluded that there 'needs to be a

75 ASBEC, *Submission 26*, Attachment 1, p. 31.

76 Ms Emma Herd, Chief Executive Officer, Investor Group on Climate Change (IGCC), *Committee Hansard*, 23 November 2017, p. 19.

77 Ms Emma Herd, IGCC, *Committee Hansard*, 23 November 2017, p. 19.

78 Mr Alan Stokes, ACCA, *Committee Hansard*, 15 March 2018, p. 25.

much more sophisticated approach to this issue than we have traditionally used in dealing with other natural hazards'.[79]

4.65 Another issue is that efforts to improve the resilience of private property can be opposed by others. Professor Lesley Hughes provided the following evidence illustrating the potential for such an outcome:

> …in the Belongil Beach-Byron Bay area we have seen where there have been considerable legal implications of sea level rise and storm surge damage there, where councils have tried to prevent individual owners sandbagging their properties, on the grounds that that has impacts on their neighbours.[80]

4.66 It was noted that some of these pressures will likely be addressed by the insurance market and decisions by prospective buyers not to invest in properties in at-risk areas such as flood prone regions. However, as discussed previously in this chapter, it was argued that there is a role for government to ensure suitable land-use planning policies are in place to guide appropriate development outcomes.[81]

4.67 Other stakeholders argued that there is a need to find alternative ways for funding investment in resilient public infrastructure.[82] Some state governments have publicly identified the need to address these issues. In its WA Coastal Zone Strategy, the Western Australian Government has suggested that coastal protection works that are in the public interest should be supported by:

- a financial plan covering construction costs and ongoing maintenance; and
- funding arrangements based on a user pays principle 'whereby those who benefit the most provide the greatest financial contribution'.[83]

79 Mr Michael Roberts, Housing Industry Association, *Committee Hansard*, 22 March 2018, p. 10.

80 Professor Lesley Hughes, Climate Council of Australia, *Committee Hansard*, 23 November 2017, p. 32.

81 Professor Lesley Hughes, Climate Council of Australia, *Committee Hansard*, 23 November 2017, p. 32.

82 Ms Megan Motto, Chief Executive Officer, Consult Australia, *Committee Hansard*, 23 November 2017, p. 24; Ms Emma Herd, IGCC, *Committee Hansard*, 23 November 2017, p. 19.

83 Western Australian Government, *WA Coastal Zone Strategy*, p. 15.

Chapter 5

Insurance and property finance

5.1 This chapter examines evidence received about the market for insuring and financing buildings and infrastructure, particularly for insurance products relating to residential properties. In doing so, it is noted that several recent and ongoing inquiries relating to natural disasters have examined issues regarding the pricing, availability and the terms and conditions of insurance, including the following:

- the 2009 Victorian Bushfires Royal Commission (2009–2010);
- the Queensland Floods Commission of Inquiry (2011–2012);
- the Australian Government's Natural Disaster Insurance Review (2011);
- the inquiry conducted by the House of Representatives Standing Committee on Social Policy and Legal Affairs into the operation of the insurance industry during disaster events (2012);
- the Productivity Commission's inquiry into the funding of natural disasters in Australia (2014);
- the Joint Select Committee on Northern Australia's inquiry into the development of Northern Australia (2014);
- the Australian Government's Northern Australia Insurance Premiums Taskforce (2015); and
- the current inquiry being conducted by the Australian Competition and Consumer Commission (ACCC) into the supply of residential building, contents and strata insurance in Northern Australia.

5.2 Although it did not explicitly address matters relating to climate change, the Senate Economics References Committee also completed an inquiry into matters relating to the insurance industry in 2017. Among other matters, that inquiry considered recent increases in the cost of insurance and the state of competition and transparency in the marketplace.

5.3 Following the 2010–11 Queensland floods, the insurance arrangements for state and territory government-owned assets were also reviewed.[1]

1 See Senate Economics References Committee, *The asset insurance arrangements of Australian state governments*, September 2011; Department of Finance and Deregulation, *Review of the Insurance Arrangements of State and Territory Governments under the Natural Disaster Relief and Recovery Arrangements Determination 2011*, September 2012.

5.4 Many of the issues relating to climate change that have implications for the insurance market also are relevant to property finance. Both insurers and lenders need to manage risk and prudential requirements successfully. A key point of difference is that property finance is long-term (such as 30-year mortgages) whereas regular property insurance contracts are for 12 months. Therefore, developments in short-term insurance contracts could influence long-term property lending. In particular, rising insurance premiums in areas considered at risk due to climate change will likely affect property values, with consequences for the approach taken by financial institutions to lending in those regions.

5.5 This chapter principally focuses on insurance as this received the most attention in submissions and during the committee's public hearings.

Pricing of insurance products

5.6 Before examining the evidence relating to climate change, it is instructive to consider how insurance products for buildings are developed and priced.

5.7 IAG explained that, fundamentally, insurance 'is a purchase for consumers to transfer certain risks to an insurer'. In offering insurance products to a customer, insurers 'identify and manage the costs of those risks to ensure there are sufficient funds to meet the cost of future claims as they arise'. In doing this, the likelihood of an event occurring that would result in the customer making a claim, and the cost of that claim, are estimated.[2]

5.8 IAG argued that risk-based pricing through insurance premiums 'provides an important signal to individuals and the communities of the level of exposure to risks'. IAG also advised that this is widely recognised, with risk-based price signals 'considered one of the most important roles that insurers play to assist society to respond to natural perils'. IAG advised that the Geneva Association's Risk Statement and the United Nation's Principles for Sustainable Insurance 'both call for insurers to adopt this approach internationally'.[3]

5.9 IAG provided the following information about how it assesses risks relating to climate change:

> At IAG we have an internal team monitoring changes to the climate and we price our policies year on year for the expected risks of the following year. The long-term risks of climate change are difficult for us to model as there are no certain data. However, our internal team works to understand future climate scenarios so this information can help inform our future strategy. As weather becomes more extreme with climate change, the year on year risk will continue to increase.[4]

2 IAG, *Submission 56*, p. 5.

3 IAG, *Submission 56*, p. 5.

4 IAG, *Submission 56*, p. 5.

5.10 The use of risk-based pricing for determining premiums assists insurers to ensure their businesses are sustainable. Policyholders are also protected through prudential standards and supervision: the Insurance Council of Australia noted that insurers are also required to 'maintain regulated amounts of capital in order to pay claims'. The Insurance Council noted there is a tension between risk and the required amount of capital holdings; that is, the 'higher the risk of claims being lodged, the higher insurance premiums can be expected to be and the larger the capital holdings held by the insurer'.[5]

Relationship between insurance and climate change risks

5.11 The implications of climate change are particularly relevant for insuring buildings and the contents within them. For example, rising sea levels, flooding, bushfires and storm surges could damage or destroy properties. Water-related damage, including from sewage, soil, and mud, could leave buildings contaminated and deemed uninhabitable.[6]

5.12 Damage from extreme events already results in high costs. For example:

- the insurance losses from Cyclone Debbie are estimated to be greater than $1.6 billion;[7] and
- the Black Saturday bushfires resulted in an estimated $1.2 billion in claims (including claims relating to property, contents and motor vehicles).[8]

5.13 Overall, the insurance industry advised that around $9 billion is paid each year in Australia in response to insurance claims linked to extreme weather events. Without climate change scenarios being taken into account (that is, based only on factors such as changes in population size and distribution, and changes in building costs), this figure is expected to increase to $39 billion by 2050.[9] The Insurance Council noted that the 'increasing migration and expansion of Australian communities, along with their insured assets, into locations with significant exposures to extreme weather has already contributed to growth in disaster losses'.[10]

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5 Insurance Council of Australia, *Submission 22*, p. 1.

6 Australian Sustainable Built Environment Council, *Submission 26*, p. 2.

7 National Insurance Brokers Association of Australia (NIBA), *Submission 8*, p. 2.

8 Victoria, 2009 Victorian Bushfires Royal Commission, *Final Report: Volume I: The Fires and the Fire-Related Deaths*, 2010, p. 343. This estimate was calculated by the Insurance Council of Australia.

9 Mr Karl Sullivan, General Manager, Policy Risk and Disaster, Insurance Council of Australia, *Committee Hansard*, 23 November 2017, p. 46.

10 Insurance Council of Australia, *Submission 22*, p. 2.

5.14 There is also evidence indicating that climate change is worsening the insurance losses associated with extreme natural hazards. For example, Lloyd's of London has estimated that, when all other factors are held constant, the 20-centimetre rise in sea level recorded at lower Manhattan since the 1950s resulted in insured losses in New York City from Superstorm Sandy being 30 per cent higher.[11]

5.15 As insurance is a product designed to manage exposure to particular risks, it follows that expected changes in risks, such as those caused by climate change, will affect insurance markets. As the Governor of the Bank of England recognised in a speech given in 2015, the insurance industry has been at the forefront of planning for climate change. Mr Carney observed:

> While there is always room for scientific disagreement about climate change (as there is with any scientific issue) I have found that insurers are amongst the most determined advocates for tackling it sooner rather than later. And little wonder. While others have been debating the theory, you have been dealing with the reality…[12]

5.16 For property owners, the key issue with climate change for insurance is how the price of insurance premiums will be affected. The remaining sections of this chapter address this issue. Other issues that have previously caused concerns following extreme events, such as the meaning of terms relied on in insurance contracts, were not considered during this inquiry.

Recent developments affecting insurance affordability

5.17 In recent years, insurance premiums have increased significantly in parts of northern Australia. A taskforce established by the Australian Government concluded that the increased premiums follow insurers aligning premiums more closely with the risk of damage to individual properties, and that the increases in northern Australia are intended to 'more accurately reflect the high risk of damage due to cyclones'.[13]

5.18 The taskforce found that the change in the setting of insurance premiums 'is not the result of any change in the behaviour of households, but has been driven by the growth in technology and competition in insurance markets and reassessments of the risk of cyclone damage'. Developments cited in support of this conclusion were:

- that more complete datasets regarding risk, greater computing power and improvements in models for estimating risks have enabled insurers to

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11 M Carney, Governor of the Bank of England, 'Breaking the Tragedy of the Horizon – climate change and financial stability', Lloyd's of London, 29 September 2015, www.bankofengland.co.uk/-/media/boe/files/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability.pdf (accessed 5 April 2018), p. 7.

12 M Carney, Governor of the Bank of England, 'Breaking the Tragedy of the Horizon – climate change and financial stability', p. 3.

13 The Treasury, *Northern Australia Insurance Premiums Taskforce: Final Report*, November 2015, p. 18.

'increasingly set premiums on properties in northern Australia in line with the risk that the individual property brings to the pool';

- losses experienced from events such as Cyclone Yasi; and
- reassessment of catastrophe reinsurance informed by advances in catastrophe modelling—that is, insurers have reallocated a greater share of the overall cost of reinsurance to premiums in northern Australia to account for the 'higher frequency of cyclones in northern Australia than, say, earthquakes in capital cities'.[14]

5.19 In commenting on the role of the insurance market in relation to regions that have a history of natural hazards, or are otherwise considered to be at an elevated risk of experiencing such hazards, the insurance sector highlighted how a well-functioning insurance market has assisted communities to recover from such events. For example, the Insurance Council submitted that:

> Without a sustainable insurance market, events like Cyclone Debbie would leave communities, businesses and individuals with little or no ability to recover from these frequent natural disasters. Without insurance being available, national, local and individual economies must absorb these substantial shocks and losses from within their own resources, or suffer the loss without recovery, ultimately restricting growth and development.[15]

5.20 IAG noted that insurance 'plays an important role in keeping the general costs of post disaster recovery down'. Without a well-functioning insurance market or if insurance was to become unaffordable, IAG argued that 'the Government may be called on to cover more of the costs to rebuild communities following an extreme weather event'.[16]

Implications for the future affordability and availability of insurance and property finance

5.21 As noted above, it is expected that the total amount paid in response to insurance claims each year is expected to increase from $9 billion in 2018 to $39 billion by 2050 based on factors such as changes in population size and distribution, and changes in building costs.[17] Climate change is also expected to result in the increased frequency or intensity of extreme weather events. Accordingly, the Insurance Council observed that:

> …any potential changes to the severity and frequency of extreme weather events, brought on by climate change, will occur in an environment where

14 The Treasury, *Northern Australia Insurance Premiums Taskforce: Final Report*, p. 18.

15 Insurance Council of Australia, *Submission 22*, p. 1.

16 IAG, *Submission 56*, p. 5.

17 Mr Karl Sullivan, Insurance Council of Australia, *Committee Hansard*, 23 November 2017, p. 46.

> extreme weather has already become more devastating and expensive for many Australian communities.[18]

5.22 These developments are expected to have implications for the affordability of insurance. At present, the Insurance Council advised that nowhere in Australia is uninsurable, however, 'there are plenty of locations where it's costing a lot of money to insure your property compared to safer locations'.[19]

5.23 The National Insurance Brokers Association of Australia (NIBA) argued that if 'the experience of insurance losses over the past 10 years continues, property insurance in Australia will start to become unaffordable'. NIBA added that many property owners in northern Queensland already face this situation.[20] Lake Macquarie City Council similarly observed that the insurance premiums of at-risk properties are expected to rise due to climate change, 'potentially making insurance unaffordable for some'.[21] Likewise, the National Climate Change Adaptation Research Facility (NCCARF) commented that in areas where 'risk is known and high', property owners are often underinsured or uninsured due to insurance either not being available or prohibitively expensive.[22]

5.24 Evidence of significant amounts of uninsured properties and underinsured properties (that is, where the sum insured does not cover the rebuilding cost) have also been revealed in the aftermath of disasters. Following the 2009 Black Saturday bushfires, it was estimated that around '13 per cent of destroyed residential properties might have been without insurance cover'. In addition, there was 'ample evidence of under-insurance'.[23] Evidence given by the Insurance Council indicated that the extent of underinsurance is clearest following bushfire events, as it is rare that other events cause a customer to reach the maximum limit of the sum insured.[24]

5.25 An additional consideration is that some of the areas with a heightened risk of climate change are also areas where the cost of claims has been increasing due to higher construction and repair costs. As Mr Karl Sullivan from the Insurance Council explained, this places further upwards pressure on insurance premiums:

> We recently completed a little piece of work looking at the cost of rebuilding around Australia. If you take a model home in Frankston in

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18 Insurance Council of Australia, *Submission 22*, p. 1.

19 Mr Karl Sullivan, Insurance Council of Australia, *Committee Hansard*, 23 November 2017, p. 47.

20 NIBA, *Submission 8*, p. 2.

21 Lake Macquarie City Council, *Submission 29*, p. 7.

22 National Climate Change Adaptation Research Facility (NCCARF), *Submission 28*, p. 5.

23 Victoria, 2009 Victorian Bushfires Royal Commission, *Final Report: Volume I: The Fires and the Fire-Related Deaths*, 2010, p. 343.

24 Mr Karl Sullivan, Insurance Council of Australia, *Committee Hansard*, 23 November 2017, p. 50.

> Victoria and say, 'This is the home that we're going to build all around Australia,' that same home will cost you 42 per cent more to build in the city of Darwin. That's because the building codes are more extensive up there to deal with the cyclone threat. But, put in very simple terms, the cost of a carpenter, a bricklayer and a roofer is much higher. The cost of all your building supplies is much higher. Their costs in terms of electricity and fuel and all the other inputs are much, much higher. If you go to Cairns it's about 30 per cent higher. If you go over to Broome, it's around 38 or 39 per cent higher. So, just taken on a like-for-like basis, a premium would be 42 per cent higher in Darwin, all things being equal—not even considering that there might be a higher frequency of cyclones.[25]

5.26 Furthermore, IAG noted that existing risk issues evident in some regions could spread to other areas that are considered low-risk at present, due to changes and increases in natural peril risks linked to climate change.[26]

5.27 As insurance premiums cover a short period, insurance customers might not appreciate the future consequences of climate change-related risks in a timely manner. Lake Macquarie City Council advised that it has 'received clear advice from the insurance industry that it does not consider future climate in determining insurance premiums as insurance policies are typically for a 12-month period, and therefore consider only the risks associated with current climate hazards'.[27]

5.28 In explaining this approach, the Insurance Council noted that, although insurers have access to long-term risk analysis such as projected flood mapping for 2100, the sector has to balance the costs associated with insuring the next 12 months and longer-term affordability. Mr Karl Sullivan from the Insurance Council explained:

> You can imagine the outcry from the community if insurers started insuring as if those scenarios were here today. We have to strike a balancing act between what we're insuring in the next 12 months—and what those costs might be and how we might drive those down—and this longer term view about: what policies can be changed and tweaked now in a very real practical sense on the ground through development control plans and the National Construction Code to make sure that what these guys are underwriting in 80 years' time is still affordable to underwrite.[28]

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25 Mr Karl Sullivan, Insurance Council of Australia, *Committee Hansard*, 23 November 2017, p. 48.

26 IAG, *Submission 56*, p. 5.

27 Lake Macquarie City Council, *Submission 29*, p. 7. Likewise, Mr Dallas Booth, Chief Executive Officer, NIBA, noted that property insurance products are 'quite short term in focus' given policies are for 12 months only. See *Committee Hansard*, 23 November 2017, p. 49.

28 Mr Karl Sullivan, Insurance Council of Australia, *Committee Hansard*, 23 November 2017, pp. 49–50.

5.29 It was also noted that insurance policies often do not cover repairs that improve resilience, such as raising flood-affected floor levels in houses that are damaged during an extreme event.[29]

5.30 The management of climate risks through appropriate urban planning, defensive infrastructure and building regulations also has implications for the scale of possible damage and the size of insurance claims. For example, it was noted that a 2014 study undertaken by CSIRO concluded that at least half of the direct damage to residential housing from coastal inundation, extreme winds, bushfire and inland flooding could be avoided through proactive intervention applying well-known measures. CSIRO advised that, in present value terms, the cost of intervention is generally one-tenth of the damages avoided or less.[30]

5.31 The committee also received evidence suggesting that lenders are declining to provide finance for buildings in at-risk areas. Regional Development Australia – South West (RDA South West) argued that, like insurance companies, lenders are similarly using climate simulation models to calculate their exposure to risk.[31]

5.32 It is noteworthy that extreme weather events have resulted in insurance and lending becoming unavailable in other countries. Although such outcomes are considered rare, the Governor of the Bank of England referred to examples in the Caribbean where storm patterns meant householders could not get insurance cover. This prompted 'mortgage lending to dry up, values to collapse and neighbourhoods to become abandoned'.[32]

5.33 In the United Kingdom, issues with insurance affordability in high flood risk areas resulted in the establishment of a flood re-insurance scheme known as Flood Re. Under this scheme, additional insurance costs associated with a high risk of flooding are funded by a levy on the insurance industry.[33]

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29 NCCARF, *Submission 28*, p. 5.

30 CSIRO, *Submission 45*, p. 19.

31 Regional Development Australia – South West, *Submission 15*, p. 8.

32 M Carney, Governor of the Bank of England, 'Breaking the Tragedy of the Horizon – climate change and financial stability', p. 9.

33 M Carney, Governor of the Bank of England, 'Breaking the Tragedy of the Horizon – climate change and financial stability', p. 9; Department for Environment, Food & Rural Affairs (UK), 'World-First Flood Re scheme open for business', www.gov.uk/government/news/world-first-flood-re-scheme-open-for-business (accessed 5 April 2018).

Responses and future directions

5.34 The Insurance Council of Australia commented that the industry is undertaking activities to assist policy makers and communities to address the implications of climate change. These activities include:

- maintaining strong prudential foundations to ensure that the industry continues to be able to respond to large extreme weather events when they occur;
- ensuring that insurance products deliver competitive price signals through risk-based pricing that assist communities and decision-makers to recognise and adapt to current and emerging extreme weather risks; and
- assisting to increase community resilience to extreme weather over time by sharing industry expertise to help policy decision-makers and the community.[34]

5.35 In the final report of the Northern Australia Insurance Premiums Taskforce, it was suggested that governments could provide additional funding for research to 'improve mitigation options particularly for roof strengthening and water ingress'. The Taskforce also recommended that mitigation could be enhanced through education campaigns encouraging property owners to improve the resilience of their properties, as well as through public works. The Taskforce further suggested that governments could subsidise the cost of mitigation works for low-income households.[35]

5.36 In its response to the Northern Australia Insurance Premiums Taskforce, the Australian Government indicated that it would not intervene directly in the insurance market and would instead proceed with reforms intended to 'place downward pressure on insurance premiums through increased accountability and transparency within the industry, as well as proposals to increase consumer understanding of insurance'. Specifically, the Government:

- urged the Insurance Council of Australia to expedite work on reforming the General Insurance Code of Practice;
- will introduce legislation to extend the unfair contract term provision in the Australian Consumer Law to insurance contracts; and
- will require the Australian Securities and Investments Commission and Treasury to undertake work that will assist consumers to understand their

34 Insurance Council of Australia, *Submission 22*, pp. 2–3.

35 The Treasury, *Northern Australia Insurance Premiums Taskforce: Final Report*, November 2015, p. 89.

> insurance needs, and to enhance transparency and disclosure practices in the insurance sector.[36]

5.37 Despite the concerns about rising premiums, the insurance sector maintained that risk-based pricing provides a useful signal for promoting and guiding adaptation. The Insurance Council submitted that:

> The insurance industry can assist governments and the community to adapt to today's residual risk and how those risks may grow into the future. The price signals offered by the market must be heeded rather than supressed, and used to motivate targeted mitigation and building design choices.[37]

5.38 The ability for price signals to provide suitable incentives for individuals to manage their risk was recognised by non-industry submitters; for example, RDA South West stated that 'to some extent these market forces will manage consumer decisions better than government regulation'.[38]

5.39 Nevertheless, insurance industry participants are also aware that a potential outcome of risk-based pricing is that insurance products could become unaffordable for some property owners. IAG submitted that it is 'aware that responding to risk through pricing alone may affect our relationship with our customers, governments and the broader community'. To address long-term issues facing the insurance market, IAG argued there is a need for 'government and the insurance industry to align thinking and work with the community to reduce, manage and adapt to the risks they face'.[39]

5.40 Similarly, the Insurance Council of Australia argued that a 'new partnership between governments and the general insurance industry on climate change adaptation would assist the community'. The Insurance Council added that tools and programs it has developed could assist local governments and the community to understand how risks might increase. In particular, it referred to its Hazard DataGlobe, the Building Resilience Rating Tool, and the Property Resilience and Exposure Program. The Insurance Council explained that the latter program 'has been designed to assist local governments to identify risk hotspots in their community and to examine the cost benefits of mitigation options to reduce those risks'.[40]

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36 The Hon Kelly O'Dwyer MP, Minister for Revenue and Financial Services, 'Government responds to Northern Australia Insurance Premiums Taskforce and General Insurance Senate Inquiry', *Media release*, 18 December 2017.

37 Insurance Council of Australia, *Submission 22*, p. 3.

38 Regional Development Australia – South West, *Submission 15*, p. 8.

39 IAG, *Submission 56*, p. 5.

40 Insurance Council of Australia, *Submission 22*, p. 3. See also Mr Karl Sullivan, Insurance Council of Australia, *Committee Hansard*, 23 November 2017, p. 49.

5.41 Another potential approach was noted by Professor Lesley Hughes, who reasoned that there might be a role for government in future to regulate insurance companies as to where 'they have a right not to insure or what they compulsorily must insure'.[41]

5.42 It was argued that there is a need for greater coordination between different levels of government on these issues, including by governments agreeing to a 'clear and consistent strategy to mitigate the nature and extent of losses that can and do arise from major weather events that regularly occur across Australia'.[42]

5.43 The need for information about climate and exposure risk was also recognised. From the perspective of individuals dealing with lenders, RDA South West argued that there 'should be complete transparency for home buyers on disaster risk profiles so consumers can make more informed decisions'.[43] For the insurance industry, it was emphasised that accurate information about risk is necessary to avoid a 'contagion' effect. Sustainable Business Australia explained:

> While only a small proportion of Australian housing might be ultimately at risk of falling value due to climate change, it should be remembered that a "contagion" effect has been observed in other markets where sudden repricing of risk occurred, particularly where there is limited information available about the extent of risk throughout the market. Relatively low levels of outright losses on subprime mortgages precipitated the financial crisis. Climate change has terrible implications for both insurers, as specialists in risk, and their customers—and by extension, for society at large. In a worst-case scenario, an insurer collapsing due to unforeseen natural disaster losses would obviously result in devastating social costs, in addition to the obvious financial ones.[44]

5.44 In the United Kingdom, the Governor of the Bank of England has urged insurers to be 'unrelenting' in pursuing improvements in risk modelling.[45]

5.45 To address climate change risks, the Insurance Council argued that appropriate revisions to land-use planning schemes (discussed in Chapter 4) and building codes (discussed in Chapter 6) are required. In addition, it argued that 'localised defensive infrastructure' would help ensure communities are able to be maintained and insured in the future.[46]

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41 Professor Lesley Hughes, Councillor, Climate Council of Australia, *Committee Hansard*, 23 November 2017, p. 32.

42 NIBA, *Submission 8*, p. 2.

43 Regional Development Australia – South West, *Submission 15*, p. 8.

44 Sustainable Business Australia, *Submission 52*, p. 12.

45 M Carney, Governor of the Bank of England, 'Breaking the Tragedy of the Horizon – climate change and financial stability', Lloyd's of London, 29 September 2015, p. 8.

46 Insurance Council of Australia, *Submission 22*, p. 2.

5.46 Similarly, IAG recommended that infrastructure, planning and zoning requirements be reviewed, as well as research undertaken into building codes to ensure they are adequate to meet the risks of future extreme weather events. It also argued for the continued creation of open data sets on current risks and weather patterns, and that community efforts to adapt and improve resilience should be encouraged and rewarded.[47]

5.47 The Northern Territory Government also commented on these issues. It submitted that:

> It may be possible in some circumstances to mitigate the impact of climate change through engineering solutions such as the construction of flood basins or diversion barriers to limit the impact of flood waters on valuable assets, thereby reducing risks, and presumably insurance premiums.
>
> It may be beneficial to improve information, mapping and data to improve forecasts of the impact of extreme events. Reviewing or upgrading engineering and building standards, and more rigorous compliance against these may be other options. Anything that can be done to reduce the uncertainty of whether infrastructure and assets will be affected, and how they will perform when they are, is likely to minimise the upward pressure on insurance premiums.[48]

5.48 Since the committee's evidence on insurance matters was received, there has been a development regarding the Australian Government's approach to improving the resilience of communities to natural disasters. In April 2018, the Minister for Law Enforcement and Cyber Security announced the creation of a Natural Resilience Taskforce to 'lead nation-wide reforms to reduce the impact and financial burden of disasters on our communities and economy'. The Minister explained that the taskforce, in consultation with the state and territory governments and the finance and insurance sectors, would 'develop a five-year national disaster mitigation framework to reduce the impact of disasters'.[49]

47 IAG, *Submission 56*, pp. 7–9.

48 Northern Territory Government, *Submission 17*, p. 12.

49 The Hon Angus Taylor MP, Minister for Law Enforcement and Cyber Security, 'Reforms to reduce impact of natural disasters in Australia', *Media release*, 10 April 2018.

Chapter 6

Residential and commercial building design

6.1 This chapter focuses on the challenges climate change presents for the resilience of residential and commercial buildings.

Issues with existing building design in the face of climate change

6.2 Evidence presented during this inquiry indicates that climate change is expected to affect the physical structure of houses and other buildings in at least three key ways:

- First, gradually and over time, changes to weather patterns such as increased temperature and rainfall, as well as increased solar radiation, could have a greater impact on the integrity of buildings than at present. For example, building materials could degrade or fail faster due to higher temperatures, and variations in rainfall could compromise building foundations.
- Secondly, other changes linked to climate change such as higher sea levels could lead to the loss or damage of property.
- Thirdly, expected increases in either the frequency or intensity of extreme events, such as storm surges, flooding, bushfires and cyclones, could significantly damage or destroy large numbers of properties.[1]

6.3 In addition to climate change affecting the physical structure of buildings, building occupants are also affected. In particular, temperature has a direct impact on the health, comfort and productivity of building occupants.

Overview of building standards

6.4 Minimum performance requirements for the design, construction and performance of building work are set by the National Construction Code (NCC), which is developed by the Australian Building Codes Board (ABCB).[2] Standards Australia also advised that the Australian Standards it develops provide guidance for

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1 Australian Sustainable Built Environment Council (ASBEC), *Submission 26*, pp. 2–3.

2 The NCC sets minimum requirements for safety, health, amenity, accessibility, and sustainability in the design and construction of new buildings and new building work in existing buildings. At present, the NCC covers building and plumbing (through the Building Code of Australia and the Plumbing Code of Australia); however, governments have agreed that all onsite building regulation will eventually be included in the NCC. The NCC is given effect by legislation in each state and territory, with each jurisdiction retaining responsibility for regulating building and plumbing. See Mr Neil Savery, Chief Executive Officer, Australian Building Codes Board (ABCB), *Committee Hansard*, 22 March 2018, p. 15; ABCB, 'About the National Construction Code, www.abcb.gov.au/ncc-online/About (accessed 16 April 2018).

the building and construction industry as many of its standards are reflected in the NCC and, therefore, state and territory building and planning regulations.[3]

6.5 The NCC is not, however, applied consistently nationwide:

- The Northern Territory Government advised that it departed from the latest energy efficiency provisions of the NCC due to the likely cost implications associated with bringing 'the Northern Territory into line' with those requirements.[4]
- In New South Wales, parts of the NCC regarding the energy efficiency of residential buildings are varied and assessment under the Building Sustainability Index (BASIX) is instead undertaken.[5]

6.6 Australian buildings are classified on a star-based scale for energy efficiency under the Nationwide House Energy Rating Scheme (NatHERS). NatHERS was added to the NCC in 2003. A recent research paper on heat stress-resistant building design provides the following explanation of the NatHERS star rating system:

> The NatHERS classifies buildings with stars from 0 to 10, based on the predicted annual thermal energy consumed for heating and cooling. The stars correlate to the nominally predicted annual thermal energy consumption, where more stars mean less energy used. The minimum requirements for new buildings were gradually raised to 6 stars, which became mandatory in 2011.[6]

6.7 For commercial buildings, the New South Wales' Young Lawyers Environment and Planning Law Committee explained that the '*Building Energy Efficiency Disclosure Act 2010* (Cth) requires commercial buildings above a certain floor space to meet energy efficiency requirements through National Australian Built Environment Rating System (NABERS) certification scheme'.[7]

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3 Standards Australia, *Submission 21*, p. 3.

4 Northern Territory Government, *Submission 17*, p. 10.

5 Under the BASIX regime, proposed development are assessed for sustainability against certain energy and water use targets that vary by region and for thermal comfort. For example, single dwellings in coastal areas are typically required to have a 40 per cent reduction in potable water consumption and 50 per cent reduction in greenhouse gas emissions compared to the benchmark set for the state. Caps in the annual amount of energy required to heat and cool the dwelling are also set, as a proxy for thermal performance and comfort of the dwelling. Department of Planning and Environment (NSW), 'BASIX targets', www.basix.nsw.gov.au/iframe/about-basix/basix-assessment/basix-targets.html (accessed 11 January 2018).

6 G Hatvani-Kovacs, M Belusko, J Pockett and J Boland, 'Heat stress-resistant building design in the Australian context', *Energy and Buildings*, vol. 158, 2018, p. 291.

7 New South Wales' Young Lawyers Environment and Planning Law Committee, *Submission 32*, p. 4.

Design requirements and practice in the face of climate change

6.8 As Australia has a history of extreme weather events, building standards have changed over time to strengthen building resilience. The changes introduced following Tropical Cyclone Tracy in 1974 were cited as examples.[8] With respect to Tropical Cyclone Yasi (2011), Standards Australia submitted the following evidence on how standards regarding wind loading developed in the 1980s have helped improve public safety:

> The powerful cyclone had extreme wind speeds and caused major destruction but did not directly result in any deaths. The damage to infrastructure in the area, although severe and the most costly throughout Australian history, was less than anticipated due to the implementation of post-1980s Australian Standards that specified the structure of housing in the cyclone-prone region. This is a story of Australian Standards working for the Australian community, ensuring competitiveness in the sector, while at the same time maintaining quality and promoting safety.[9]

6.9 Similarly, the Chief Executive Officer of the ABCB highlighted how data collected as a result of cyclones since Cyclone Larry in 2006 indicate that buildings constructed in accordance with the new standards 'are largely holding up'.[10] Furthermore, a representative of the Housing Industry Association (HIA) commented that during the 2011 Brisbane floods:

> …the buildings that were designed to stay dry during the one-in-100-year event based on 1974 calculations all stayed dry. It was only buildings that had been allowed to be built in areas that weren't safe from one-in-100-year floods that got wet.[11]

6.10 Other elements of building standards that are relevant when considering climate change are energy efficiency and water sensitive design. Various efforts to improve the sustainability and energy efficiency of buildings were referred to during this inquiry, such as the Green Building Council Australia's Green Star rating scheme. Since the Green Star scheme commenced in 2003, over 1400 projects have been Green Star-certified, including 37 per cent of office space in central business districts and apartments that house 40,000 people.[12]

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8 National Climate Change Adaptation Research Facility (NCCARF), *Submission 28*, p. 3; Standards Australia, *Submission 21*, p. 4.

9 Standards Australia, *Submission 21*, p. 4.

10 Mr Neil Savery, Chief Executive Officer, ABCB, *Committee Hansard*, 22 March 2018, p. 19.

11 Mr Michael Roberts, Executive Director, Planning and Environment, Housing Industry Association, *Committee Hansard*, 22 March 2018, p. 12.

12 See Green Building Council Australia, *Submission 50*, p. 4.

6.11 Other examples drawn to the committee's attention include:

- buildings at universities, such as the first six star Green Star education building in Australia opened at Bond University in 2008;[13]
- a housing estate managed by South East Water in Melbourne where, in addition to energy efficiency measures, houses are being developing with remote controlled rainwater tanks that enable water to be released before intense rainfall events, thus reducing the risk of urban flooding and damage to waterways;[14] and
- passive apartment design that can keep the internal temperatures of the apartments moderate without relying on air conditioning, such as the Nightingale apartments in Melbourne.[15]

6.12 Nevertheless, evidence received during this inquiry indicates that Australian buildings are generally not well suited to the existing climate, let alone a future further affected by climate change. It was also argued that the uptake of schemes to improve housing standards in the face of climate change such as the Green Star program is not occurring as rapidly as is required.[16]

6.13 Heat stress in existing housing stock is a particular concern. For example, the National Climate Change Adaptation Research Facility (NCCARF) submitted:

> In many parts of Australia, housing is poorly adapted to the current climate, and this is particularly the case for many modern developments, where lack of insulation and passive design elements mean that auxiliary heating or cooling, which accounts for about 40% (or much more in some climates) of energy use in the average Australian home, are the only way to maintain a comfortable environment for much of the year.[17]

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13 Professor Tor Hundloe, Chair, Climate Change Special Interest Section, Environment Institute of Australia and New Zealand (EIANZ), *Committee Hansard*, 15 March 2018, p. 10; Bond University, 'Bond Introduces Australia's Newest World-Leading Sustainable Building', *Media release*, https://bond.edu.au/news/44557/bond-introduces-australias-newest-world-leading-sustainable-building (accessed 12 April 2018).

14 Ms Dominique La Fontaine, Executive Officer, South East Councils Climate Change Alliance (SECCCA), *Committee Hansard*, 15 March 2018, p. 27.

15 Mr Brett Walters, Manager, Sustainability and Transport, City of Port Phillip, *Committee Hansard*, 15 March 2018, p. 31.

16 Professor Tor Hundloe stated that, in his view, the take up of the Green Star building scheme 'is moving slowly', considering that the problems it addresses have been clearly identified at least since the 2008 report of the Garnaut Climate Change Review. Professor Tor Hundloe, EIANZ, *Committee Hansard*, 15 March 2018, p. 10.

17 NCCARF, *Submission 28*, p. 3.

6.14 From a Western Australian perspective, Regional Development Australia – South West (RDA South West), noted that most houses are 'still constructed of double brick', which it submitted has a higher thermal conductivity (0.6–1.0 W/(m K)) than other building materials, such as 'timber (0.12), glass (0.96), gypsum board (0.17), rock wool (0.045) and other insulation materials (0.0035–0.16)'.[18]

6.15 As the introduction of mandatory energy efficiency requirements only apply to new buildings, most buildings have a much lower efficiency rating. Using Victoria as an example, the Centre for Sustainable Infrastructure at the Swinburne University of Technology highlighted how the majority of the housing stock is significantly below the new energy efficiency requirements:

> In Victoria, approximately 1.9 million (86%) of the existing houses were built before the introduction of mandatory energy efficiency requirements in 2005. Through an on-ground assessment of 60 sample houses, Sustainability Victoria reported that average NatHERS energy star rating of the existing houses constructed before 2005 is 1.81.[19]

6.16 Building design has clear implications for human health. For example, there is concern that building occupants are increasingly dependent on air conditioning during heat periods, and that this dependency exposes large numbers of people to health risks, including death, during heatwave events. The Centre for Sustainable Infrastructure at Swinburne University of Technology explained these concerns in its submission as follows:

> In Australia, heat events have killed more people than any other natural hazard experienced over the past 200 years. Humans spend most of their time indoors during heatwave period, as such assessment of indoor heat stress is an important issue for public health care. During [the] 2003 heatwave in Paris, 74% of excess deaths occurred among those who were staying at home. The situation in Australia is similar to that in Paris considering that the most vulnerable population is the elderly people group. In Australia, there is a growing dependence on mechanical air-conditioning to reduce the impact of heat stress. In March 2014, 74% of dwellings in Australia had coolers, up from 59% in 2005. However, this dependency on air-conditioning overloads the power grid and results in power outages during heatwaves as observed during 2009 and 2014 heatwaves in Melbourne and Adelaide. Therefore, it is crucial to ensure that the dwellings are thermally comfortable in the absence of air-conditioning during a heatwave period.[20]

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18 Regional Development Australia – South West, *Submission 15*, p. 8.

19 Centre for Sustainable Infrastructure, Swinburne University of Technology, *Submission 9*, p. 3 (citations omitted).

20 Centre for Sustainable Infrastructure, Swinburne University of Technology, *Submission 9*, p. 1 (citations omitted).

6.17 The implications of existing building design in the face of the warming climate are clear from studies that analysed and modelled previous warm weather events. This report briefly discusses the results of the following two research projects into heat stress:

- a simulation of how occupants of houses with different building energy efficiency would cope with the Melbourne heatwave event that occurred between 28–30 January 2009;[21] and
- a 2018 paper that assessed cooling consumption, peak cooling demand and the risk of indoor overheating for typical single-storey homes in Adelaide and Sydney.[22]

6.18 For the Melbourne study, the relationship between the ability of a building to mitigate heat stress in the absence of air-conditioning and heat-related mortality and morbidity was examined. Houses with different NatHERS energy ratings were assessed with reference to two indices for measuring heat stress: the WetBulb Globe Temperature (WBGT) index and the Discomfort Index (DI).[23] The study found that for a typical duplex house, the occupants of 0.9 star houses experienced extreme heat stress condition for almost 25 hours under the WBGT index and 17 hours according to the DI heat stress index. Occupants of 5.4 star houses were exposed to extreme conditions for only 6 hours (WBGT index) or 3 hours (DI).[24]

6.19 The heatwave event resulted in excess mortality of 374 deaths (that is, 374 deaths in addition to what would otherwise be expected at that time).[25] The study concluded, however, that upgrading building energy ratings would have a significant impact on related mortality and morbidity. Assuming that the occupants of 0.9 energy star houses were the victims of the 2009 heatwave event, the analysis determined that if all Melbourne homes had at least a 1.8 star energy rating, the number of excess

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21 During this heatwave, Melbourne experienced three consecutive days of temperatures above 43°C. Australian Bureau of Statistics (ABS), 'The exceptional heatwave of January–February 2009 in south-eastern Australia' in *Year Book Australia 2009–10*, cat. 1301.0, June 2010, www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/1301.0Chapter1042009%E2%80%9310 (accessed 3 January 2018). The research is published as M Alam et al, 'Modelling the correlation between building energy ratings and heat-related mortality and morbidity', *Sustainable Cities and Society*, vol. 22, 2016, pp. 29–39.

22 G Hatvani-Kovacs, M Belusko, J Pockett and J Boland, 'Heat stress-resistant building design in the Australian context', *Energy and Buildings*, vol. 158, 2018, pp. 290–299.

23 See M Alam et al.,' Modelling the correlation between building energy ratings and heat-related mortality and morbidity', *Sustainable Cities and Society*, 2016, vol. 22, pp. 29–39.

24 Centre for Sustainable Infrastructure, Swinburne University of Technology, *Submission 9*, pp. 2–3.

25 Department of Human Services (Victoria), *January 2009 Heatwave in Victoria: an Assessment of Health Impacts*, 2009, www2.health.vic.gov.au/Api/downloadmedia/%7B959CCD3C-8285-4938-872E-62E15AA62C62%7D (accessed 3 January 2018), p. iv.

deaths from a 2009-type heatwave would be reduced to around 240. This would reduce further to 37 if all houses could be upgraded to a minimum of 5.4 stars.[26]

6.20 In addition to projected reductions in mortality, corresponding reductions in heat-related morbidity and pressure on the health system were also identified. The results of the analysis are summarised at Table 6.1.

Table 6.1: Predicted health impacts of a heatwave based on the 2009 Melbourne event in different energy rated houses

	0.9 star	*1.8 star*	*2.3 star*	*3.7 star*	*4.5 star*	*5.4 star*
Deaths	374	240	197	96	62	37
Ambulance calls	514	399	347	196	129	63
Emergency department presentations	1055	864	774	511	394	280
After hours doctor consultations	71	59	50	28	20	13

Source: Centre for Sustainable Infrastructure, Swinburne University of Technology, *Submission 9*, p. 4.

6.21 The 2018 paper analysing typical houses in Adelaide and Sydney focused on whether the NatHERS energy efficient design requirements increased heat stress resistance. House design options of 6–8 stars as well as two types of traditional, energy-inefficient homes were simulated.[27]

6.22 The results of the Adelaide analysis included the following observations:

> The cooling consumption of a home with 6 stars (49.1 MJ/m2/year) can be nearly the same as an energy-inefficient, double-brick home with 2.6 stars (50 MJ/m2/year). Meanwhile, a design option with 7.2 stars (41.4 MJ/m2/year) used significantly more energy for cooling than one with only 6.2 stars (25.1 MJ/m2/year). Similarly, a home with 8.0 stars

26 Centre for Sustainable Infrastructure, Swinburne University of Technology, *Submission 9*, pp. 3–4. These results were examined further at the committee's public hearing in Melbourne: see Dr Morshed Alam, Senior Research Fellow; and Professor Patrick Zou, Professor of Construction, Centre for Sustainable Infrastructure, Swinburne University of Technology, *Committee Hansard*, 15 March 2018, pp. 1–7; and the document 'Impact of Climate Change on Occupants' Health', tabled at the 15 March 2018 public hearing. Importantly, the researchers advised that they relied on assumptions to overcome data limitations. These limitations relate to the number of hours of heat stress a person can be subjected to (which differs between individuals) and that the available data on excess mortality does not indicate whether the people were inside their house when they suffered from heatstroke.

27 The analysis was simulated using typical meteorological year data, with mid-February used for Adelaide (with a maximum temperature of 43.7°C) and late October/early November for Sydney (with a maximum temperature of 42.2°C and daily maximum temperatures generally remaining under 30°C during the adjacent days. G Hatvani-Kovacs, M Belusko, J Pockett and J Boland, 'Heat stress-resistant building design in the Australian context', *Energy and Buildings*, vol. 158, 2018, p. 291.

(22.7 MJ/m2/year) used nearly twice as much energy for cooling as a home with 7.1 stars (11.6 MJ/m2/year).[28]

6.23 For Sydney, the analysis found that all homes with 5.6 stars and above were within the maximum heating and cooling thresholds, and that the two types of traditional homes were within the maximum cooling threshold. The study also found that a 6.9-star home had higher cooling energy consumption than a 2.3-star double-brick home, and that the 5.7 star and 7.9 homes examined used the same amount of cooling energy. The paper concluded that 'the star rating did not indicate the cooling energy consumption of a building either in Adelaide or Sydney'.[29]

Particular implications for vulnerable households

6.24 Submissions also noted that certain categories of households are more likely to experience climate change-related risks as they generally live in lower quality housing. Some of these categories include:

- low income homeowners who cannot afford to retrofit their existing house or purchase similar priced housing with better energy efficiency;
- renters who cannot influence their landlords to improve the efficiency of their building or are unable to move to more efficient accommodation; and
- residents in public housing.

Low socioeconomic status homeowners

6.25 As noted above, low income homeowners may not be able to afford to retrofit their existing house or move to similar priced housing that would have lower heating and cooling costs as a result of better energy efficiency. It was also suggested that appropriate retrofitting efforts to make a house more flood resilient or energy efficient might, in addition to cost, be beyond the knowledge of some homeowners.[30]

6.26 Government programs to address residential energy efficiency have directly targeted low-income households, such as the Low Income Energy Efficiency Program operated by the Australian Government between 2011 and 2016.[31]

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28 G Hatvani-Kovacs, M Belusko, J Pockett and J Boland, 'Heat stress-resistant building design in the Australian context', *Energy and Buildings*, vol. 158, 2018, p. 293.

29 G Hatvani-Kovacs et al, 'Heat stress-resistant building design in the Australian context', p. 293.

30 SECCCA, *Submission 30*, p. 5.

31 Department of the Environment and Energy, 'Energy programs – closed', www.energy.gov.au/government-priorities/energy-programs-closed#low-income-energy-efficiency-program (accessed 24 April 2018).

Rental housing

6.27 Thirty-one per cent of Australian homes are rented.[32]

6.28 The committee was referred to a 2013 report which found that Australia's rental housing 'is poorly adapted to climate change, incorporates the lowest quality housing which is over represented by low income earners, and is the most vulnerable to climate change'.[33]

6.29 The City Futures Research Centre at UNSW advised that a research project into the barriers to low carbon living that low income individuals encounter found that the most significant of the housing-related barriers identified related to 'the prevalence of split incentives in the rental sector'. The Centre explained that landlords are often unwilling to implement efficiency upgrades as 'the benefits of their capital investments would be reaped mostly (if not solely) by the tenant'. The Centre continued:

> This issue especially disadvantages lower income households who are more likely renters than owner-occupiers and, without explicit cooperation from the landlord, are left with few recourses to protect themselves from climate change and extreme weather events even if they have the financial means to do so. One of our participants illustrates the situation: "*the landlord wasn't interested in insulation. We offered to put solar panels on but he wouldn't hear of it, and he wasn't interested in insulating the ceilings which is a pity*" (older couple in private rental, Tasmania).[34]

6.30 Hobsons Bay City Council noted that recently arrived migrants who are renting are also at a disadvantage, as they will need to learn about the need for efficiency measures in the Australian climate as well as their rights as tenants.[35]

Public housing

6.31 Concerns about public housing centred on older public housing stock that is poorly designed and maintained, and/or when public housing residents are unable to pay for air conditioning.[36] The South East Councils Climate Change Alliance (SECCCA), which represents several councils located south east of Melbourne, submitted that studies reveal '50,000 public housing properties in Victoria fail to meet

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32 ABS, 'Census of Population and Housing: Australia Revealed, 2016', cat. 2024.0, June 2017, www.abs.gov.au/ausstats/abs@.nsf/mf/2024.0 (accessed 17 April 2018).

33 Climate and Health Alliance, *Submission 16*, p. 5. The report cited is L Instone et al, *Climate change adaptation and the rental sector*, NCCARF, 2013.

34 City Futures Research Centre, UNSW, *Submission 24*, p. 1.

35 Hobsons Bay City Council, *Submission 7*, p. 12.

36 NCCARF, *Submission 28*, p. 5.

energy efficiency standards indicating that public housing tenants are less able to adapt to rising energy, water prices and contribute to climate change mitigation'.[37]

6.32 The NCCARF submitted that retrofitting, and the use of features such as cool refuges, could be pursued in response to these problems. The NCCARF explained:

> Retrofitting (e.g. to improve thermal performance) can be prioritised, and will provide value in reducing the climate risk. Particular care needs to be taken in the design and management of public housing for Indigenous Australians, to ensure it is appropriate with respect to cultural practices and to the often-extreme climatic conditions experienced by those living in regional and remote locations.
>
> External building features and landscapes can be an important contributor to improving resilience for public housing (e.g. cool refuges, flood protection) and should be considered in public housing design. External cool refuges, which may be swimming pools, are of particular importance in heatwaves, providing respite to residents unable to afford mechanical cooling or who are more vulnerable to heat stress.[38]

6.33 The committee was advised of projects underway to retrofit existing public and social housing to better withstand current climatic conditions. An example put forward is the Cooling Communities initiative undertaken by the City of Moreland with an $80,000 grant from the state government.[39]

6.34 The Northern Territory Government advised that guidelines and recommendations have been developed for public housing it supplies 'to promote site-responsive passive designs suitable for Northern Territory climate zones'. The Government submitted that it 'acknowledges that climatically appropriate design is integral to the liveability and sustainability of urban and remote public housing dwellings'.[40]

Suggestions for change

6.35 In response to the issues identified with the design of individual houses and other buildings, stakeholders put forward suggestions regarding changes to building standards and providing incentives for homeowners to improve the efficiency of their dwellings.

37 SECCCA, *Submission 30*, p. 5.

38 NCCARF, *Submission 28*, p. 5 (citation omitted).

39 Northern Alliance for Greenhouse Action, *Submission 19*, p. 4.

40 Northern Territory Government, *Submission 17*, p. 10.

Building standards and measuring energy efficiency

6.36 The benefits of a nationally consistent approach to construction regulation were recognised, with Green Building Council Australia characterising Australia as being 'fortunate' to have the NCC in place.[41] Similarly, the HIA advised that the NCC 'is seen as the benchmark by many overseas countries with respect to the technical construction standards it has established, particularly regarding building in bushfire- and cyclone-prone areas'.[42] Other recent improvements were also noted, such as the Victorian Government's Better Apartments Design Standards.[43]

6.37 Despite these positive comments about the NCC and building practices more generally, many stakeholders argued that strengthened or additional minimum building requirements are required to adapt to the effects of climate change. This evidence is discussed in the following paragraphs.

Need to reconsider minimum building requirements

6.38 Several submitters highlighted that existing building standards prescribed in the NCC are not suitable for extreme climate events associated with climate change. For example, the NCCARF submitted:

> Much of Australia's housing stock does not meet existing building standards and can be poorly designed for extreme climate events (e.g. heat, cyclones). Building guidelines currently use historic climate conditions to evaluate the energy demand and performance of a building, and these are unlikely to be adequate for future climate conditions. We do have a reasonable understanding of design features that can target heat reduction (e.g. orientation, shading, provision of appropriately sized eaves, light colours, reflective roofing, inclusion of a cool refuge, complimentary landscaping) but these are not formalised into the National Building Code.[44]

6.39 The NCCARF added that, despite the engineering-based standards introduced following Cyclone Tracy to improve the resilience of buildings to high wind speeds, there is '[s]ome evidence that modern housing may not be performing as expected under the Code'. The NCCARF suggested that ongoing review of the NCC 'is required to ensure that new buildings can withstand present-day and likely future high windspeed events'.[45]

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41 Green Building Council Australia, *Submission 50*, p. 14.

42 Mr Michael Roberts, Housing Industry Association, *Committee Hansard*, 22 March 2018, p. 9.

43 Mr Brett Walters, Manager, Sustainability and Transport; Mr Steven McKellar, Senior Project Manager, Climate Adaptation and Sustainability, City of Port Phillip, *Committee Hansard*, 15 March 2018, p. 31.

44 NCCARF, *Submission 28*, p. 3.

45 NCCARF, *Submission 28*, p. 3.

6.40 The Climate and Health Alliance also noted that previous papers and public inquiries have highlighted gaps in the NCC, including that the Code does not include design measures for buildings to withstand hail, storm tide or heat stress.[46]

6.41 IAG also recognised that the current building code might 'not be adequate to meet the risks of future extreme weather events'. IAG submitted:

> It is important that research is conducted into both the drivers of damage to buildings as well as improved understanding of the potential changes to extreme weather events so that building codes are more effective in managing future community risk. Providing upfront protection of assets, buildings and infrastructure minimises the impact to community post disaster. This is an issue now and will only increase in its impact to communities as we see an increase in more extreme weather events.[47]

6.42 Apparent issues with the NCC relating to health attracted significant attention. The Climate and Health Alliance argued that the study of Melbourne housing based on the 2009 heatwave event (see paragraphs 6.17–6.19) indicates that the Building Code of Australia, which forms two volumes of the NCC, is deficient with respect to extreme heat.[48]

6.43 Similarly, the authors of the 2018 study of heat stress-resistant building design in Adelaide and Sydney homes (see paragraphs 6.17 and 6.21–6.23) concluded that overreliance on air conditioning can present a public health hazard and that integration of heat stress resistance in the NatHERS should occur. The researchers argued that, at present, energy efficiency schemes such as NatHERS 'can be potentially counterproductive to heat stress resistance'. A result that particularly supports this conclusion is the finding from the Sydney analysis that although all homes with 5.6 stars and above were within the maximum heating and cooling thresholds, the two types of traditional homes were also within the maximum cooling threshold. The researchers described this as an unexpected result that highlights that the cooling threshold requirement 'is lenient'.[49]

6.44 Overall, the authors of the study concluded:

> …NatHERS does not directly encourage heat stress resistance in new homes and can even deliver buildings with worse heat resistance than traditional, energy-inefficient buildings. Current building construction methods, compliant with the NatHERS, rely greatly on AC, thus increasing

46 Climate and Health Alliance, *Submission 16*, pp. 5–6.

47 IAG, *Submission 56*, p. 8.

48 Climate and Health Alliance, *Submission 16*, pp. 5–6.

49 G Hatvani-Kovacs, M Belusko, J Pockett and J Boland, 'Heat stress-resistant building design in the Australian context', *Energy and Buildings*, vol. 158, 2018, p. 293. Evidence received from the ABCB confirmed that the NatHERS software assumes 'that at a certain point, or over a certain temperature, there is going to be artificial climate control'. Mr Neil Savery, ABCB, *Committee Hansard*, 22 March 2018, p. 18.

> the population's dependence on it. New homes can potentially be more hazardous without AC during heatwaves than traditional, double-brick buildings. Consequently, the risk exists that the NatHERS, without modification, can adversely impact on human health during heatwaves. Energy efficiency and heat stress resistance can be both achieved in the design process. A design approach that considers both aspects is recommended, particularly considering future increases in the vulnerability of the population and climate change. [50]

6.45 The study recommended that heat stress-resistant measures should be implemented in NatHERS to 'decrease risks associated with the population's dependence on [air conditioning], ensure a thermally safe indoor environment and reduce pressure on electricity prices'.[51] Further research into Australian building practices and how the NatHERS affects heat stress resistance was also suggested.[52]

6.46 Evidence from the City of Melbourne supported the researchers' concerns about the relevance of NatHERS for heatwaves. Mr Gavin Ashley, who leads the City's climate resilience team, commented:

> Where the Building Code currently sits, the six-star minimum standard for NatHERS is not sufficient in its ability to address heatwaves in particular. It's based on year-round energy use and splits that between your cooling and heating requirements. That doesn't give a great indication of how your building is going to perform in a heatwave. Additional guidance, which essentially puts buildings through a model that allows us to understand what the internal thermal comfort conditions are going to be during a heatwave, is critical to understanding how the building is performing. That's not currently a metric that's included in the Building Code. In order for us to plan properly and for developers to get it, it needs to be.[53]

6.47 To address heat stress risks, Green Cross Australia argued that a heat stress building code needs to be developed and 'that available disparate knowledge about effective responses to heat is integrated and combined with guidance material to support users'.[54] The Australian Health Economics Society suggested that building design and building codes for housing and commercial premises should 'emphasise passive cooling and to minimise heat gain when air conditioning is not available (e.g. due to power supply disruption)'.[55]

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50 G Hatvani-Kovacs et al, 'Heat stress-resistant building design in the Australian context', p. 297.

51 G Hatvani-Kovacs et al, 'Heat stress-resistant building design in the Australian context', p. 297.

52 G Hatvani-Kovacs et al, 'Heat stress-resistant building design in the Australian context', p. 291.

53 Mr Gavin Ashley, Team Leader, Climate Resilience, City of Melbourne, *Committee Hansard*, 15 March 2018, p. 28.

54 Green Cross Australia, *Submission 38*, p. 5.

55 Australian Health Economics Society, *Submission 23*, p. 4.

6.48 Work that has been undertaken on bushfires and wind loading was noted, although it was acknowledged that further work could be undertaken in response to extreme weather conditions. Standards Australia submitted:

> As a result of extreme weather conditions and technological shifts, there is further scope for standards development in key areas, ensuring that the infrastructure we build remains future-focused and responsive to our environmental conditions.[56]

6.49 Other stakeholders supported reviewing and revising building standards, including the NCC, to improve the energy efficiency of buildings and resilience of housing design to climate change risks.[57] In particular, Green Building Council Australia argued that the minimum standards in the NCC regarding energy efficiency should be updated more frequently. The Green Building Council submitted:

> The gap between minimum practice outlined in the NCC and best practice grows wider by the year. Lifting minimum standards for energy efficiency in the NCC will ensure that new buildings in Australia do not miss opportunities for emissions reduction, as well as creating opportunities to reduce running costs over the life of buildings.[58]

6.50 The Green Building Council added that a 'goal of net zero emissions for the NCC supported by a trajectory of planned updates over time will encourage innovation and regular upskilling of industry, and deliver more high performing buildings'.[59] Similarly, the ASBEC called for a national plan to be established to move towards zero carbon buildings by 2050.[60]

6.51 The New South Wales' Young Lawyers Environment and Planning Law Committee argued that Australian Standards 'should include preventing property damage occasioned by climate change as part of their goals, to the extent that this would help to protect lives'. Furthermore, although it was acknowledged that there are difficulties in updating Australian Standards 'where future impacts of climate change are uncertain', it was argued that updates could be progressed based on a precautionary approach that considers worst-case scenarios using 'best practice scientific data'.[61]

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56 Standards Australia, *Submission 21*, p. 4.

57 See NCCARF, *Submission 28*, p. 4; Tasmanian Government, *Submission 4*, p. 4; Sustainable Business Australia, *Submission 52*, p. 16; City of Melbourne, *Submission 43*, p. 3; New South Wales' Young Lawyers Environment and Planning Law Committee, *Submission 32*, p. 7; Northern Territory Government, *Submission 17*, p. 4; Wesfarmers, *Submission 20*, p. 4; ASBEC, *Submission 26*, p. 6.

58 Green Building Council Australia, *Submission 50*, p. 14.

59 Green Building Council Australia, *Submission 50*, p. 14.

60 ASBEC, *Submission 26*, p. 6.

61 New South Wales' Young Lawyers Environment and Planning Law Committee, *Submission 32*, p. 8.

6.52 The Australian Sustainable Built Environment Council (ASBEC) described the building regulation and standards development processes as 'slow and reactive'. It noted that this 'is perhaps understandable, considering that changes to these documents are required to be supported by evidence, cost-effective, and subject to regulatory impact assessment'. Nevertheless, the ASBEC argued that 'regular review processes are needed to enable building codes and standards to reflect, in a timely way, new climate change research and industry feedback'.[62]

6.53 Finally, it was suggested that, at least in some jurisdictions, it would be desirable to confirm that the energy ratings indicated at the outset of new developments are actually achieved. The Western Australian Local Government Association argued that occupancy certificates required for single residential properties should 'confirm that the Energy Rating prepared at the start of the project, has actually been achieved once the build is completed'.[63]

Work currently underway and need for further research

6.54 The appropriateness and effectiveness of current building standards from a climate change perspective has been the subject of policymakers' attention recently. Mr Michael Roberts from the HIA explained that there are currently three reviews considering the future benchmarks that should be set for housing. In addition, Mr Roberts noted that the NCC is due to be amended in 2019 and will be reviewed again in 2022. In summary, Mr Roberts noted that these reviews indicate there is 'a continuing discussion about how buildings need to improve'.[64]

6.55 The ABCB is also undertaking work and monitoring developments in this area. The Chief Executive Officer of the ABCB, Mr Neil Savery, explained that the Board 'continues to monitor events and the science of climate change to determine if any further changes to the NCC are warranted'.[65]

6.56 In support of this statement, Mr Savery referred to a 2014 paper produced by the ABCB which 'explores what natural hazards might be relevant to the NCC, the challenges that they present and the boundaries within which the ABCB has to operate'. On heat stress, the paper concluded that it is an area 'where further analysis was warranted, which resulted in its consideration as part of the board's current work in updating the NCC's energy efficiency provisions for 2019'. Mr Savery advised that the approach being taken by the ABCB:

> …draws a strong correlation between improving the performance of a building's energy efficiency with providing a more comfortable

62 ASBEC, *Submission 26*, Attachment 1, p. 31.

63 Western Australian Local Government Association, *Submission 57*, p. 8.

64 Mr Michael Roberts, Housing Industry Association, *Committee Hansard*, 22 March 2018, p. 12.

65 Mr Neil Savery, ABCB, *Committee Hansard*, 22 March 2018, p. 16.

> environment for occupants in extreme temperatures. This includes the introduction of split heating and cooling loads, as part of the proposed changes for NCC 2019, to improve the passive performance of buildings in extreme temperatures as well as reduce greenhouse gas emissions from artificial heating and cooling.[66]

6.57 Mr Savery added that further work on energy efficiency involving NatHERS and BASIX 'is anticipated to be undertaken for the NCC…which, subject to the modelling from the current work, may result in the consideration of additional cost-effective measures'. Mr Savery explained that the proposed change to the NatHERS software would shift the refocus of NatHERS from keeping homes warm to ensuring the home is suitable for all seasons; that is, a minimum performance requirement equivalent to six stars would need to be achieved in a house every day of the year.[67]

6.58 Although the ABCB is having regard to heat stress issues as part of its energy efficiency work, Mr Savery nonetheless emphasised that there is no project in the ABCB's work program at present 'that is specifically related to heat stress'. Mr Savery further added that if the energy efficiency project does not sufficiently address the issue of heat stress, then it would be proposed to the Board that additional work be undertaken; however, this would mean that any changes subsequently identified that met the COAG regulatory requirements could not commence until the 2022 revision of the NCC.[68]

6.59 It was also suggested that further research would assist policymakers in ensuring that measures to address heat stress are effective. For example, researchers from Swinburne University of Technology commented that research is needed into:

- how heat traps and overheating in high rated energy efficient dwellings can be created by inadequate ventilation; and
- the behaviour of building occupants during heatwave periods.[69]

Other considerations

6.60 Although most stakeholders that commented on the NCC suggested the Code needs reviewing to ensure houses are more resilient to climate change and safer for building occupants, some evidence was received that cautioned against changing the overall process for updating the NCC, or which raised other issues that should be considered.

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66 Mr Neil Savery, ABCB, *Committee Hansard*, 22 March 2018, p. 16.

67 Mr Neil Savery, ABCB, *Committee Hansard*, 22 March 2018, pp. 16–17.

68 Mr Neil Savery, ABCB, *Committee Hansard*, 22 March 2018, p. 19.

69 Dr Morshed Alam and Professor Patrick Zou, Swinburne University of Technology, *Committee Hansard*, 15 March 2018, p. 4.

6.61 The HIA warned against changes to how the NCC and relevant Australian Standards are developed. The HIA observed that ensuring 'residential and commercial buildings are resilient to natural hazards is not a new concern'.[70] In the HIA's view, the building industry and existing processes for updating the NCC and relevant Australian Standards are well placed to respond to any challenges climate change might present. In particular, the HIA emphasised that the current process requires any proposed changes to be 'evidence-based and be informed by Regulation Impact Analysis in accordance with COAG principles'.[71]

6.62 How changes to building standards could affect building users on a day-to-day basis also attracted comment. SECCCA noted that raising the standards of construction in relation to energy efficiency 'may adversely impact housing affordability'.[72] Mr Savery from the ABCB also made this point; he commented that the NCC needs to be developed with 'regard to what society can afford to pay'. Mr Savery observed:

> Whilst it is technically feasible to build a building that in the conditions of, say, seven consecutive days of plus-35—and possibly plus-40 in some parts of Australia—the cost of doing that for the average house would potentially be extremely high.[73]

6.63 Mr Karl Sullivan from the Insurance Council of Australia observed that extreme weather events are rare and, accordingly, policymakers need to consider not only the merits of enhanced building standards, but also their cost and whether any everyday benefits (or detriments) would be associated with them. To illustrate this point, Mr Sullivan commented:

> An example of that is how you wrestle with the potential of conflating sea level rise and storm surge and how buildings address the streets. From a simple urban design perspective, do we want to be raising buildings…above the pavement and have all the issues that are associated with disabled access for those sorts of buildings or are we investing in other solutions that can occasionally see water in the streets but can give us greater amenity throughout the 99 per cent of the year when that isn't going to be a problem?[74]

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70 Housing Industry Association, *Submission 47*, p. 1.

71 Housing Industry Association, *Submission 47*, p. 7. The Chief Executive Officer of the ABCB explained that amendments to the NCC are subject to regulatory impact assessment that considers 'the cost of compliance in comparison with the net benefits derived from compliance', including whether the benefits are 'likely to generate an outcome that is inconsistent with the NCC goal of imposing only minimum necessary regulation'. Mr Neil Savery, ABCB, *Committee Hansard*, 22 March 2018, p. 15.

72 SECCCA, *Submission 30*, p. 5.

73 Mr Neil Savery, ABCB, *Committee Hansard*, 22 March 2018, p. 17.

74 Mr Gavin Ashley, City of Melbourne, *Committee Hansard*, 15 March 2018, p. 27.

6.64 Evidence given by the ICA indicated, however, that additional costs could be offset by reductions in insurance premiums. To demonstrate how this can occur, Mr Sullivan from the ICA referred to the FORTIFIED Home program in the United States which, he explained, outline 'essentially a set of insurable characteristics that you build into your home and you get automatic discounts in your premium'.[75]

6.65 Discussion of these issues also revealed seemingly contrasting views about the purpose of the NCC. For example, Mr Sullivan advised that the Insurance Council's position is that a building constructed to the minimum standards under the NCC should be 'resilient or remain operational and functional given the predictable natural perils that it may face'.[76] The insurance company IAG similarly argued that the focus of the NCC on life safety is 'unquestionably vital'; nevertheless, it also considers there should be a focus on reducing the cost of damage from natural disasters to aid community resilience to such events.[77] However, the ABCB emphasised that the intention of the NCC is to protect the occupant of the building, not the building itself. Mr Savery commented that, following an extreme event:

> Ideally, the building stands and you can go back and occupy it. But if not, if it falls over, it's done its job. It's not about the durability of the building.[78]

6.66 Although several submitters consider the NCC needs to be reviewed to better address heat stress issues, it was recognised that there are other potential approaches. For example, rather than changing mandatory minimum building requirements, it was noted that higher quality buildings could be encouraged through incentives provided by insurance pricing or government programs.[79]

6.67 Finally, it was noted that better outcomes can be achieved by addressing myths about minimum building requirements.[80]

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75 Mr Karl Sullivan, General Manager, Policy Risk and Disaster, Insurance Council of Australia, *Committee Hansard*, 23 November 2017, p. 53.

76 Mr Karl Sullivan, Insurance Council of Australia, *Committee Hansard*, 23 November 2017, p. 53.

77 IAG, *Submission 56*, p. 8.

78 Mr Neil Savery, ABCB, *Committee Hansard*, 22 March 2018, p. 19.

79 Mr Karl Sullivan, Insurance Council of Australia, *Committee Hansard*, 23 November 2017, p. 53.

80 Mr Savery referred to a matter the ABCB addressed 'where designers were taking it that they had to essentially seal their buildings to meet the 6-star requirements of the code, which wasn't ever expected or required. In fact, it was the complete opposite; it was about promoting natural ventilation'. Mr Neil Savery, ABCB, *Committee Hansard*, 22 March 2018, p. 19.

Retrofitting existing buildings and ensuring homeowners are informed

6.68 In addition to strengthening building standards for new construction, it was argued that heat stress risks in existing buildings need to be addressed.[81] For example, the Climate and Health Alliance argued that the Australian, state and territory governments should 'identity retrofit opportunities for existing buildings to address climate risks, including extreme heat'. The Alliance suggested that retrofit works should 'include a particular focus on public housing, schools and early childhood centres, as well as health and social services infrastructure'.[82]

6.69 However, the costs associated with retrofitting are high. For example, the Northern Australia Insurance Premiums Taskforce estimated that a retrofit scheme for strengthening roofs for older properties in northern Queensland could cost around $1 billion.[83] In Melbourne, where researchers from the Swinburne University of Technology consider the majority of the 2.2 million homes are considered to have low energy ratings, the committee was advised that a preliminary estimate indicates that upgrading a dwelling from 0.9 star to 5.4 star through insulation and sealing could cost about $5000.[84]

6.70 It has been recognised in other jurisdictions that home and building owners may be reluctant to spend large sums on energy improvements if they expect to relocate in forthcoming years and the investment will not be recovered before they sell their property.[85]

Existing government policies regarding energy efficiency

6.71 State governments have considered energy efficiency issues. For example, the Victorian Government's *Climate Change Framework* commits to providing financial support for energy efficiency and resilience retrofitting.[86] Examples of specific programs or legislative requirements include the following:

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81 See Climate and Health Alliance, *Submission 16*, pp. 6–7; Dr Morshed Alam, Swinburne University of Technology, *Committee Hansard*, 15 March 2018, p. 3.

82 Climate and Health Alliance, *Submission 16*, pp. 6–7. As noted at paragraph 6.32, the NCCARF also argued that the suitability of public housing stock for retrofit measures should be assessed and investment in retrofit projects prioritised (NCCARF, *Submission 28*, p. 5).

83 The Treasury, *Northern Australia Insurance Premiums Taskforce: Final Report*, November 2015, p. 89.

84 Dr Morshed Alam, Swinburne University of Technology, *Committee Hansard*, 15 March 2018, pp. 3–4.

85 National Conference of State Legislatures (US), 'PACE Financing' www.ncsl.org/research/energy/pace-financing.aspx, 26 January 2016 (accessed 4 January 2018).

86 Victorian Government, *Victoria's Climate Change Framework*, 2016, p. 26.

- The Victorian Government's Energy Efficiency Target—under this scheme, accredited businesses can offer discounts to households and organisations to make energy efficiency improvements.[87]
- The Victorian Government's Residential Efficiency Scorecard—the star ratings obtained as part of the scorecard are intended to assist homeowners to make home improvements efficiently and cost effectively.[88]
- The South Australian Retailer Energy Efficiency Scheme—under this scheme, accredited operators can provide homeowners and tenants with a range of free or discounted services, including the installation of insulation, building sealing and the installation of thermally efficient windows.[89]
- In the Australian Capital Territory, since 2004 all homes for sale must have an energy rating. In addition, when advertising that a dwelling is for rent, the existing energy rating must be disclosed.[90]
- Long-term financing arrangements for building improvements known as Environmental Upgrade Agreements (EUAs, or Environmental Upgrade Finance in Victoria) are available in many parts of Australia. EUAs are a local government-based financing mechanism that help businesses access funding to improve building efficiency.

6.72 The Australian Government has previously implemented measures designed to encourage improved energy efficiency, such as the Green Building Fund for commercial office buildings introduced in 2008. As noted at paragraph 6.7, energy efficiency information is also required to be provided when commercial office space of 1000 square metres or more is offered for sale or lease.[91] The Clean Energy Finance Corporation also provides finance to support the utilisation of energy efficient technology solutions in commercial buildings and in new and existing community housing.[92]

87 Essential Services Commission, 'VEET scheme', www.veet.vic.gov.au/Public/Public.aspx?id=Home (accessed 13 April 2018).

88 Ms Dominique La Fontaine, SECCCA, *Committee Hansard*, 15 March 2018, p. 29.

89 Government of South Australia, 'Energy efficiency assistance', www.sa.gov.au/topics/energy-and-environment/using-saving-energy/retailer-energy-efficiency-scheme (accessed 13 April 2018).

90 Environment, Planning and Sustainable Development Directorate (ACT Government), 'Energy Efficiency Standards, Ratings and Disclosure', www.environment.act.gov.au/energy/smarter-use-of-energy/energy-efficiency-standards,-ratings-and-disclosure (accessed 13 April 2018).

91 Australian Government, 'Commercial Building Disclosure Program', http://cbd.gov.au/ (accessed 13 April 2018).

92 Clean Energy Finance Corporation, 'Sustainable Cities Investment Program', www.cefc.com.au/where-we-invest/sustainable-cities (accessed 24 May 2018).

Proposals to encourage retrofitting

6.73 One possible approach for improving the efficiency of older dwellings is through the imposition of mandatory requirements. Dr Morshed Alam suggested that greater energy efficiency outcomes could be achieved through a requirement that houses must reach an identified star rating by a certain year.[93] Wesfarmers also expressed support for 'the potential establishment of minimum energy performance standards for existing buildings'.[94]

6.74 In particular, it was suggested that prospective buyers and tenants could benefit if the provision of information about energy efficiency was required for property sales and leases. The energy efficiency disclosure requirements in place in the Australian Capital Territory (see paragraph 6.71) was highlighted as an example that could be followed in other jurisdictions.[95] The precedent of requirements for the disclosure of energy efficiency information for commercial buildings was also noted (see paragraph 6.72).[96]

6.75 Another potential approach is through the provision of incentives and information to encourage retrofitting and greater consideration of energy efficiency. Submitters noted that individuals building new homes are increasingly 'looking to build with a view to what it will cost to run homes'.[97] Existing homeowners may also decide to make alternations, although a range of factors can influence such decisions. The NCCARF explained:

> For private house owners, ability to respond to climate change risks is often related to financial capacity, support networks, and knowledge and understanding of risk. Once well-informed, private homeowners may undertake building alterations. Past experience of an extreme event can be motivating. Barriers to action include cost, design and construction of the existing home, insurance limitations, and government restrictions.[98]

6.76 The NCCARF argued that there is a need to consider 'mechanisms and incentives to support retrofit of private housing to improve resilience'.[99] For new homes, RDA South West similarly argued that there is a need to develop incentives to

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93 Dr Morshed Alam, Swinburne University of Technology, *Committee Hansard*, 15 March 2018, p. 3.

94 Wesfarmers, *Submission 20*, p. 4.

95 Ms Kristin Brookfield, Chief Executive, Industry Policy, Housing Industry Association, *Committee Hansard*, 22 March 2018, p. 12; Mr Brett Walters and Mr Steven McKellar, City of Port Phillip, *Committee Hansard*, 15 March 2018, p. 32.

96 Mr Brett Walters and Mr Steven McKellar, City of Port Phillip, *Committee Hansard*, 15 March 2018, p. 32.

97 Regional Development Australia – South West, *Submission 15*, p. 8.

98 NCCARF, *Submission 28*, p. 5.

99 NCCARF, *Submission 28*, p. 5.

encourage the use of more efficient materials in new houses. In particular, RDA South West suggested that:

- incentives could be offered to first home owners to encourage them to build in timber;
- incentives, tax concessions and farming programs relating to the plantation industry and for reforesting catchments to encourage 'further home cost savings in timber or light frame homes'; and
- governments could promote the use of timber frames, double glazing, insulation and solar water in public housing projects.[100]

6.77 Sustainable Business Australia argued that, to promote business and civil society actions on climate risks, the Australian Government should focus on developing financial incentives and innovative instruments that would 'continue and accelerate subsidization of energy auditing of buildings'. In addition, it argued that taxes applied to renovation, insulation work, and heating and cooling generally should be reduced to support improved energy efficiency in buildings. Sustainable Business Australia further suggested that the Australian Government could facilitate access to low interest loans, referring to the Property Assessed Clean Energy (PACE) programs available in the United States.[101]

6.78 The continued use, promotion or extension of existing schemes was suggested. The New South Wales' Young Lawyers Environment and Planning Law Committee observed that retrofitting could be supported by promoting greater uptake of EUAs.[102] The HIA argued that governments need to provide financial incentives—it endorsed rebate schemes for energy efficiency measures in place in Victoria and South Australia as models for providing 'a way for homeowners to tap into a little bit of support'.[103]

6.79 Other ideas put forward during this inquiry included:

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100 Regional Development Australia – South West, *Submission 15*, p. 8.

101 Sustainable Business Australia, *Submission 52*, p. 16. Financing provided under the PACE program enables local governments, state governments, or other inter-jurisdictional authorities to fund the up-front cost of energy improvements on commercial and residential properties, which are paid back over time by the property owners. See US Department of Energy, 'Property Assessed Clean Energy Programs', https://energy.gov/eere/slsc/property-assessed-clean-energy-programs (accessed 4 Janaury 2018) and National Conference of State Legislatures (US), 'PACE Financing' www.ncsl.org/research/energy/pace-financing.aspx, 26 January 2016 (accessed 4 January 2018).

102 New South Wales' Young Lawyers Environment and Planning Law Committee, *Submission 32*, pp. 4, 8.

103 Ms Kristin Brookfield, Housing Industry Association, *Committee Hansard*, 22 March 2018, p. 14.

- the development of an app to allow users to calculate the expected cost associated with installing insulation in their house as well as the expected savings over several years; and
- that electricity retailers include information on customer bills that enables a simple assessment about energy use and efficiency compared to similar households (some retailers already provide this information).[104]

6.80 As the committee was advised that owners of heritage buildings are often surprised that retrofitting work can be undertaken,[105] tailored guidance could be developed for owners of such properties.

104 Ms Megan Motto, Chief Executive Officer, Consult Australia, *Committee Hansard*, 23 November 2017, p. 27.

105 Mr William Millard, Director, Strategic Development, Hobsons Bay City Council, *Committee Hansard*, 15 March 2018, p. 30.

Chapter 7

Transport and utilities

7.1 This chapter considers the implications of climate change for the types of critical infrastructure that support essential services and economic activity, and are otherwise important for modern life. Types of infrastructure considered in this chapter include transportation, water supply and sewage, and energy networks. However, this inquiry did not examine all types of essential infrastructure—communications, for example, is not considered.

7.2 This chapter commences by briefly outlining some matters that are useful to take into account when considering the implications of climate change for transport and utilities. Following this, the chapter considers the following categories of infrastructure in turn: transport, water supply and sewage, and energy.

Introduction

7.3 Many of the implications for infrastructure assets used for transportation and utilities are the same as those buildings and communities face generally; for example, sea level rises will have the same consequences for essential infrastructure in low-lying areas as it will for houses and other buildings. As noted in Chapter 3, however, when considering the implications of climate change for infrastructure it is critical to account for the interconnectivities and interdependencies between different infrastructure types. Utilities and transportation reveal these interdependencies most clearly. For example, electricity is essential for many types of transportation services to operate, such as metropolitan trains; however, resilient transportation assets such as roads are also needed for accessing electricity generation and network facilities and equipment.

7.4 It is also clear that outages of critical infrastructure can have significant economic effects. For example, it is estimated that the January 2009 heatwave in Melbourne resulted in financial losses of approximately $800 million, primarily due to electricity outages and transport network disruption.[1]

7.5 Another consideration is that assets used for transport and utilities are intended to have a long economic life. This reinforces the need for careful consideration of climate change issues in these sectors. As Dr Craig James from CSIRO observed:

> If you're worrying about what crop to plant next season, you don't have to worry about climate change. You have to worry about weather but not climate change. If you're going to build an airport that you want to last 200 years—to take the other ludicrously big extreme—then clearly you

1 Climate Council of Australia, *Submission 40*, p. 4 (citation omitted).

> have to think about flooding, sea level, wind loads, all sorts of things. You want to future-proof that investment dramatically compared with what you might do today.[2]

7.6 The long-term nature of transportation and utilities infrastructure can present design challenges. Ms Megan Motto, Chief Executive Officer, Consult Australia, observed that engineers can design for a specified end point, however, 'we don't know what the end point will exactly be with regard to temperature rise, sea-level rise, extreme weather conditions et cetera because no parameters have been set at the upper limits'. Ms Motto argued that this necessitates a 'precautionary approach rather than a risk management approach' to infrastructure design.[3]

7.7 Ms Motto also called for more information to be captured via post-project reviews. Ms Motto commented:

> We don't do very good post-project reviews in this country. We don't look at what worked well and what didn't work well. There's often the risk of project reviews being sidelined because of the exposure they would give to something that could have gone better, particularly pointing to accountability of some individuals or agencies when things have gone wrong or might have gone better. The risk-averse nature of human beings means that we don't necessarily want those exposed, yet they can tell us so much about how to do things better in the future. So having a better approach to all aspects of post-project reviews would be really fantastic.[4]

Transport

7.8 Well-functioning transport networks are clearly vital for a wide range of activities needed for modern society, including the facilitation of the efficient movement of people; ensuring communities are supplied with essential goods and services; for trade; and for economic activity generally.

7.9 The importance of transport infrastructure networks within Australia was highlighted by the Northern Territory Government, which explained that the Territory 'is heavily dependent on long distance road and rail freight for the supply of essential goods'. The Government added that there are 'limited alternative routes available in the event of infrastructure failure due to heat stress or flooding'.[5]

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2 Dr Craig James, Research Program Director, CSIRO, *Committee Hansard*, 22 March 2018, p. 3.

3 Ms Megan Motto, Chief Executive Officer, Consult Australia, *Committee Hansard*, 23 November 2017, p. 23.

4 Ms Megan Motto, Consult Australia, *Committee Hansard*, 23 November 2017, p. 25.

5 Northern Territory Government, *Submission 17*, p. 4.

7.10 In addition to state and territory-wide implications, individual communities can be particularly vulnerable to disruptions to regular transportation networks. The Northern Territory Government noted that many remote coastal and island communities in its jurisdiction are reliant on barge landings for a wide variety of goods. For the coastal communities, road-based transportation can be unavailable for lengthy periods during the wet season due to road closures.[6]

7.11 The assets that form transport networks vary significantly in size and scale. For example, the resilience of small-scale local assets, such as coastal trails, is not of national importance but can be of significant value for local residents. At the other end of the spectrum are assets that have a high economic value and make a significant contribution to the economy, such as Sydney Airport, which in 2014 was estimated to contribute $30.8 billion in economic activity per year and facilitated $14.6 billion in freight exports.[7] Despite the gulf in the economic value of these examples of transportation assets, they both are exposed to climate-related risks and careful planning is required to ensure they are resilient to climate change.

Implications of climate change for transportation networks

7.12 As this report has already noted, climate change is projected to result in extreme weather events that are more intense, and in some cases, more frequent. The National Climate Change Adaptation Research Facility (NCCARF) advised that, nationally, 'between 26 000 and 33 000 kilometres of roads are potentially at risk from the combined impacts of inundation and shoreline recession due to sea level rise'.[8]

7.13 Hobsons Bay City Council provided the following insight into the various ways climate change could affect transport networks in the urban environment:

> Bus access may also be restricted due to flooding of roads. Neighbouring streets may not be suitable for buses to bypass an area of flooding. Flooded pedestrian underpasses can render a train station inoperable. Heat waves can expand and bend railway lines shutting down whole networks. Train, tram and bus users can become trapped at platforms and bus stops, exposed to the elements, with limited shelter and a lack of water. A lack of water and drinking fountains around public transport infrastructure during extreme heat increases the risk of dehydration and heat stress.[9]

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6 More generally, the Northern Territory Government noted that only 25 per cent of the 36,000 kilometres of roads in the Territory are sealed. Many of these roads 'are subject to restrictions such as seasonal closures, weight limits, or access restricted to four wheel drive vehicles only'. Northern Territory Government, *Submission 17*, pp. 2, 8.

7 Deloitte Access Economics, *The economic contribution of Sydney* Airport, April 2015, www.sydneyairport.com.au/corporate/about/reports-and-publications (accessed 23 January 2018), pp. i, 2.

8 National Climate Change Adaptation Research Facility (NCCARF), *Submission 28*, p. 2.

9 Hobsons Bay City Council, *Submission 7*, p. 8.

7.14 Natural disasters are a clear risk to transportation and can result in significant repair and replacement costs. The Queensland Tourism Industry Council noted that in Queensland, where a range of natural disasters were encountered between 2010 and 2013, transport network reconstruction costs to repair 8,741 kilometres of state-controlled roads and 1,733 bridges and culverts totalled $6.4 billion.[10] The NCCARF referred to an analysis that found the cost of extreme weather events incurred by Sydney Trains currently represents approximately 1 per cent of its combined annual operational and maintenance costs.[11]

7.15 There is a wide range of other climate-related threats which have direct implication for transport infrastructure. These include the following:

- Climate change could mean that the lifespan of many infrastructure assets is shorter than planned or that maintenance costs increase significantly. For example, more frequent exposure to seawater as a result of sea level rise could reduce the lifespan of bridges and embankments.[12] Storm surges are also resulting in local governments replacing or relocating coastal infrastructure, such as coastal trails, and it is expected that this activity will increase with sea level rise.[13]
- Repairs and other maintenance may be needed more regularly. For example, flooding events from storm surges or high intensity rainfall could require more frequent road repairs.[14] The NCCARF also observed that cooling infrastructure might require more frequent servicing.[15]
- Similarly, materials used in transportation infrastructure could deteriorate more quickly, increasing maintenance costs and the frequency in which they need to be replaced. Dr Lauren Rickards advised that, in addition to short-term damage, droughts and floods can cause longer-term issues for ground-based transport infrastructure by altering ground conditions and destabilising their foundations.[16]
- Higher temperatures are expected to increase heat stress on transport infrastructure, with sealed roads and rail lines particularly vulnerable.[17]

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10 Queensland Tourism Industry Council, *Submission 10*, p. 8.

11 NCCARF, *Submission 28*, p. 1.

12 NCCARF, *Submission 28*, p. 1.

13 Hobsons Bay City Council, *Submission 7*, p. 6.

14 NCCARF, *Submission 28*, p. 1.

15 NCCARF, *Submission 28*, p. 1.

16 Dr Lauren Rickards, *Submission 49*, p. 1.

17 For example, the Northern Territory Government submitted that heat stress on sealed roads and rail lines 'has the potential to significantly disrupt freight distribution and export to and from the Northern Territory'. Northern Territory Government, *Submission 17*, p. 4.

7.16 Financial implications from the disruption of transport infrastructure due to climate change are foreshadowed. Examples include lost income and productivity from public transport service interruption, as well as lost income from supply chain disruption or the closure of airports or ports.[18] Extreme weather events can also prevent people from being able to purchase essential items, prevent these items from being restocked, and result in food in supermarkets spoiling.[19]

7.17 There are also non-financial implications. Individuals are clearly inconvenienced and can experience discomfort when transport networks are disrupted. Life threatening situations could also occur more frequently; for example, the NCCARF noted that emergency services could be prevented from attending incidents and cars could be swept off flood-affected roads.[20]

Challenges and responses

7.18 The committee received evidence demonstrating that climate change projections are being considered as part of specific infrastructure projects. An example highlighted by several submitters is the Brisbane Airport Parallel Runway Project. Brisbane Airport is built on reclaimed coastal land, which makes it vulnerable to any increase in sea level and storm surges. To account for this, the new runway was built at a higher elevation above sea level.[21]

7.19 In its submission, Sydney Airport also advised that it has undertaken a climate risk assessment and developed an adaptation plan to safeguard the airport from risks associated with climate change. Sydney Airport explained that the assessment, which will be reviewed at least every three years, currently involves:

- mapping and understanding the baseline climatic conditions at the airport;
- developing 'a set of future climate scenarios based on the main climate variables such as sea level risk, temperature, east coast lows, wind and drought' and identifying climate based risks; and
- documenting existing controls and strategies in place and identifying further actions required, such as technical studies and stakeholder engagement.[22]

7.20 However, the Environment Institute of Australia and New Zealand (EIANZ) is of the view that, in general, little consideration of climate change occurs when transport infrastructure is planned and constructed, with examples such as the new runway at Brisbane Airport being uncommon exceptions. The EIANZ argued that:

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18 NCCARF, *Submission 28*, p. 1.

19 Wesfarmers, *Submission 20*, p. 4.

20 NCCARF, *Submission 28*, pp. 1–2.

21 NCCARF, *Submission 28*, p. 2; Environment Institute of Australia and New Zealand (EIANZ), *Submission 36*, p. 4.

22 Sydney Airport, *Submission 33*, p. 3.

> Climate risks are generally given only cursory treatment in environmental assessment studies. For example, new motorways can be expected to exacerbate climate risks due to increasing dependence on fossil-based transport (even allowing for expected expansion in low or zero emission technologies). Even public transport projects such as urban railways fail to acknowledge risks such as power outages due to extreme weather events.[23]

7.21 The EIANZ argued that the approach taken to the Brisbane Airport Parallel Runway Project should be adopted with respect to other major infrastructure that is at particular risk from climate change, such as ports.[24]

7.22 In addition to the suggestion that climate change is not being taken into account sufficiently when decisions about transport infrastructure are made, it was noted that consideration of climate change adaptation is complicated by an existing infrastructure backlog. The Australian Local Government Association (ALGA) argued that local governments are already struggling to cope with infrastructure demands. It submitted:

> Local government owns and manages over 680,000km of roads in Australia and spends billions each year on their upkeep. A 2006 report by PricewaterhouseCoopers into the financial sustainability of the sector estimated a substantial infrastructure backlog of around $14.5 billion and an under-spend on renewals in excess of $2 billion per annum. A more recent report on the State of the Local Roads Assets prepared in 2011 estimated an underinvestment in local roads alone of around $2.2 billion per annum. These studies demonstrate that local government is already under considerable pressure to manage and maintain existing non-financial assets within current budgetary constraints.
>
> The impact of climate change and extreme weather events exacerbate these challenges.[25]

7.23 To respond effectively to the challenges that climate change projections indicate owners of transportation infrastructure will face, it was emphasised that there is a need for long-term decision making and planning that accounts for these risks. For example, ALGA submitted that 'existing infrastructure and infrastructure designed today must be designed and managed for future climate change'.[26] The Northern Territory Government acknowledged that, in its jurisdiction, planning for new transport infrastructure requires consideration of the impacts of increased temperatures, rainfall, changes in sea level and coastal flooding.[27]

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23 EIANZ, *Submission 36*, p. 5.

24 EIANZ, *Submission 36*, p. 5.

25 Australian Local Government Association, *Submission 12*, p. 4.

26 NCCARF, *Submission 28*, p. 2.

27 Northern Territory Government, *Submission 17*, pp. 2, 4.

7.24 The NCCARF also emphasised that there is a need to overcome barriers to effective adaptation. It argued that 'given the potential for risk and loss, owners and managers of transport infrastructure have a compelling case for adaptation'. However, it argued that uncertainty around future climate projections and appropriate design guidelines for the future, as well as a lack of awareness by management of climate change being a financial or corporate risk, might inhibit effective responses. In addition, the NCCARF acknowledged that business realities might result in short-term risks taking priority over long-term planning, particularly if the long-term planning is incompatible with investment timeframes.[28]

7.25 For public transport, Hobsons Bay City Council argued that the relevant infrastructure 'needs to be designed with both the end user and their exposure to climate risk in mind, at all times during travel'. The Council suggested that risks could be reduced by research, such as into the use of 'light coloured ballast around train lines to reduce heat exposure'. More generally, the Council argued that a 'coordinated and considered approach is needed to manage the exposure of transport systems to climate change'.[29]

7.26 Finally, change in the transportation sector can contribute to the Australian economy reaching net zero emissions. A recent study argued that the transportation sector could be powered entirely by clean energy through renewable energy powered vehicles, the greater use of public and active transport, and heavy transport fuelled by renewable hydrogen. The study cited research from the Institute for Sustainable Futures at the University of Technology, Sydney indicating that, by 2035, renewable energy could meet 40 per cent of transportation needs.[30]

Water supply and sewage treatment systems

7.27 The importance of water to sustain life is readily evident. Water is also used for a wide range of other essential activities, such as cleaning and food production. As contaminated water can readily lead to the outbreak of disease, and is otherwise undesirable for a range of environmental, social and economic reasons, the reliable supply of potable water and the effective removal and treatment of wastewater are long-established public health priorities. The Climate and Health Alliance provided the following information on how damage to infrastructure for different water-related uses could have negative public health risks:

- drinking water infrastructure, such as drinking water reservoirs, reticulation systems and storage tanks—damage to this infrastructure 'can result in the

28 NCCARF, *Submission 28*, p. 2.

29 Hobsons Bay City Council, *Submission 7*, p. 8.

30 N Ison, M Lyons and J Atkinson, *A Plan to Repower Australia: Homegrown Power Plan Version 2*, Repower Australia, 2018, www.repoweraustralia.org.au/uploads/2018/05/02/Repower_Australia_Plan_FINAL_Mar29_2018_WEB.pdf (accessed 4 May 2018), pp. 3, 26.

ingress of microbial pathogens and chemicals into drinking water and pose unacceptable risks to health';

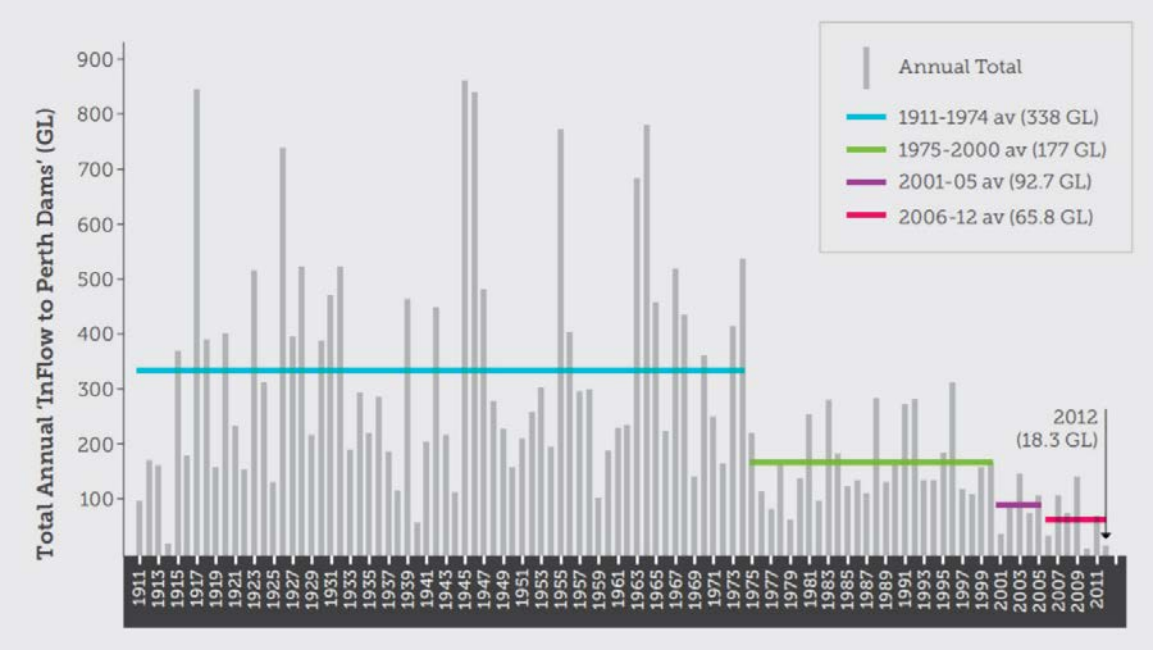
- sewerage infrastructure—damage 'can lead to sewage overflows and human exposure to unsafe concentrations of microbial pathogens and chemicals'; and
- recycled water infrastructure—when used to supply recycled water for the irrigation of food crops, damage 'can result in the ingress of pathogens and chemicals and pose risks to the food supply'.[31]

7.28 Accordingly, the implications of climate change for water supplies and the infrastructure needed to convey water and wastewater is an important consideration.

Implications of climate change for water and sewage infrastructure

7.29 Projections that climate change is likely to worsen drought conditions in southwest and southeast Australia (see Chapter 2) are expected to exacerbate existing water scarcity issues facing major cities, such as Melbourne, Sydney and Perth. To illustrate the potential effects, the rainfall decline in southwest Western Australia since the mid-1970s was highlighted. The Climate Council of Australia explained that rainfall in that region has declined by 19 per cent over that period, which has resulted in a disproportionately higher decline in the annual average stream flow into Perth's dams of nearly 80 per cent (Figure 7.1).[32]

Figure 7.1: Trend in total annual stream flow into Perth dams 1911–2012



Source: Climate Commission; provided in Climate Council of Australia, *Submission 40*, p. 11.

31 Climate and Health Alliance, *Submission 16*, p. 3.

32 Climate Council of Australia, *Submission 40*, p. 10.

7.30 The Climate Council added that, in Melbourne, water storage levels fell to a record minimum of 25.6 per cent in 2009, with stage 3 water restrictions in place from 2007 to 2010.[33]

7.31 The Climate Council explained that 'assessments of future impacts of drought on both water supply and urban water demand at the regional and/or catchment level suggest that water scarcity could increase across Australia'. It referred to an analysis undertaken by the New South Wales Office for Water in 2010 that projected water inflows to key Sydney dams, such as Warragamba and Shoalhaven, could decrease by 25 per cent by 2070.[34]

7.32 Extreme events present various challenges for water supplies and water and sewerage infrastructure. For example:

- Increasing numbers of very hot days are expected to increase the frequency and length of the periods when demand for water peaks. High temperatures may also result in equipment failure when the design standards of the structure or equipment is exceeded.[35]
- Dry soil conditions during periods of drought can exacerbate the collapse and failure of pipes.[36]
- Floods create issues regarding the quantity and quality of water supplies and, in urban environments, the capacity of stormwater systems to deal with runoff.[37]
- Bushfires affect water supplies due to damage to water infrastructure and because ash and sediment caused by the bushfire can ultimately end up in reservoirs as runoff, contaminating the water supply.[38] Bushfires can also cause damage and affect access to assets.[39]

33 Climate Council of Australia, *Submission 40*, p. 10.

34 The 25 per cent reduction is based on 'a high emissions scenario along with high population growth and less rapid technological change'. Climate Council of Australia, *Submission 40*, p. 10 (citation omitted).

35 Water Services Association of Australia (WSAA), *Submission 54*, p. 3.

36 South East Councils Climate Change Alliance (SECCCA), *Submission 30*, p. 30.

37 Dr Lauren Rickards, *Submission 49*, p. 1.

38 Eastern Alliance for Greenhouse Action (EAGA), *Submission 13*, pp. 2–3; Northern Alliance for Greenhouse Action (NAGA), *Submission 19*, p. 2. NAGA noted that the Toorourong Reservoir and catchment was significantly affected by the 2009 Kilmore–Murrindindi fire.

39 Mr Stuart Wilson, Deputy Executive Director, WSAA, *Committee Hansard*, 23 November 2017, p. 3.

7.33 Interactions of water, stormwater and sewage infrastructure with the ocean is another issue that climate change is expected to complicate. For example:

- Sea level rise, storm surge risk and, in some locations, more intense cyclones, are particular concerns for sewerage infrastructure. The Northern Territory Government noted that Darwin and Palmerston's wastewater treatment plants are all located near the coast. It noted that existing storm surge risk could be exacerbated by forecast sea level rises. The Government is concerned that more intense cyclones 'could affect the structural integrity of sewerage infrastructure' across the coastline.[40]
- Failures of sewerage systems can have health consequences. The South East Councils Climate Change Alliance (SECCCA) noted that increased rainfall intensity during storms is contributing to an increasing incidence of sewer overflows.[41] It is considered that overflow from the sewerage system into the stormwater system has resulted in E. coli (*Escherichia coli*) being detected near stormwater outlets in Port Phillip.[42]

7.34 Climate change is also expected to increase pressure on water and wastewater treatment infrastructure. SECCCA submitted that 'increased salinity levels in recycled water due to rising seawater levels resulting in increased infiltration to sewerage network and at wastewater treatment plants'.[43] The Northern Territory Government also observed that increasing ocean temperatures due to climate change 'will decrease dissolved oxygen levels and may require sewerage to be treated to a higher level before being discharged in order to mitigate the risk of potential adverse effects such as fish kills'.[44]

7.35 As the introduction to this chapter noted, the resilience of different types of essential infrastructure has interdependencies; for example, power interruptions can affect water and sewage infrastructure.[45]

7.36 Additional unique challenges for remote parts of the country were also detailed in the submissions from the Northern Territory Government and the Australian Medical Association (AMA).[46]

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40 Northern Territory Government, *Submission 17*, p. 7.

41 SECCCA, *Submission 30*, p. 30.

42 Mr Brett Walters, Manager, Sustainability and Transport, City of Port Phillip, *Committee Hansard*, 15 March 2018, p. 27.

43 SECCCA, *Submission 30*, p. 30.

44 Northern Territory Government, *Submission 17*, p. 7.

45 Climate and Health Alliance, *Submission 16*, p. 3.

46 See Northern Territory Government, *Submission 17*, p. 7 and Australian Medical Association, *Submission 34*, p. 3.

Responses

7.37 The committee was informed of efforts underway to improve the understanding of the risks facing the water sector. The Water Services Association of Australia (WSAA) explained that the Australian urban water industry 'has been amongst the first built environment systems to be affected by climate change and amongst the first industries globally which have had to develop an adaptation response'. For example, the WSAA has developed Climate Change Adaptation Guidelines to advise participants in the Australian water industry about best practice responses.[47] The WSAA also highlighted AdaptWater, which is a 'web-based climate change adaptation and asset-planning tool' that provides hazard mapping and assists to quantify climate change risks and undertake cost–benefit analyses of adaptation options.[48]

7.38 The redevelopment of the Mount Crosby pumping station in southeast Queensland was highlighted as an example where infrastructure is being made more resilient to climate change risks. Dr Karl Mallon from Climate Risk, which provides advice to the water sector including the WSAA, explained that the pumping station:

> …is probably one of the most critical pieces of infrastructure for South-East Queensland. It takes river water downstream from the Lockyer township, which we know had the so-called inland tsunami. It pumps it from the river, treats it and then sends it down into South-East Queensland. That facility was built in the 1890s, and a few years after it was built they had a major flooding event. One of the problems with these sorts of assets is that if you are going to take water from a river you have to put it near a river, and that means you are prone to flooding. There aren't choices; sometimes these assets have to be placed within areas where there are these hazards. That facility is being redeveloped to, essentially, last another hundred years. But the critical issue here is that it's designed to be fit for purpose so that at the end of this century it is still running properly and hasn't become a victim of the change in the flood regime.[49]

7.39 The committee is also aware of efforts to improve the utilisation of stormwater and wastewater. In particular, existing efforts to increase the utilisation of stormwater to improve the resilience of the water supply, including several specific stormwater related projects, were considered by the committee during a previous inquiry into stormwater management (see Box 7.1).

47 Mr Stuart Wilson, WSAA, *Committee Hansard*, 23 November 2017, p. 3.

48 WSAA, *Submission 54*, p. 4.

49 Dr Karl Mallon, Director, Science and Systems, Climate Risk Pty Ltd, *Committee Hansard*, 23 November 2017, pp. 3–4.

Box 7.1: Inquiry into stormwater management in Australia

During 2015, the committee appointed in the 44th Parliament conducted an inquiry that considered the utilisation of stormwater in Australia's cities. Evidence presented to the committee indicated that, with the exception of Perth, it is estimated that less than 3 per cent of rainwater and stormwater is used. Future growth in Australia's urban centres and more frequent or intense extreme weather events due to climate change is expected to increase volumes of stormwater further.

The committee's report considered proposals to increasing the utilisation of stormwater to reduce pressure on traditional water supplies, particularly for uses such as supporting green spaces in cities and reducing the urban heat island effect. The report discussed existing projects for stormwater harvesting, as well as the concepts of water sensitive urban design and water sensitive cities. Essentially, the overall theme of the inquiry was how water management practices could be altered to consider urban areas as water catchments.

The committee recommended that the Australian Government work with the state and territory governments to develop and implement a national policy framework for stormwater management (a National Stormwater Initiative).

In its response to the committee's report, the Government agreed with the intent of the committee's recommendation. The Government stated that, as a first step, it would 'consult with the states and territories to seek their views on jointly reviewing the Australian Guidelines for Urban Stormwater Management (2000) and whether these guidelines could form the basis of a national policy framework for stormwater management'. The Government also noted that, as part of its City Deals program, where stormwater management and urban water are identified as a priority issue, the City Deal could facilitate a coordinated response.

7.40 One of the key areas for response identified in submissions is the need for greater diversity in water supplies. Long-term declines in the water collected in catchments as well as periods of drought have already necessitated the development of climate-resilient sources of water. In Perth, two seawater desalination plants have commenced operation (the first in 2006 and the second in 2013). The plants produce a combined 145 billion litres of drinking water a year, representing around half of Perth's water supply.[50] In Adelaide, the desalination plant that commenced operating in 2011 can supply around half of Adelaide's water needs.[51] Desalination plants are also located in Melbourne, Sydney and the Gold Coast.

50 Water Corporation (WA), 'Perth Seawater Desalination Plant', www.watercorporation.com.au/water-supply/our-water-sources/desalination/perth-seawater-desalination-plant (accessed 24 April 2018); 'Southern Seawater Desalination Plant', www.watercorporation.com.au/water-supply/our-water-sources/desalination/southern-seawater-desalination-plant (accessed 24 April 2018).

51 SA Water, 'Adelaide desalination plant', www.sawater.com.au/community-and-environment/our-water-and-sewerage-systems/water-treatment/desalination/adelaide-desalination-plant-adp (accessed 24 April 2018).

7.41 In response to its water supply challenges, the Northern Territory Government submitted that the potential for managed aquifer recharge (that is, diverting surplus water into underground aquifers) is being investigated, with this technique being used in one coastal community.[52]

7.42 Councils in the Melbourne metropolitan area also highlighted the need to diversify and decentralise water supplies in response to climate change and increasing population. The Northern Alliance for Greenhouse Action (NAGA) noted that the majority of bulk water supplied to the region administered by its local governments is provided through the Yan Yean Catchment and Toorourrong Reservoir, and that all reservoirs in the region are within bushfire prone areas.[53]

7.43 To improve the resilience of the water supply in its region, NAGA called for increased government efforts to address water waste, including the more effective utilisation of stormwater for non-potable purposes, such as irrigating sporting fields and other urban green spaces.[54] Similar observations were made regarding water use in other regions: Regional Development Australia – South West (RDA South West) noted that, in the Greater Bunbury area, seven gigalitres of semi-treated water 'flows into the ocean when it could be used on eight nearby ovals, a racecourse and on multiple local parks'. RDA South West argued that a targeted government funding program could support simple projects 'which make a big difference'.[55]

7.44 Improving water efficiency is another way to reduce pressure on water supplies. RDA South West suggested that minimum standards for water use by white goods could be enhanced.[56] To help facilitate water efficiency in buildings, the Victorian Government established the Plumbing Industry Climate Action Centre in Geelong 'to deliver the next generation of sustainable and water efficient buildings'.[57]

7.45 From a public health perspective, the AMA highlighted the need to improve the resilience of water supplies in regions and communities in Australia that do not have access to infrastructure that delivers clean and potable water. The AMA argued that the 'provision of safe and affordable water for all Australians' should be pursued as part of Australia's commitment to the Sustainable Development Goals.[58]

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52 Northern Territory Government, *Submission 17*, p. 7.

53 NAGA, *Submission 19*, p. 2. See also EAGA, *Submission 13*, pp. 2–3.

54 NAGA, *Submission 19*, p. 2.

55 Regional Development Australia – South West (RDA South West), *Submission 15*, p. 7.

56 RDA South West, *Submission 15*, p. 7.

57 Victorian Government, *Victoria's Climate Change Framework*, 2016, p. 26.

58 Australian Medical Association, *Submission 34*, p. 3 (citations omitted).

7.46 On the planning of water infrastructure assets and systems, it was argued that there is a need for a fundamental change in approach. In their joint submission, a group of engineers and scientists noted that water-focused infrastructure assets such as reservoirs, flood-relief installations and drains have historically been designed with reference to records of previous rainfall (both extremes and averages). However, the submission observed that 'in recent decades, rainfall has been considerably more variable in its amounts and characteristics'.[59] That is, 'most design has assumed that data collected in the instrumental record (over approximately the last 150 years) will represent the variability over the foreseeable future'. The joint submission argued that, given the 'current understanding of climatic variability and climate change, it would be unwise to continue with undertaking hydrological analysis and design using only historical data'.[60]

7.47 The Climate and Health Alliance argued that the current approach of water supply and sewerage infrastructure being 'largely subject to voluntary standards specified in water industry codes of practice' should be replaced by 'strengthened national standards'.[61]

7.48 Ongoing research also was supported. The WSAA submitted:

> The challenges we face in a climate of uncertainty are significant. Ongoing research and scenario planning is essential to help inform decision-making. Robust and on-going climate research must be in a form suitable for hydrologic and hydraulic models (e.g. for environmental flow modelling and forecast), water supply modelling, flood modelling, evaporation and evapotranspiration rates, and even water supply demand modelling.[62]

7.49 The Climate and Health also called for the Australian Government to support research 'into new climate-resilient water and sewerage construction materials and technologies'.[63]

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59 Dr Phillip Jordan, Mr Michael Wrathall, Dr Richard Cresswell, Dr Katherine Daniell, Ms Penelope Springham, Dr William Glamore and Mr Andrew Herron, *Submission 48*, p. 3.

60 Dr Phillip Jordan et al, *Submission 48*, p. 4.

61 Climate and Health Alliance, *Submission 16*, p. 5.

62 WSAA, *Submission 54*, p. 6.

63 Climate and Health Alliance, *Submission 16*, p. 5.

Electricity

7.50 The final type of critical infrastructure networks considered in this report are the assets used to generate and supply electricity.

7.51 The committee recognises that the implications of climate change for the energy sector was considered in detail in the 2017 final report of the Independent Review into the Future Security of the National Electricity Market, chaired by Dr Alan Finkel AO (the Finkel Review). In addition, this issue has been examined in several Senate committee inquiries in recent years, including:

- the Senate Select Committee into the Resilience of Electricity Infrastructure in a Warming World (2017);
- this committee's inquiry into the retirement of coal fired power stations (2017); and
- this committee's inquiry into the performance and management of electricity network companies (2015).

7.52 In this section, the report briefly outlines issues related to the implications of climate change for electricity infrastructure assets. However, the committee does not wish to duplicate the extensive inquiries that have already been conducted and refers readers to those reports for further details and discussion on system and market developments.

Overview of the implications of climate change for the electricity system

7.53 The following paragraphs discuss the implications of climate change for electricity generation, networks, retailers and consumers in two sections. The first examines the implications of increased temperatures and more frequent or more intense extreme weather events and natural hazards. The second section considers recent and projected changes in electricity generation, including changes linked to international greenhouse gas emissions commitments.

Increased demand and implications of extreme events

7.54 Higher temperatures and increases in periods of successive very hot days is expected to result in additional demand due to increased use of air conditioning. CSIRO noted that, in all states except Tasmania, higher peaks in summer electricity demand as a result of increased air conditioner use would require either greater generational capacity or other adaptations to ensure the demand can be met.[64]

64 CSIRO, *Submission 45*, p. 15. CSIRO explained that in Tasmania, peak winter demand is greater than peak summer demand; consequently, in that state the maximum capacity of the electricity system focuses on winter demand.

7.55 In addition to the increased peak demand associated with hot days, heat events also affect the reliability of infrastructure. High temperatures affect the efficiency of generators and 'can lead to breakdowns and an increase in maintenance costs'.[65] Many elements in the power system also 'have maximum operating temperatures above which they disconnect to avoid damage'; higher temperatures due to climate change will result in these controls being triggered more frequently.[66]

7.56 Examples of high temperatures and heatwave events that resulted in significant disruption to electricity networks include the following:

- In January 2009, high temperatures as part of a heatwave affecting Victoria and South Australia resulted in transmission infrastructure outages and decreased generation output, including the outage of the Basslink interconnector that links the Victorian and Tasmanian components of the National Electricity Market (NEM).[67] It also resulted approximately 500,000 people losing power in Melbourne and other areas of Victoria.[68]
- The February 2017 heatwave in South Australia and New South Wales resulted in load shedding to restore the electricity system to a secure operating state.[69]
- On 28 January 2018, around 48,000 households in Victoria were without power after various network faults such as blown fuses and failed transformers related occurred due to a heat-related spike in demand.[70]

65 Independent Review into the Future Security of the National Electricity Market, *Blueprint for the Future*, Commonwealth of Australia, 2017, p. 70. See also CSIRO, *Submission 45*, p. 15.

66 Independent Review into the Future Security of the National Electricity Market, *Blueprint for the Future*, p. 70.

67 Australian Energy Market Commission, *Review of the Effectiveness of NEM Security and Reliability Arrangements in light of Extreme Weather Events*, May 2010, www.aemc.gov.au/sites/default/files/content/6bc855c4-b77a-4188-ae56-95fbf0938edb/Final-Report-no-appendices.pdf (accessed 26 April 2018), p. 1.

68 Mr Steven McKellar, Senior Project Manager, Climate Adaptation and Sustainability, City of Port Phillip, *Committee Hansard*, 15 March 2018, p. 40; 'Melbourne blackout causes chaos', ABC News, 30 January 2009, www.abc.net.au/news/2009-01-30/melbourne-blackout-causes-chaos/278640 (accessed 24 April 2018).

69 For information on the South Australian heatwave event, see Climate Council of Australia, *Submission 40*, pp. 5–6; and Associate Professor Seth Westra, *Submission 37*, p. 2.

70 'Power cuts in Victoria as Melbourne sweats through summer's hottest night', ABC News, 29 January 2018, www.abc.net.au/news/2018-01-29/melbourne-heat-brings-hottest-night-of-summer-blackouts/9369228 (accessed 29 January 2018); S Smith and M Butler, 'Power out as state sizzles', *Herald Sun*, 29 January 2018, p. 2.

7.57 The Finkel Review described heatwaves as posing 'the most significant threat to the power system at a bulk supply level'. The Finkel Review's final report stated:

> Heatwaves are an ongoing challenge as they can affect large parts of the network simultaneously…The increase in air conditioning in response to high temperatures generally results in peak demand, which causes stress to electricity infrastructure. Higher temperatures also limit infrastructure capabilities and reduce generator capacity and efficiency. Transmission lines can expand with hot weather, causing the cable to sag below height limitations and potentially becoming an ignition source for bushfires. Even when a heatwave has been forecast, any errors for electricity demand can lead to risks to the security of the NEM.[71]

7.58 Electricity networks are also vulnerable to other extreme weather events. A clear example is the severe storms in South Australia on 28 September 2016 that caused five transmission system faults and toppled 23 transmission towers. These storms ultimately resulted in all supply to the state's electricity system being lost (a black system event).[72]

7.59 The Finkel Review noted that increases in the frequency and intensity of extreme weather events would affect transmission and distribution networks, which the Finkel Review noted are 'vulnerable' to such events.[73] Comments in the Finkel Review's final report on how different extreme events can affect electricity infrastructure are at Box 7.2.

7.60 Submissions to this inquiry also warned that electricity network infrastructure is vulnerable to extreme events that could increase in frequency or intensity as a result of climate change. Specific examples were provided. On bushfire risk in its area, SECCCA submitted that the electricity network service provider has 'identified the loss of two sub-transmission 66 kV lines between their Dromana and Rosebud zone substations in a bushfire event [as] a credible contingency event'. SECCCA added that the risk is greatest in Arthurs Seat State Park, where the lines are in close proximity to each other. SECCCA warned that the loss of these lines 'would result in the total loss of electricity supply to the majority of the Lower Mornington Peninsula'.[74]

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71 Independent Review into the Future Security of the National Electricity Market, *Blueprint for the Future*, p. 71.

72 CSIRO, *Submission 45*, p. 15. Supply to the South Australian system was lost at 4.18 pm on 28 September 2016. Supply was restored to a first round of customers by 7 pm and by midnight, 80–90 per cent of the load capable of being restored had been restored. However, it was only by 11 October 2016 that supply had been restored to all customers. Australian Energy Market Operator, *Black System South Australia 28 September 2016*, March 2016, p. 6.

73 Independent Review into the Future Security of the National Electricity Market, *Blueprint for the Future*, p. 70.

74 SECCCA, *Submission 30*, p. 4.

Box 7.2: The Finkel Review's comments on how natural hazards can affect electricity infrastructure

In its final report, the Finkel Review summarised how a wide range of natural hazards can threaten electricity infrastructure and the reliability of electricity supply. In addition to heatwaves, which were discussed in the above paragraphs, bushfires, cyclones, floods and drought are particularly relevant to climate change. Accordingly, the observations regarding these hazards are reproduced below in full:

> Bushfires may damage transmission lines and can trigger lines to be de-rated or shut down to prevent damage. Smoke can also induce transmission line faults, resulting in a loss of supply. Transmission lines may also be shut down for the safety of emergency personnel. A bushfire can severely damage electricity infrastructure and result in communities being without power until repairs can be made. AEMO [Australian Energy Market Operator] specifically monitors lightning and bushfires, assesses the threat to the NEM and will send out market notices if required.
>
> Cyclones can damage power stations, substations and transmission lines, resulting in a loss of generation or ability to transmit power. Cyclones and severe storms often result in restoration costs for network businesses. Network businesses have a comprehensive range of measures to prepare the network and employees for each storm and cyclone season.
>
> Floods can lead to damage to electricity infrastructure, resulting in significant repairs or rebuilds. The FY2012 flooding in Queensland resulted in significant damage which meant that power supply could not be reconnected for periods ranging from weeks to months. Additionally for areas not directly affected by floods, power supply may still need to be disconnected due to other parts of the network being affected.
>
> Drought can reduce the generating capacity of both hydro and thermal generation. During the FY2007 drought, generation was curtailed due to water shortages. Since then, information on the impact of water availability on generation capacity has improved and generators have invested in more efficient use of water. Nevertheless, protracted drought events will have an impact.

Source: Independent Review into the Future Security of the National Electricity Market, *Blueprint for the Future*, Commonwealth of Australia, 2017, p. 71. The implications of extreme weather events and a long-term decline in rainfall for hydroelectricity generation was also noted in the Tasmanian Government's submission. The Government explained that such developments could have 'significant short- and long-term impacts' on the state's energy supply. Tasmanian Government, *Submission 4*, p. 3.

7.61 As has been noted elsewhere in this report, the loss of electricity supply can have significant consequences for other essential services. The Climate and Health Alliance noted that power outages during heatwaves 'substantially increases the risk of human morbidity and mortality'. A further example is that communications

infrastructure which facilitates information sharing during extreme events can also be affected by electricity outages.[75]

7.62 Electricity infrastructure can also cause extreme events. As noted in Chapter 2, a trend of more frequent dangerous fire weather has been recorded and it is expected that climate change will increase the likelihood of dangerous fire weather occurring more frequently. Failures in electricity infrastructure can cause bushfires; for example, five of the 15 fires examined by the Royal Commission into the 2009 Black Saturday bushfires were associated with the failure of electricity assets. The Royal Commission observed that:

> Although the proportion of fires that are caused by electricity infrastructure is low—possibly about 1.5 per cent of all ignitions in normal circumstances—on days of extreme fire danger the percentage of fires linked to electrical assets rises dramatically. Thus, electricity-caused fires are most likely to occur when the risk of a fire getting out of control and having deadly consequences is greatest.[76]

7.63 Finally, it was noted that in many instances, the implications of climate change for electricity infrastructure could be gradual, such as through the accelerated deterioration of materials.[77]

International emissions commitments and developments in electricity generation

7.64 Climate change also influences decisions and planning around how electricity is generated. As a signatory to the Paris Agreement, the Australian Government has committed to reduce Australia's greenhouse gas emissions by 26–28 per cent below 2005 levels by 2030. As the Finkel Review noted, electricity generation accounted for around 35 per cent of Australia's emissions in 2016 and, accordingly, 'any effort to significantly reduce Australia's emissions will require a reduction in emissions from the electricity sector'. Australia's commitments also come at a time when consideration needs to be given to how Australia's 'ageing fleet of coal-fired generators' will be retired.[78]

7.65 As the Finkel Review also noted, however, governments are only one driver of change in the transformation of the electricity market. Change is also caused by many other factors, including 'international trade competitiveness, innovation, business appetite for lower costs, competition to drive new technology, and

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75 Climate and Health Alliance, *Submission 16*, pp. 3–4 (citations omitted).

76 Victoria, 2009 Victorian Bushfires Royal Commission, *Final Report: Summary*, 2010, p. 12.

77 Accelerated deterioration would require maintenance of infrastructure assets to occur more frequently. Dr Lauren Rickards, *Submission 49*, p. 1.

78 Independent Review into the Future Security of the National Electricity Market, *Blueprint for the Future*, pp. 29, 30.

consumers' desire to take greater control of their energy costs and do their bit for the environment'.[79]

7.66 The trend towards a more decentralised electricity system was examined in the committee's 2015 inquiry into the performance and management of electricity network companies. That report explored how the increased use of embedded generation assets within the distribution network, such as solar photovoltaic (PV) panels, is likely to present significant challenges for the ongoing utility and maintenance of extensive transmission networks. The report also discussed the potential of further disruptive technologies and the potential for significant numbers of customers going 'off grid'.[80]

7.67 A roadmap developed by Energy Networks Australia and CSIRO in 2017 to inform the transition of the electricity sector also noted that, by 2050, 'millions of customer owned generators will supply 30–45% of Australia's electricity needs'. Accordingly, 'customers or their agents—not utilities—will determine how over $200 billion in system expenditure is spent'.[81]

Responses

7.68 The Australian Government has various policies and agencies focused on the energy sector. These include:

- the Renewable Energy Target, which comprises two schemes:
  - a large-scale target, 'which encourages investment in renewable power stations to achieve 33,000 gigawatt hours of additional renewable electricity generation by 2020', and
  - a small-scale scheme intended to support 'small-scale installations like household solar panels and solar hot water systems';[82]
- the Clean Energy Finance Corporation and the Australian Renewable Energy Agency;
- the National Energy Productivity Plan, which is intended to ensure energy productivity improves by 40 per cent over the period 2015 to 2030;

79 Independent Review into the Future Security of the National Electricity Market, *Blueprint for the Future*, p. 3.

80 Senate Environment and Communications Reference Committee, *Performance and management of electricity network companies: Interim report*, April 2015, pp. 113–134.

81 Energy Networks Australia and CSIRO, *Electricity Network Transformation Roadmap: Final Report*, April 2017, p. i.

82 Clean Energy Regulator, 'Renewable Energy Target: How the scheme works', www.cleanenergyregulator.gov.au/RET/About-the-Renewable-Energy-Target/How-the-scheme-works (accessed 20 February 2018).

- the Solar Communities Program, which provides funding for community groups in selected regions across Australia to install rooftop solar PV, solar hot water and solar-connected battery systems; and
- the National Energy Guarantee, which will consist of 'dual obligations that will require energy retailers and some large users across the NEM to deliver reliable and lower-emissions energy generation each year'.[83]

7.69 State and territory governments have also undertaken work regarding renewable energy, energy reliability and network infrastructure:

- Under the premiership of the Hon Jay Weatherill MP, the former South Australian Government pursued targets to increase the amount of electricity generated from renewable energy, first with the target set in 2009 of 33 per cent renewable energy by 2020, and subsequently the target set in 2014 of 50 per cent renewable energy generation by 2025.[84] The former government's focus on renewable energy is perhaps most clearly demonstrated by the agreement it reached between French renewable energy company Neoen and US company Tesla on the installation of the world's largest lithium ion battery at a Neoen-owned wind farm.[85]
- The Australian Capital Territory has a target of 100 per cent renewable energy by 2020.[86]
- The Queensland Government has set a target of 50 per cent renewable energy by 2030.[87]

7.70 In response to extreme weather threats, the Council of Australian Governments (COAG) Energy Council is developing a strategy 'to improve the integrity of energy infrastructure and the accuracy of supply and demand forecasting'. This strategy responds to the concerns expressed in the Finkel Review's report that increasing and more intense extreme weather events will make forecasting and

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83 Department of the Environment and Energy, *2017 Review of Climate Change Policies*, December 2017, pp. 25, 48–49. The Energy Security Board released a consultation paper on the development of the National Energy Guarantee in February 2018.

84 Government of South Australia, 'Climate change', www.sa.gov.au/topics/energy-and-environment/environment-and-natural-resources/climate-change (accessed 20 February 2018).

85 The Hon Jay Weatherill MP, Premier of South Australia, 'Tesla to pair world's largest lithium ion battery with Neoen wind farm in SA', *Media release*, 7 July 2017.

86 ACT Government, '100% renewable energy for Canberra by 2020', www.act.gov.au/our-canberra/latest-news/2016/may/100-renewable-energy-for-canberra-by-2020 (accessed 3 May 2018).

87 Department of Natural Resources, Mines and Energy (Queensland), 'Powering Queensland Plan: an integrated energy strategy for the state', www.dnrme.qld.gov.au/energy/initiatives/powering-queensland (accessed 24 May 2018).

managing the electricity system prior to and during these events more difficult.[88] The COAG Energy Council is also considering the National Energy Guarantee referred to above.

7.71 Some of the risks presented by ageing infrastructure are also being addressed. For example, in response to the final report of the Royal Commission into the 2009 Victorian Bushfires, the Victorian Government established the Powerline Bushfire Safety Program. This is a ten year, $750 million program of works to improve electricity assets and controls.[89]

7.72 New infrastructure is also assessed for resilience. The Northern Territory Government explained that networks in its jurisdiction 'have been engineered to deliver a high level of resilience'. To illustrate, the Government advised that 'transmission lines are built to withstand Category 4 cyclones, and regulated network assets including distribution transformers and ring main units are located so they are above a 1 in 100 year flood level'.[90]

7.73 Despite this, it was argued that investment will be required to improve the resilience of assets in response to the risks presented by heat, coastal inundation and bushfires.[91] CSIRO advised that preliminary modelling indicates that 'it could cost every consumer an additional 2.8 cents per kilowatt hour by 2050 to adapt the current electricity supply chain to climate change'.[92]

7.74 As part of a response to climate change and the significant developments occurring in the electricity system, CSIRO's submission indicated that various measures across the electricity system need to be considered to facilitate demand management. It explained that demand management 'to enable more flexible capacity is an important way of adapting to a more variable supply and load'. CSIRO advised that greater demand management could be achieved through:

- battery energy storage;
- heat storage in various materials, such as molten salts;
- pumped-storage hydroelectricity;

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88 Department of the Environment and Energy, Bureau of Meteorology, Great Barrier Reef Marine Park Authority, Attorney-General's Department, Department of Agriculture and Water Resources, and Geoscience Australia, *Submission 39*, pp. 3–4.

89 Victorian Department of Environment, Land, Water and Planning, 'Powerline Bushfire Safety Program', www.energy.vic.gov.au/safety-and-emergencies/powerline-bushfire-safety-program (accessed 30 January 2018).

90 Northern Territory Government, *Submission 17*, p. 9.

91 CSIRO, *Submission 45*, p. 15; RDA South West, *Submission 15*, p. 7. See also Independent Review into the Future Security of the National Electricity Market, *Blueprint for the Future*, p. 70.

92 CSIRO, *Submission 45*, p. 15 (citation omitted).

- incentives to reduce electricity use at periods of peak demand, such as bill discounts or rebates for customers who use efficient air conditioning that can operate in economy mode when the network is under stress; and
- pricing reform for distribution networks and retail that establishes 'greater opportunities for small customers or their agents to provide a range of demand management services to different parts of the grid'.[93]

7.75 On the generation component of the electricity system, AGL Energy submitted that in the longer-term, decarbonisation of the generation sector 'is likely to provide an opportunity for growth and value creation'. AGL has committed to closing all of its existing coal-fired power stations by 2050 while continuing to invest new renewable and near-zero emissions technologies.[94]

7.76 A specific example is the planned retirement of AGL's Liddell Power Station in 2022. After announcing the planned retirement, AGL subsequently announced that the generators at Liddell would be converted into synchronous condensers. In addition, the lost generation would be supplemented with 'a mix of high-efficiency gas peakers, renewables, battery storage and demand response, coupled with an efficiency upgrade at Bayswater Power Station'. AGL stated that an analysis of this plan estimated the levelised cost of energy for the replacement generation at $83/MWh, compared with extending Liddell at $106/MWh.[95]

7.77 Also in relation to generation, a collection of Melbourne-based local governments comprising the Eastern Alliance for Greenhouse Action (EAGA) argued that it would be beneficial to promote solar PV in households, particularly among low-income households. The EAGA submitted:

> …low income households are particularly vulnerable to climate change, with high power prices and outages during heatwave events and other extreme events leading to higher morbidity and mortality risks, particularly for the aged. There is mounting evidence to demonstrate that the installation

93 CSIRO, *Submission 45*, pp. 15–16 (citations omitted).

94 AGL, *Submission 27*, p. 2.

95 AGL, 'AGL announces plans for Liddell Power Station', *Media release*, 9 December 2017, www.agl.com.au/about-agl/media-centre/asx-and-media-releases/2017/december/agl-announces-plans-for-liddell-power-station (accessed 31 January 2018); AGL, *Submission 27*, pp. 2–3. AGL's plans for Liddell were subject to some uncertainty, with AGL receiving in April 2018 what it described as a 'non-binding, highly conditional indicative offer' from Chow Tai Fook Enterprises and Alinta Energy to acquire the Liddell Power Station. However, AGL subsequently announced that it would not proceed any further with the offer. AGL Energy, 'Receipt of unsolicited highly conditional proposal from Alinta Energy', *Media release*, 30 April 2018, www.agl.com.au/about-agl/media-centre/asx-and-media-releases/2018/april/receipt-of-unsolicited-highly-conditional-proposal-from-alinta-energy (accessed 30 April 2018); 'AGL completes assessment of offer from Chow Tai Fook Enterprises and Alinta Energy', 21 May 2018, www.agl.com.au/about-agl/media-centre/asx-and-media-releases/2018/may/agl-completes-assessment-of-offer-from-chow-tai-fook-enterprises-and-alinta-energy (accessed 22 May 2018).

> of solar PV supports greater capacity for cooling in households where energy costs represent a large proportion of ongoing living costs. The ability of the technology to provide low cost energy throughout the day means these householders can cool their homes without fear of 'price shock'.[96]

7.78 The EAGA advised that it is leading a program involving 21 local governments to 'deliver solar PV for low income households'.[97]

7.79 It was also observed that, given the age of existing infrastructure, it would be timely to start planning replacement infrastructure that is more resilient in the face of climate change. The EAGA submitted:

> As much of Victoria's electricity infrastructure is approaching the end of its lifecycle in the next 10 years, now is an important time for the policy settings to help drive this transition in a least cost, equitable way. [We consider]…that Victoria has an enormous opportunity to strategically upgrade its grids to ensure a decentralised and decarbonised energy system going forward, and one that is resilient to the impacts of climate change.[98]

7.80 The Climate Council argued that there is a need for an overarching national transition plan for Australia's electricity system. It argued that such a plan should:

- increase the utilisation of renewable energy, energy efficiency and storage technologies to enable electricity generation using fossil fuels to end by 2040;
- achieve a minimum of 50 per cent electricity generation by renewables by 2030;
- ensure the system can be 'secure and robust' when faced with extreme weather events; and
- ensure that net zero emissions are reached 'well before 2050, aiming for 2040'.[99]

7.81 Finally, a recent study that considered how to transition the electricity sector to a clean energy future called for a comprehensive overhaul of the NEM. The study argued that:

- the National Electricity Objective should be amended to include a commitment to achieving 100 per cent clean energy;
- a public interest retailer that would provide clean energy services (such as energy efficiency upgrades and solar PV) for low-income households; and

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96 EAGA, *Submission 13*, p. 3. See also NAGA, *Submission 19*, p. 3.

97 EAGA, *Submission 13*, p. 3.

98 EAGA, *Submission 13*, p. 3; NAGA, *Submission 19*, p. 3.

99 Climate Council of Australia, *Submission 40*, p. 12.

- local energy trading should be facilitated—the study suggested that the aim should be to 'make the electricity market act more like the internet', such as by establishing a website that enables users to purchase electricity from local clean energy sources.[100]

100 N Ison, M Lyons and J Atkinson, *A Plan to Repower Australia: Homegrown Power Plan Version 2*, Repower Australia, 2018, www.repoweraustralia.org.au/uploads/2018/05/02/Repower_Australia_Plan_FINAL_Mar29_2018_WEB.pdf (accessed 4 May 2018), p. 4.

Chapter 8

Health, education, social services, recreation and tourism

8.1 This chapter considers the implications of climate change for buildings and infrastructure relied on in a wide range of areas, including health care, aged care, education, tourism and public recreation.

Health care, aged care and emergency services

8.2 The evidence received during this inquiry about the implications of climate change for health-related services can be grouped in the following three categories:

- direct risks to buildings used for these services, such as inundation from sea-level rise;
- infrastructure required for these services becoming less reliable, such as electricity outages and damage to transportation infrastructure; and
- services being overwhelmed due to health risks associated with climate change.

8.3 These three categories are related. The Australian Medical Association (AMA) submitted:

> Human health is ultimately dependent on the health of the planet and its ecosystem. Consequently, climate change poses a myriad of direct and indirect risks to human health. These health impacts manifest inequitably, both within and between countries, with some groups being particularly vulnerable. The impact of climate change on the health system is twofold as extreme weather events increase the demand on health services whilst impeding the capacity of health systems to provide even the most basic care.[1]

8.4 It was also highlighted that during extreme weather events, health systems can come under substantial pressure relatively quickly. The AMA noted:

> As the intensity and frequency of extreme weather events increase, the consequences cascade and manifest in unpredictable ways. It is clear that there are vulnerabilities in the Australian system. Hurricane Katrina and the 2003 San Diego wildfires are tangible examples of the complex and volatile challenges that extreme weather events present, and a sobering reminder that even the most developed healthcare systems can struggle under sustained environmental pressure.[2]

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1 Australian Medical Association (AMA), *Submission 34*, p. 2.

2 AMA, *Submission 34*, p. 4.

Direct threats to buildings and infrastructure

8.5 Health and emergency services buildings and infrastructure in high-risk coastal areas face the same climate challenges as other buildings located in these areas. Sustainable Business Australia submitted that, by 2100, a 1.1 metre sea-level rise would 'place $266 billion of coastal infrastructure at risk, including 258 police, fire and ambulance stations as well as 75 hospitals and health services'.[3]

8.6 Extreme events such as flooding and bushfires also disrupt normal health services, including to the point of shutdown. In addition, to disrupting facilities, these events can also damage or contaminate equipment and supplies.[4]

8.7 Health and emergency services rely on other infrastructure, such as transportation and energy networks, and disruption to these networks can have significant consequences. Energy implications are particularly significant. The AMA noted that hospitals and community health centres 'are dependent on a secure and stable energy supply'. For hospitals, the AMA highlighted that 'the consequences of even momentary disruptions to electrical circuits are catastrophic'.[5] The AMA provided the following observations about recent energy reliability issues to demonstrate the potential for future risk:

> Hospitals can utilise backup power generators to accommodate for temporary lapses in power supply, however in recent years there have been a number of instances in which extreme weather events have also disrupted the functionality of backup power systems, leading to failure of critical medical equipment and emergency patient evacuations.
>
> In late 2016, a number of hospitals in South Australia lost power, after generators failed during a state-wide blackout which was caused by an extreme weather event. At Flinders Medical Centre, as a result of the power outage, patients requiring ventilation had to be evacuated to a neighbouring medical facility, and a number of embryos awaiting transfer were tragically destroyed. The human toll of this power outage was likely minimised due to the availability of the nearby medical facility with capacity to accept these patients. However, if future power outages were to occur in the midst of a mass casualty event or in a more remote part of Australia, the feasibility of such evacuations is drastically reduced.[6]

3 Sustainable Business Australia, *Submission 52*, p. 11.

4 Australian Health Economics Society, *Submission 23*, pp. 4–5.

5 AMA, *Submission 34*, p. 3.

6 AMA, *Submission 34*, p. 3 (citations omitted). See also Australian Health Economics Society, *Submission 23*, pp. 4–5.

8.8 Disruption to transportation infrastructure can affect the ability of staff to report for work, as well as the ability to transport patients and to undertake community or home-based visits.[7]

8.9 During a previous inquiry, the committee also was advised that there is a direct relationship between higher temperatures and hospital staffing and budgets. Mr Andrew King from Stormwater South Australia gave the following evidence on this issue:

> Hospitals have a key temperature in the high thirties where they put on extra staff, and the cost to the health service every year of that cut-off point is hundreds of millions of dollars. They budget that they are going to get five or six of those days a year. That is budgeted in. If we raise our city temperatures by 10 degrees and those five or six days become 12, even doubling it, you have hundreds of millions.[8]

Increases and changes in demand for services

8.10 Evidence regarding health and aged care services being required to cope with increased demand focused on how climate change is expected to result in heatwave events occurring more frequently. However, other factors are also evident, such as:

- that any increase in the frequency of natural disasters would place pressure on emergency support; and
- with ageing populations, there is 'likely to be increased pressure on social services to support people to age in place and to utilise social support infrastructure'.[9]

8.11 Nevertheless, heat stress is considered to be 'the primary climate change driver of increased demand for social and health services'.[10] As noted by the AMA, 'heatwaves kill more Australians than any other type of natural disaster'. The AMA argued that climate change 'is no longer a projection of what is to come, but rather the present reality for which Australia's healthcare system remains ill prepared'.[11]

8.12 The AMA commented on the 2009 heatwave event as well as other heatwaves to demonstrate the pressure these events are already placing on the health system. On the 2009 event, the AMA submitted:

> The January 2009 heatwave was an indicator of what Australia confronts should global warming patterns continue on current trajectories. Some parts

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7 Australian Health Economics Society, *Submission 23*, pp. 4–5.

8 Senate Environment and Communications References Committee, *Stormwater management in Australia*, December 2015, pp. 17–18.

9 Lake Macquarie City Council, *Submission 29*, p. 5.

10 Lake Macquarie City Council, *Submission 29*, p. 5.

11 AMA, *Submission 34*, pp. 1, 2.

> of Australia experienced unseasonable periods of temperatures above 43 degrees for three consecutive days, whilst overnight lows failed to yield their usual reprieve. Ambulance services were quickly overwhelmed as they became inundated with calls for help from patients experiencing cardiac arrests, heatstroke, exacerbation of pre-existing conditions and other heat-related conditions. Emergency departments struggled to make room for the influx of patients.[12]

8.13 The AMA explained that the excess mortality of 374 deaths (that is, 374 excess deaths over what would otherwise be expected)[13] attributed to the heatwave overwhelmed the conventional storage capacity of the mortuary 'and temporary refrigeration systems had to be brought in to accommodate the unprecedented amount of fatalities'.[14]

8.14 The AMA also commented on a severe heatwave that affected southeast Australia in 2014. In Victoria, that heatwave 'resulted in a 24 per cent increase in mortality and a 97 per cent increase in cardiac emergencies'.[15]

8.15 In considering heatwave events, it was noted that the elderly are particularly vulnerable. Hobsons Bay City Council advised that in the 2014 heatwave, the number of aged care clients admitted to hospital increased by 250 per cent.[16]

8.16 In addition, it was suggested that consideration needs to be given to the implications of heatwave events for maternal and child health. Hobsons Bay City Council advised that maternal and child health nurses are 'already rescheduling checkups and immunisation appointments for parents who do not wish to take their infants out and expose them to extreme weather'. The Council highlighted that 'low income families are particularly impacted as they are less likely to have an air conditioned car to safely transport their child to and from appointments during heatwaves'.[17]

Suggested responses

8.17 When considering the impacts of climate change under different emissions scenarios, the health system's impact on climate change was highlighted. The Australian Health Economics Society noted that 'health systems in developed countries typically generate between 4 and 8% of national greenhouse gas emissions'.

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12 AMA, *Submission 34*, p. 2.

13 Department of Human Services (Victoria), *January 2009 Heatwave in Victoria: an Assessment of Health Impacts*, 2009, www2.health.vic.gov.au/Api/downloadmedia/%7B959CCD3C-8285-4938-872E-62E15AA62C62%7D (accessed 3 January 2018), p. iv.

14 AMA, *Submission 34*, p. 2.

15 AMA, *Submission 34*, p. 2.

16 Hobsons Bay City Council, *Submission 7*, p. 10.

17 Hobsons Bay City Council, *Submission 7*, p. 10.

The Society argued that the 'continued imperative to reduce emissions through effective design and planning of health infrastructure therefore remains critical to climate change mitigation efforts'.[18]

8.18 CSIRO suggested that the health system would be supported by measures to address some of the heat-related health risks people face due to urban and building design (this evidence was discussed in Chapters 4 and 6). For example, CSIRO identified that, due to the reduction in urban heat that would result, doubling Melbourne's vegetation coverage 'would reduce heat-related mortality by 5 to 28 per cent'.[19]

8.19 This report has already examined research indicating that inefficient building design has serious implications for human health during heatwave events. As noted in Chapter 6, a study of the 2009 Melbourne heatwave concluded that upgrading building energy ratings would have a significant impact on related mortality. Assuming that the occupants of 0.9 energy star houses were the victims of the 2009 heatwave event, if all Melbourne homes had at least a 1.8 star energy rating, the number of excess deaths from a 2009 type heatwave is projected to reduce to around 240. This would reduce further to 37 if all houses can be upgraded to a minimum of 5.4 stars.[20]

8.20 It is also projected that increases in the energy efficiency of dwellings would result in declining rates of ambulance calls, emergency department presentations and after hours doctor consultations. Therefore, addressing heat stress in housing could lead to potential savings from reduced demand for these services.[21]

8.21 The Australian Health Economics Society also noted that other variables in the future demand for health services need to be taken into account, such as population ageing, changing disease burdens, risk factors (such as obesity) and changing medical technologies.[22] Nevertheless, it was recognised that there are

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18 Australian Health Economics Society, *Submission 23*, p. 6.

19 CSIRO, *Submission 45*, p. 16.

20 Centre for Sustainable Infrastructure, Swinburne University of Technology, *Submission 9*, pp. 3–4.

21 Dr Morshed Alam, Senior Research Fellow, Swinburne University of Technology, *Committee Hansard*, 15 March 2018, p. 7; Centre for Sustainable Infrastructure, Swinburne University of Technology, *Submission 9*, pp. 3–4. For example, in 2015–16, the average cost associated per admitted acute separation is $5,194 and is $652 for each emergency department presentation. Independent Hospital Pricing Authority, *National Hospital Cost Data Collection Cost Report: Round 20 Financial Year 2015-16*, February 2018, www.ihpa.gov.au/sites/g/files/net4186/f/publications/nhcdc_cost_report_round_20_financial_year_2015-16_0.pdf (accessed 24 April 2018), p. 7.

22 Australian Health Economics Society, *Submission 23*, p. 4.

'a range of more direct impacts of climate change on health care infrastructure that can be identified for adaptation'.[23]

8.22 To help manage risks to facilities, Regional Development Australia – South West argued that emergency services infrastructure and hospitals 'should not be located within the vicinity of "at risk" areas or where disaster events could be reasonably believed to impact on transport, communications or energy infrastructure'.[24] Similarly, the Australian Health Economics Society suggested that the resilience of health care infrastructure could be maximised by robust site selection; that is 'avoiding the siting of facilities in high-risk locations altogether, and minimising site-specific risks where they cannot be completely eliminated'.[25]

8.23 The Climate and Health Alliance added that the design of new health facilities and the maintenance of new and existing facilities should be subject to mandatory standards that prioritise resilience to direct and indirect climate risks.[26]

8.24 In addition, the Australian Health Economics Society outlined several other suggestions for improving the resilience of health services infrastructure in the face of climate change. These include:

- designing 'for maximum passive cooling capability during hot conditions'—it was suggested that more traditional building designs are superior to lightweight modular buildings in terms of managing the risk of overheating;
- designing and maintaining 'for maximum resilience of IT and communications infrastructure';
- ensuring 'back-up and/or redundant supplies of key utilities (e.g. electricity, water)';[27]
- developing and maintaining effective business continuity plans and undertaking exercises for extreme weather events; and
- ensuring 'access to "surge" capacity to deal with peak demand during extreme weather events—this could include 'opening normally closed wards, or going as far as some US states who, in response to lessons from Hurricane Katrina, maintain "shuttered" hospitals as reserve capacity to be staffed by personnel whose home facility has had to be evacuated'.[28]

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23 Australian Health Economics Society, *Submission 23*, p. 4.

24 Regional Development Australia – South West, *Submission 15*, p. 5.

25 Australian Health Economics Society, *Submission 23*, p. 5.

26 Climate and Health Alliance, *Submission 16*, p. 7.

27 On the need for reliable electricity supplies, the Climate and Health Alliance suggested that investments 'in secure technological innovations and knowledge management systems for health services to withstand power interruption' should be undertaken. Climate and Health Alliance, *Submission 16*, p. 7.

28 Australian Health Economics Society, *Submission 23*, pp. 5–6.

8.25 Outreach strategies and further research relating to vulnerable populations was suggested. For example:

- On maternal and child health, Hobsons Bay City Council referred to research into how maternal and child health services 'could be effectively delivered despite climate change pressures'. The Council argued that 'further research and sharing of this research is needed'.[29]
- It was argued that pressures on the health system could be reduced if new migrants receive support to learn to adapt to Australian climatic conditions.[30]

8.26 The AMA argued that a national strategy for climate change and human health is required. The AMA envisaged that the strategy would seek to enhance healthcare preparedness to 'safeguard the provision of healthcare services in the context of an increasingly volatile climate'. The AMA also argued that consideration should be given to ensuring that the health sector 'is adequately resourced to meet the significant demands of extreme heat events'.[31]

8.27 Other submitters pointed to international initiatives and strategies that could support the Australian health care system to adapt. For example:

- Doctors for the Environment Australia suggested that the Australian Government should adopt the World Health Organization's 'Health in all Policies' framework, in recognition 'that policy decisions in non-health arenas such as infrastructure can have profound effects on population health'. It was argued that doing so would help identify 'potential synergies for health and environmental protection'.[32]
- The Climate and Health Alliance argued that the Australian Government should work with the state and territory governments to expand and promote the Global Green and Healthy Hospitals initiative.[33]

29 Hobsons Bay City Council, *Submission 7*, p. 10.

30 Hobsons Bay City Council, *Submission 7*, p. 11.

31 AMA, *Submission 34*, p. 3.

32 Doctors for the Environment Australia, *Submission 41*, p. 4.

33 Climate and Health Alliance, *Submission 16*, p. 7. The Global Green and Healthy Hospitals initiative is an international network of hospitals and other health care facilities and organisations that seek to reduce the carbon footprint of the health system, become more climate resilient, and help societies transition to a low carbon energy future. The initiative is a project of Health Care Without Harm, a US based organisation. See Global Green and Healthy Hospitals, www.greenhospitals.net/who-we-are; and www.greenhospitals.net/about-hcwh (accessed 5 April 2018).

8.28 On heat stress risks, representatives from the City of Melbourne and the South East Councils Climate Change Alliance drew the committee's attention to the Victorian Government's Healthy Homes Program.[34] Under that program, up to 1000 vulnerable and low income Victorians who live with complex healthcare needs can seek energy efficiency upgrades for their house. However, the program is limited to two geographic regions (Melbourne's western suburbs and the Goulburn Valley) and is focused on improving indoor temperatures in winter.[35]

8.29 Finally, it was noted that further research could assist with better understanding the costs and benefits associated with minimising climate-related health risks. For example, the researchers who studied the 2009 Melbourne heatwave advised that they are considering undertaking a more detailed cost–benefit analysis to quantify the extent that measures to improve the energy efficiency of housing could reduce costs in the health system.[36]

Education

8.30 The main point made in submissions regarding the implications of climate change for school infrastructure is that, as with other buildings, schools could be at risk from climate change-related flooding, inundation and extreme weather events. Higher temperatures will also place pressure on operating budgets due to increased expenses associated with cooling.[37]

8.31 It was also emphasised that children 'are particularly vulnerable to extreme heat'. In addition, it was noted that many school buildings are not well suited to extreme weather conditions. Hobsons Bay City Council explained:

> There are no design standards to ensure that schools, childcare centres and other related facilities protect them from extreme heat. Many school buildings were designed and built with no or minimum insulation, poor airtightness and inefficient heating and cooling systems. School playgrounds are not typically designed to protect children from a range of elements including extreme heat.[38]

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34 Ms Dominique La Fontaine, Executive Officer, South East Councils Climate Change Alliance; Mr Gavin Ashley, Team Leader, Climate Resilience, City of Melbourne, *Committee Hansard*, 15 March 2018, pp. 29–30.

35 Sustainability Victoria, 'Victorian Healthy Homes Program', www.sustainability.vic.gov.au/About-Us/Grants-and-Funding/Victorian-Healthy-Homes-Program (accessed 24 April 2018).

36 Dr Morshed Alam, Senior Research Fellow, Swinburne University of Technology, *Committee Hansard*, 15 March 2018, p. 7.

37 Lake Macquarie City Council, *Submission 29*, p. 5.

38 Hobsons Bay City Council, *Submission 7*, p. 9.

8.32 Hobsons Bay City Council argued that indoor and outdoor facilities used for children 'need to be designed with climate impacts, specifically extreme heat, in mind'.[39]

8.33 On school design, Williamstown High School was highlighted as an example of efficient and sustainable design which could be followed elsewhere. Green Building Council Australia submitted that in 2005, an $11 million project to redevelop the school resulted in 5 Star Green Star certification. In addition to efficiency and sustainability benefits, Green Building Council Australia argued that green schools can support student performance; it submitted that research indicates green schools can improve 'progression by 20 per cent in mathematics and 26 per cent in reading, while improving student health by 41.5 per cent'.[40]

8.34 School finish times also attracted comment. Hobsons Bay City Council noted that schools 'often finish at around 3 pm, which, in summer, is often the hottest part of the day'. The Council provided the following overview of the possible implications of this:

> Many students use active transport, such as walking and cycling, to get home. An increase in temperatures may increase the risk of heat stress. In addition to this, transport congestion during term time may increase due to extreme weather events. Similarly, students who catch the train home can also find their mode of transport impacted by extreme weather.[41]

8.35 To address this risk, the Council argued that schools and families 'need the capacity to plan for and manage the risk posed to students by a range of extreme weather events during this commute'.[42]

Tourism and public recreation

8.36 Australia's national parks, tourism assets, public recreation areas and sporting facilities face a diverse range of challenges due to climate change. For example:

- as with other coastal assets, assets in coastal regions can be at risk of inundation and damage from storm surges and, in some areas, cyclones;
- Australia's snowfields are expected to be significantly affected by climate change, with modelling undertaken by a CSIRO researcher indicating that, by 2050, snow cover in the Victorian Alps could decrease by up to 80 per cent from current levels;[43] and

39 Hobsons Bay City Council, *Submission 7*, p. 9.

40 Green Building Council Australia, *Submission 50*, p. 9.

41 Hobsons Bay City Council, *Submission 7*, p. 9.

42 Hobsons Bay City Council, *Submission 7*, p. 9.

43 Sustainable Business Australia, *Submission 52*, p. 11.

- areas such as the Blue Mountains could face increased bushfire risk.[44]

Overview of climate change risks

8.37 In a 2018 report on the implications of climate change for tourism, the Climate Council of Australia concluded that the top five attractions for international visitors—beaches, wildlife, the Great Barrier Reef, wilderness areas and national parks—are all 'at risk from climate change'.[45]

8.38 Although a common theme in submissions around the country is that coastal areas are relied on for tourism, the potential consequences for Queensland were particularly highlighted. The Queensland Tourism Industry Council (QTIC) submitted that the coast is 'fundamental to the attractiveness and competitiveness of a large number of destinations across Queensland'.[46]

8.39 On extreme weather events, the QTIC submitted:

> Extreme weather can render resorts, hotels or facilities unusable, creating stranded assets and causing financial losses to investors thereby making Queensland a less attractive investment state. Further consequences of extreme weather events on tourism infrastructure are additional costs associated with protecting assets. A large proportion of Queensland is now deemed at flood and/or cyclone risk resulting in high insurance premiums and creating a more challenging business environment for operators.[47]

8.40 Tropical cyclones, which are projected to increase in intensity due to climate change, have caused extensive damage to tourism infrastructure and assets in the past. For example, Cyclone Debbie caused in excess of $10 million in damage to natural park infrastructure across the Whitsunday Islands. Reduction in visitor numbers following the cyclone also affected local businesses reliant on tourism.[48]

8.41 The implications for tourism from coral bleaching of the Great Barrier Reef are also widely recognised. The committee examined this in the detail in 2017 as part of its inquiry into the impacts of climate change on marine fisheries and biodiversity.[49]

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44 Sustainable Business Australia, *Submission 52*, p. 11.

45 Climate Council of Australia, *Icons at risk: climate change threatening Australian tourism*, 2018, www.climatecouncil.org.au/tourism-2018 (accessed 21 February 2018), p. 31.

46 Queensland Tourism Industry Council, *Submission 10*, p. 6.

47 Queensland Tourism Industry Council, *Submission 10*, pp. 7–8.

48 Queensland Tourism Industry Council, *Submission 10*, p. 7.

49 See Senate Environment and Communications References Committee, *In hot water: the impacts of climate change on marine fisheries and biodiversity*, December 2017.

8.42 Coastal councils provided examples of issues facing their region for public recreation and tourism. For example, Hobsons Bay City Council explained that:

- aerial photos show there has been significant loss of low lying coastal parklands in its jurisdiction, particularly around Altona Coastal Park and the Ramsar-listed Cheetham Wetlands; and
- the cost associated with protecting, upgrading and repairing assets such as coastal tracks, which already have to be replaced or relocated due to storm surge damage, 'is expected to increase with climate change and sea level rise'.[50]

8.43 Lake Macquarie City Council noted that an increase in relative sea level of 0.9 metres in its jurisdiction could result in permanent inundation of over 93 hectares of residential land, which includes public foreshore land. This would reduce public access to the foreshore and result in the 'damage or loss of sensitive foreshore ecosystems'.[51]

8.44 Climate change will also have implications for public recreation and sporting facilities, with higher temperatures and heatwave events of particular concern. The implications of climate change for public recreation has been recognised for some time, an example being the Western Australian Government's 2007 publication intended to assist organisations to understand how climate change could affect sport and recreation activities.[52]

8.45 How heat affects stadiums is a clear example of climate risk, with a striking case being the Ashes test cricket series in 2017–18 where, during the Sydney test match, the temperature reached 43.4°C.[53] The Australian Open tennis tournament has also experienced heatwaves in previous years.

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50 Hobsons Bay City Council, *Submission 7*, p. 6.

51 Lake Macquarie City Council, *Submission 29*, p. 2.

52 Department of Sport and Recreation (WA), *Climate change: Climate change is no longer a just a concept—how climate change could affect sport and recreation now and in the future*, www.dsr.wa.gov.au/docs/default-source/file-about-us/file-plan-for-the-future/climate-change.pdf?sfvrsn=0 (accessed 24 April 2018).

53 The 43.4°C reading was recorded at the Observatory Hill Bureau of Meteorology station on 7 January 2018. Media reports indicate that at the Sydney Cricket Ground, a heat stress tracker, which measures environmental factors such as wind and humidity to produce a 'feels like' temperature, recorded 57.6°C. See A Wu, 'Ashes 2017/18: SCG Sunday roast fries players and 33,285 fans on 'hottest day of Test cricket in Australia', *Sydney Morning Herald*, 7 January 2018, www.smh.com.au/sport/cricket/ashes-201718-scg-sunday-roast-fries-players-and-33285-fans-on-hottest-day-of-test-cricket-in-australia-20180107-h0eodw.html (accessed 19 January 2018).

Possible responses

8.46 When considering the impacts of climate change on tourism and public recreation infrastructure, it is important to note that, as with other areas discussed in this chapter such as the health system, tourism is dependent on other infrastructure which could be disrupted due to climate change. The Northern Territory Government submitted:

> Many tourism and recreational experiences across the Territory are dependent on road, rail, marine and air transport. Climate change disruption to transport networks may therefore also impact on recreation and tourism infrastructure and facilities.[54]

8.47 There are also particular challenges associated with areas of particular natural beauty or ecological or cultural significance, such as world heritage sites. The QTIC observed that there is a likelihood of such areas being closed more frequently due to increases in various risks such as temperature, fire risk and extreme weather events. Adaptive actions in response can be more challenging than in other areas; this is because 'each natural park site is unique, adaptive actions are expensive, contentious, and often one-off experiments that come with the risk of losing the very asset that is trying to be protected'.[55]

8.48 In response to the threats presented by climate change, it was suggested that for coastal parklands, 'foresight, planning and regulation' would be required. In particular, it was argued that 'the most effective method of protection is to leave room for coastal retreat particularly along waterways'. More generally, the need for government support 'to assist coastal communities to manage the loss or relocation of these assets and to prepare their local economies' was also highlighted.[56]

8.49 Local governments that are dependent on tourism are also constructing infrastructure in response to climate risks. The committee was informed that the Gold Coast City Council is currently undertaking a project to build a 16-kilometre seawall to protect the City's beaches.[57]

8.50 The design of stadiums could also be reassessed. In an article published in *The Conversation*, Dr Paul Govind, a lecturer at Macquarie University, argued that greater consideration needs to be given to sustainable and climate-adaptable stadium design due to Australian summers becoming more prone to extreme heat conditions.[58]

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54 Northern Territory Government, *Submission 17*, p. 10.

55 Queensland Tourism Industry Council, *Submission 10*, p. 7.

56 Hobsons Bay City Council, *Submission 7*, p. 13.

57 Mr Alan Stokes, Executive Director, Australian Coastal Councils Association, *Committee Hansard*, 15 March 2018, p. 25.

58 See P Govind, 'We need to "climate-proof" our sports stadiums', *The Conversation*, 17 January 2018, https://theconversation.com/we-need-to-climate-proof-our-sports-stadiums-90020 (accessed 19 January 2018).

Chapter 9

Commonwealth, state and territory climate change policies

9.1 The terms of reference for this inquiry direct the committee to examine the adequacy of current state and Commonwealth policies for assessing, planning and implementing adaptation plans and improving the resilience of infrastructure.

9.2 This report has already discussed various plans and programs developed by governments, such as coastal planning strategies that require decision-makers to take into account sea level rise benchmarks. Programs developed in response to specific threats or challenges, such as the Victorian Government's Powerline Bushfire Safety Program for upgrading electricity infrastructure, have also been noted.

9.3 This chapter builds on these examples of government actions in particular sectors, or in response to particular types of threats, by examining the overall approach that the Australian, state and territory governments have taken to managing the climate risks affecting houses, buildings and infrastructure.

Overview of government plans and policies

9.4 Governments across Australia have developed and updated strategies, plans and measures to guide climate change mitigation and adaptation over many years. Some of these are multi-jurisdictional, a key example being the National Climate Change Adaptation Framework adopted by the Council of Australian Governments (COAG) in 2007. That Framework:

> …established priorities for action and a significant evidence base, national climate change science and adaptation research capacity and institutions, and a wide range of resilience-building initiatives. The Framework continues to anchor and guide resilience action by Australian governments.[1]

9.5 Submissions received during this inquiry provided numerous examples of Australian, state and territory government strategies, plans and programs relating to climate change. Some of these measures were discussed in detail. This section does not provide a comprehensive overview of these documents and programs; however, those that are particularly significant or relevant when considering the evidence received during this inquiry are outlined below.

1 Australian Government, *National Climate Resilience and Adaptation Strategy*, 2015, p. 5.

Australian Government policies and programs

9.6 The Australian Government's approach to addressing climate change is influenced by its international commitments to reduce emissions. In particular, as a party to the Paris Agreement, in August 2015 the Australian Government committed to reduce emissions by 26 to 28 per cent below 2005 levels by 2030.[2]

9.7 Following its Paris Agreement commitments, in December 2015, the Government released a National Climate Resilience and Adaptation Strategy. The Strategy 'affirms a set of principles to guide effective adaptation practice and resilience building, looks at leading practice nationally, and considers areas for future review, consultation and action'.[3]

9.8 Across the Australian Government, specific measures relating to climate change include the following:

- Emissions Reduction Fund—this is a voluntary scheme that provides incentives for Australian farmers and landholders to adopt new practises and technologies to reduce greenhouse gas emissions. Under the Fund, participants can earn Australian carbon credit units (ACCUs) for emissions reduction. ACCUs 'can be sold to generate income, either to the government through a carbon abatement contract, or in the secondary market'.[4] A safeguard mechanism places limits (baselines) on the emissions of facilities that emit more than 100,000 tonnes of emissions a year.[5]
- Various measures relating to energy generation and usage, including the Renewable Energy Target, the Clean Energy Finance Corporation, the Australian Renewable Energy Agency, the National Energy Productivity Plan, the National Energy Guarantee and the Solar Communities program (these are discussed in Chapter 7).
- The National Strategy for Disaster Resilience (2011, reviewed 2015) and the National Partnership Agreement on Natural Disaster Resilience, through which the Australian Government supports states and territories to invest in priority disaster resilience projects.
- The Critical Infrastructure Resilience Strategy and the accompanying Critical Infrastructure Resilience Strategy Plan, which encourage critical infrastructure

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2 Australian Government, *National Climate Resilience and Adaptation Strategy*, 2015, p. 13.

3 Australian Government, *National Climate Resilience and Adaptation Strategy*, 2015, p. 5.

4 Clean Energy Regulator, 'About the Emissions Reduction Fund', www.cleanenergyregulator.gov.au/ERF/About-the-Emissions-Reduction-Fund; Department of the Environment and Energy, 'About the Emissions Reduction Fund', www.environment.gov.au/climate-change/government/emissions-reduction-fund/about (accessed 20 February 2018).

5 Department of the Environment and Energy, *2017 Review of Climate Change Policies*, December 2017, p. 48.

owners and operators to better manage risks to the continuity of their operations, including climate change.[6]

9.9 In addition to these programs, various government agencies undertake work relating to climate change as part of their broader responsibilities. For example, projects undertaken by CSIRO to assist government decision-makers were noted in Chapter 4.

9.10 The Australian Government has also supported other research in climate change adaptation, such as the National Climate Change Adaptation Research Facility (NCCARF) at Griffith University (the NCCARF is discussed in Chapter 3).

9.11 The joint submission from multiple Australian Government departments and agencies provides further detail regarding policies, measures and initiatives relating to climate change in place at the Commonwealth level of government. Examples include:

- providing leadership in emergency management matters through the Australia–New Zealand Emergency Management Committee (a committee of the COAG Crime and Community Safety Council);
- coordinating Australia's implementation of the Sendai Framework for Disaster Risk Reduction 2015–2030, which is an agreement reached by United Nations Member States in 2015 that 'emphasises management of disaster risk as opposed to focusing solely on disaster response or recovery';
- supporting the development of hazard information capabilities, such as the next generation National Fire Danger Rating System; and
- assisting states and territories to manage and deliver public safety communications systems.[7]

9.12 Finally, the Australian Government's cities policy overseen by the Minister for Urban Infrastructure and Cities is also relevant.[8] Of particular note are the City Deals being negotiated by the Australian Government. One of the areas of focus for City Deals is 'liveability and sustainability', which among other things covers local responses to climate change.[9] For example, in the Launceston City Deal, the Northern

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6 Department of the Environment and Energy, Bureau of Meteorology, Great Barrier Reef Marine Park Authority, Attorney-General's Department, Department of Agriculture and Water Resources, and Geoscience Australia, *Submission 39*, pp. 6–7.

7 Department of the Environment and Energy et al, *Submission 39*, pp. 6–7.

8 The current Minister is the Hon Paul Fletcher MP. The decision to appoint a Commonwealth minister for cities was described in the National Climate Resilience and Adaptation Strategy as indicating 'the Australian Government's interest in finding opportunities to strengthen the climate resilience and liveability of our cities and built infrastructure'. Australian Government, *National Climate Resilience and Adaptation Strategy*, 2015, p. 37.

9 Department of Infrastructure, Regional Development and Cities, 'City Deal – focus areas', https://cities.infrastructure.gov.au/city-deal-focus-areas1 (accessed 30 April 2018).

Suburbs Revitalisation Plan addresses the need to ensure resilience to the effects of climate change.[10]

State government policies

9.13 As outlined above, this section does not provide a comprehensive overview of climate change-related policies and measures. Policies regarding specific matters, such as coastal planning and renewable energy, have been discussed in previous chapters. However, those policies are underpinned by overarching climate change legislation and strategies. Examples of key strategies and policies are at Table 9.1.

Table 9.1: Examples of state government legislation and policies

Jurisdiction	*Legislation/policy document*
New South Wales	NSW Climate Change Policy Framework
Victoria	*Climate Change Act 2017* (Vic) Victoria's Climate Change Framework
Queensland	Queensland Climate Adaptation Strategy 2017–2030 (2017) Queensland Climate Transition Strategy (2017)
South Australia	Towards a resilient state: the South Australian Government's Climate Change Adaptation Action Plan* South Australia's Climate Change Strategy 2015–2050 – Towards a low carbon economy*
Western Australia	Adapting to our changing climate
Tasmania	Climate Action 21: Tasmania's Climate Change Action Plan 2017–2021
Australian Capital Territory	*Climate Change and Greenhouse Gas Reduction Act 2010* (ACT) Climate Change Strategy and Action Plan Climate Change Adaptation Strategy
Northern Territory	Although a strategy is not in place, the Government is developing a 'whole-of-government framework to respond to climate change, taking into consideration the environmental, economic, social and health implications'.[11]

* The March 2018 South Australian election triggered a change in government which may affect the status of these strategies.

10 Australian Government, Tasmanian Government and City of Launceston, *Launceston City Deal*, https://cities.infrastructure.gov.au/launceston-city-deal (accessed 30 April 2018), p. 33.

11 Northern Territory Government, *Submission 17*, p. 1.

9.14 These strategies outline various targets and objectives regarding the implications of climate change. Key focuses of these documents are commitments or aspirational commitments to reduce emissions, such as the Victoria's legislated target of net zero emissions by 2050[12] and the Queensland Government's target of net zero emissions by 2050 and an interim target of reducing emissions by at least 30 per cent below 2005 levels by 2030.[13]

9.15 On the implications for infrastructure specifically, the following sample of state government policies provide insight into the approaches being taken.

9.16 The Victorian Government's *Climate Change Framework* highlights areas of particular concern regarding infrastructure. Overall, the Framework is a strategy to 'maximise the opportunities while minimising the adverse impacts of climate change for our state'. The Framework includes the objectives of building the resilience of Victoria's 'infrastructure, built environment and communities through effective adaptation and disaster preparedness action'. Among other matters, the Framework includes specific measures for the resilience of buildings, transport networks and energy infrastructure.[14]

9.17 The climate change strategy issued by the Western Australian Government in 2012, *Adapting to our changing climate*, also has a significant focus on infrastructure.[15] The strategy highlights the need to support 'infrastructure risk assessment and adaptation planning'. It also focuses on integrating climate change considerations into a range of government decisions, including development assessments; land-use and infrastructure planning; infrastructure procurement; and maintenance programs. The strategy also notes the need to accelerate infrastructure development in other areas, such as additional water supply sources.[16]

9.18 In Queensland, changes to planning laws enacted by the *Planning Act 2016* (Qld) and the State Planning Policy (2017) required local governments to 'respond to climate change in their planning instruments'. In addition, the state government is 'required to consider and respond to climate change in the preparation of a Coastal Management Strategy under the *Coastal Protection and Management Plan 1991*'.[17]

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12 *Climate Change Act 2017* (Vic).

13 Queensland Government, *Submission 58*, pp. 2–3.

14 Victorian Government, *Victoria's Climate Change Framework*, 2016, pp. 5, 26.

15 See Department of Water and Environmental Regulation, 'Adapting to climate change', www.der.wa.gov.au/your-environment/climate-change/254-adapting-to-climate-change (accessed 30 April 2018).

16 Western Australian Government, *Adapting to our changing climate*, October 2012, pp. 3, 8.

17 Local Government Association of Queensland, *Submission 11*, p. 7.

Perspectives on government strategies and policies on adaptation

9.19 As discussed in Chapter 2, in commenting on the adequacy of current Commonwealth policies regarding climate change, many stakeholders emphasised the need for a strong mitigation response. As mitigation has already been addressed in this report, this section will focus on adaptation strategies, particularly those specifically targeting the resilience of buildings and infrastructure.

9.20 The committee received evidence indicating how Commonwealth and state governments are working together to inform strategies for climate change adaptation. For example, the Tasmanian Government highlighted how work undertaken by CSIRO assisted it to develop its climate change strategy by informing sea level rise projections and planning allowances.[18]

9.21 Some issues that climate change could exacerbate are already the focus of established government programs. For example, Lake Macquarie City Council noted that procedures for floodplain risk management and bushfire are 'relatively mature' in New South Wales.[19] The Tasmanian Government also explained the initiatives it has undertaken to manage bushfire risk, including a fuel reduction program and various programs to educate communities at risk from bushfire about planning strategies.[20]

9.22 Stakeholders also expressed positive opinions about approaches being taken by certain state governments. Mr Dwayne Honor, the Queensland Director of Floodplain Management Australia (FMA), commented that the Queensland Government's decision to require planning policies to account for a sea level rise of 0.8 metres for the entire coast 'has been a positive move' that has resulted in consistent planning scheme controls.[21] Ms Kirsty Kelly from the Australian Sustainable Built Environment Council (ASBEC) commented that the Australian Capital Territory Government is 'quite strong in the resilience space'.[22]

9.23 However, the committee received a significant amount of evidence questioning the effectiveness of current approaches. For example, key stakeholders criticised the Australian Government's 2015 National Climate Resilience and Adaptation Strategy. The Local Government Association of Queensland argued that, with the exception of the CoastAdapt tool, the Strategy 'has not been adequately

18 The information provided by CSIRO was used to develop coastal inundation and erosion maps, which form 'an important input into the new Tasmanian Planning Scheme'. Tasmanian Government, *Submission 4*, p. 3.

19 Lake Macquarie City Council, *Submission 29*, p. 4.

20 Tasmanian Government, *Submission 4*, p. 4.

21 Mr Dwayne Honor, Queensland Director, Floodplain Management Australia, *Committee Hansard*, 23 November 2017, p. 5.

22 Ms Kirsty Kelly, Representative, Australian Sustainable Built Environment Council (ASBEC), *Committee Hansard*, 23 November 2017, p. 38.

informed by the needs of the 'frontline' stakeholders, particularly local governments'.[23] When asked whether the Climate Council had a view on the Strategy, Professor Lesley Hughes noted that he was 'not terribly familiar' with the Strategy and agreed with the proposition that this indicates the Strategy is not as effective as it could be.[24]

9.24 From the perspective of local governments in Western Australia, the representative body for local governments in that state submitted:

> There is little in the way of State and Commonwealth plans or resources directed to adaptation, despite the fact that Local Governments are currently undertaking adaptation action, and needing to make plans for future adaptation action. There is a particularly significant policy vacuum within the Western Australian Government, with negligible demonstrated and coordinated leadership and long-term planning across all areas. For example, the WA Government Climate Change Strategy which was released in October 2012 is inadequate and in need of an update and review.[25]

9.25 A particular concern is that the strategy documents developed at all levels of government have not resulted in the necessary 'on the ground' responses. Regional Development Australia – South West (RDA South West) submitted:

> The paradox is the considerable volume of people working on rising sea-level issues have produced so little effective coastal management response.
>
> In Western Australia there are a number of policy notes and/or draft versions but little coordination between agencies. This is not uncommon. Taking into account academia, CSIRO, Geoscience Australia, the Australian Oceanographic Data Centre, Australian Hydrographic Service, Bureau of Meteorology, Institute of Marine Science, Department of Environment, and State bodies plus a multitude of international organisations and experts, there is a lack of a widely recognised co-ordination and response body.[26]

9.26 Similarly, Green Cross Australia argued that 'it is now well-recognized that…despite a large number of adaptation plans and planning guidelines being written by governments, the private sector and communities, there is a lack of on-the-ground adaptation occurring'. Green Cross Australia considers that this is due to 'the political risk of undertaking adaptation actions, difficulties in securing adaptation funding, and perverse incentives in the property development sector'.

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23 Local Government Association of Queensland, *Submission 11*, p. 6.

24 Professor Lesley Hughes, Climate Council of Australia, *Committee Hansard*, 23 November 2017, p. 35.

25 Western Australian Local Government Association, *Submission 57*, p. 8 (emphasis omitted).

26 Regional Development Australia – South West, *Submission 15*, p. 9.

Green Cross Australia concluded that there is 'a clear role for the Australian Government to assist in removing some of these barriers'.[27]

9.27 The need for effective sector-based strategies was also noted. The Queensland Tourism Industry Council (QTIC) argued that 'there is a gap in existing plans, strategies and framework' relating to the consideration of climate change for the long-term future of the tourism industry. The QTIC called for the development of sector-based climate change mitigation and adaptation sector plans to be expedited and for climate change mitigation and adaptation plans to be integrated into other existing strategies.[28]

9.28 Finally, it was argued that certain Australian Government programs regarding emissions reduction are not well suited to the building sector. Green Building Council Australia argued that, regarding the Emissions Reduction Fund, 'several barriers have prevented the buildings sector—where many low-cost opportunities exist—from accessing the scheme'. Among others, these barriers include a minimum bid size of 2000 tonnes C02-e average abatement per annum; the Green Building Council explained that this bid size 'is difficult to achieve for a single building, except for very large, energy-hungry facilities'.[29]

Calls for greater government leadership and coordination of policies

9.29 A key role several submitters envisaged for the Australian Government is the coordination of efforts to develop a robust, best practice and nationally consistent response to climate change.

9.30 It was argued that, without greater leadership and actions to further climate change adaptation and resilience from the Australian Government, it will be more difficult for the approaches taken by other governments and stakeholders to succeed. The Law Institute of Victoria argued that long-term emissions reduction targets and other measures pursued by state governments, such as the *Climate Change Act 2017* (Vic), will be 'undermined without a nation-wide policy commitment to combatting climate change'.[30] A representative from the Law Institute of Victoria argued that actions taken by state governments 'lack the unifying clarity the federal government can create and which we say is required for a global issue such as climate change'.[31]

9.31 Local governments also called on the Australian and state governments to develop policies that support their adaptation efforts. The City of Melbourne

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27 Green Cross Australia, *Submission 38*, p. 5.

28 Queensland Tourism Industry Council, *Submission 10*, p. 2.

29 Other barriers are identified in the submission: see Green Building Council Australia, *Submission 50*, p. 15.

30 Law Institute of Victoria, *Submission 59*, p. 3.

31 Mr Hubert Algie, Chair, Environmental Issues Committee, Law Institute of Victoria, *Committee Hansard*, 15 March 2018, p. 13.

submitted that the implementation of its Energy, Water and Waste Efficiency local planning policy 'could be made easier by the introduction of State and Federal policy'.[32]

9.32 Ms Emma Herd, Chief Executive Officer, Investor Group on Climate Change (IGCC), argued that a national approach to climate change adaptation would help achieve beneficial outcomes. Ms Herd observed that 'generally in Australia we reduce the economic costs of the response if we're more or less doing the same thing across all states and areas'. Ms Herd envisaged that a national approach to adaptation would involve all levels of government and address the following matters:

> …who was responsible for what; how we get a nationally consistent response to climate change across all jurisdictions; how we bring in private sector participation, whether it's in terms of planning or construction or, in our case, investment into solutions; how we get all parts of the economy working together and pulling in the same direction with a common understanding of what the impacts are likely to be and what some of the available solutions actually are.[33]

9.33 Ms Herd added that a national approach to climate change does not require 'over-planning or over-management', rather the objective should be more effectively articulating 'levels of responsibility and opportunities for public-private partnership' and ensuring scientific knowledge regarding climate projects is used to achieve 'a more consistent approach to climate change adaptation management'.[34] Ms Herd suggested that a multijurisdictional reference group could be formed to harmonise climate change policies, forecast scenarios and risk assessment models across different jurisdictions.[35]

9.34 Professor Lesley Hughes from the Climate Council of Australia and Ms Kirsty Kelly from the ASBEC supported the idea of developing a national plan, and the ASBEC also supported the IGCC's suggestion of forming a multijurisdictional reference group to harmonise climate change policies. Notwithstanding this overall support, they emphasised that a national plan should recognise the need to account for developments that are relevant at a state and territory level, such as different rates of sea level rise in different locations. A national plan should also not displace grassroots actions.[36]

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32 The policy 'seeks to ensure that all new buildings, including residential development, achieve high environment standards'. City of Melbourne, *Submission 43*, p. 7.

33 Ms Emma Herd, Chief Executive Officer, Investor Group on Climate Change (IGCC), *Committee Hansard*, 23 November 2017, pp. 16, 20.

34 Ms Emma Herd, IGCC, *Committee Hansard*, 23 November 2017, pp. 15–16.

35 Ms Emma Herd, IGCC, *Committee Hansard*, 23 November 2017, p. 20.

36 Professor Lesley Hughes, Climate Council of Australia, *Committee Hansard*, 23 November 2017, p. 33; Ms Kirsty Kelly, ASBEC, *Committee Hansard*, 23 November 2017, p. 39.

9.35 Similarly, Mr Andrew Petersen, Chief Executive Officer, Sustainable Business Australia, argued that it is 'critical' that greater national coordination of responses to climate risks takes place, although he added that this would not have to be 'a top-down approach, because there is a lot of excellent work that goes on amongst most states and territories at the moment'.[37]

9.36 The QTIC called for a coordinated approach to climate change mitigation and adaptation strategies across levels of government, although it added that industry should also be involved. The QTIC reasoned that, from the perspective of tourism sector, its infrastructure and assets 'cross multiple industries', such as agriculture and transportation, requiring a 'united approach toward mitigation and adaptation strategies' across all relevant sectors.[38]

9.37 Stakeholders also identified issues on which they consider governments should provide explicit guidance and nationally consistent policies. For example, Ms Megan Motto from Consult Australia called for the Australian Government to provide the built environment sector with certainty about the climate risks for which they should be designing. Ms Motto exampled that the sector wants:

> …leadership, particularly from government saying: 'We expect the industry to design to X. Above that, we're not going to hold you responsible because you didn't foresee an unknown future.' So I think that the government needs to show a little bit of ownership in particular as a great owner and deliverer of assets in the Australian jurisdiction. I think the government needs to take a little bit of ownership of where that line in the sand would be to give industry the certainty it needs to perform to a standard.[39]

9.38 Local governments also called on the Australian Government to work with both them and the state governments to prepare and respond to coastal risks. The Australian Coastal Councils Association (ACCA) questioned the merits of the Australian Government having a limited role in these matters to date. Although it acknowledged the argument that constitutional arrangements mean that the states have primary responsibility for the protection of life, property and the environment, the ACCA argued that 'the national scale of the risk' associated with climate change requires 'a coordinated national approach to managing climate hazards in the coastal zone'. The ACCA added:

> This would involve a commitment by the three tiers of government to work collaboratively to ensure the sustainability of the coastal environment and coastal communities. The proposed integrated approach would require each tier of government to play its role in safeguarding the coast from the impact of coastal hazards.

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37 Mr Andrew Petersen, Chief Executive Officer, Sustainable Business Australia, *Committee Hansard*, 23 November 2017, p. 12.

38 Queensland Tourism Industry Council, *Submission 10*, p. 2.

39 Ms Megan Motto, Chief Executive Officer, Consult Australia, *Committee Hansard*, 23 November 2017, p. 26.

> Coastal councils are at the forefront of responding to key issues in the coastal zone, such as climate risks, but are ill-equipped to respond appropriately to the complex and difficult set of challenges involved. These include lack of funding for effective adaptation measures and lack of appropriate policy guidance in many jurisdictions. There is a clear need for enhanced coordination of planning and management of the coastal zone at a local, regional, state and Commonwealth level as well as a greater need for cross-jurisdictional coordination between all levels of government in relation to coastal planning and management.[40]

9.39 RDA South West suggested that the objective of increased national coordination to advance coastal management responses could be achieved through the creation of a 'nationally consistent framework' with 'a respected apex organisation…to co-ordinate all effort and pull together stakeholders'. RDA South West acknowledged that a nationally coordinated approach could potentially reduce the opportunities for flexible and collaborative local responses; however, it is of the view that moving to a single agency approach with 'planning certainty' is required.[41]

9.40 Finally, another area where governments could demonstrate commitment to improving the resilience of buildings to climate change risk is by leading by example through their own property requirements. Green Building Council Australia explained that a decision by the Victorian Government to require all of its new office space to be Green Star-certified is a key example of government leadership on improving building standards. The Green Building Council provided the following evidence regarding how this decision resulted in wider benefits:

> At the time, Green Star certification was still relatively new and only a small portion of industry was familiar with it. However, to supply government demand for high quality Green Star office space, industry rapidly upskilled and adopted Green Star and today 4 and 5 Star Green Star certification is usually achieved on a cost-neutral basis.[42]

9.41 The Green Building Council Australia reasoned that 'with increasing commitments by all governments to reach net zero emissions targets by 2050, it is important that parallel commitments are reflected in government procurement policy'. Accordingly, it argued that a Green Star rating for any government building or office fit-out should be a pre-condition for procurement.[43]

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40 Australian Coastal Councils Association, *Submission 61*, p. 3.

41 Regional Development Australia – South West, *Submission 15*, p. 9.

42 Green Building Council Australia, *Submission 50*, p. 17.

43 Green Building Council Australia, *Submission 50*, p. 17.

Calls for legislative reform and changes to institutional arrangements

9.42 The Commonwealth's responsibilities regarding the environment focus on the protection of matters of national environmental significance, whereas the states and territories have responsibility for matters of state and local significance. This framework means that there can be overlap between levels of government; for example, projects can be subject to both Commonwealth and state frameworks and approval processes. However, responsibilities can be devolved; for example, bilateral agreements between the Commonwealth and states accredit state assessment processes for assessing certain actions that are covered by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In addition, state governments impose requirements on local governments regarding environmental matters, such as considering environmental considerations in decision-making processes.

Concerns raised in evidence

9.43 Key stakeholders are critical of the current legislative framework regarding climate change and environment protection, as well as how this framework has developed over time. The Chair of the Law Institute of Victoria's Environmental Issues Committee, Mr Hubert Algie, argued that 'the incremental development of Australia's environmental law and policy has generally resulted in an extremely complex, fragmented and uncoordinated legal and regulatory system'. Mr Algie added that:

> The size, scale and impenetrable complexity of environmental legislation, regulation, codes and policies makes real responses to climate change or leadership difficult. The numerous agreements between Commonwealth and states, overlaid by international treaties, complicates matters further.[44]

9.44 Witnesses representing the Law Institute argued that the EPBC Act is particularly deficient for addressing climate change. Mr Algie stated:

> The EPBC Act is complex, and reforms to it over a number of years have made it more complex. It actively divested the federal government of its responsibilities. It's moved them further away from the federal government and further away from federal government leadership on environmental issues. The starting point for climate change reform should be reviewing the EPBC Act…The reality is the EPBC Act was drafted in a time that didn't fully scope the impacts and the speed at which our climate changed. The act itself does not make reference to climate change other than to international treaties on that point. That is an oversight. The reality is the federal environmental legislation ignores those impacts.[45]

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44 Mr Hubert Algie, Law Institute of Victoria, *Committee Hansard*, 15 March 2018, p. 13.

45 Mr Hubert Algie, Law Institute of Victoria, *Committee Hansard*, 15 March 2018, pp. 17–18. See also Dr Leonie Kelleher, Member, Environmental Issues Committee, Law Institute of Victoria, *Committee Hansard*, 15 March 2018, p. 14.

9.45 The Law Institute argued that the complexity of the current framework 'should be remedied as part of wholescale environmental law reform at a federal level'.[46] Although the Law Institute did not endorse any particular reform proposals, it highlighted a suite of recommendations developed by the Australian Panel of Experts on Environmental Law (APEEL)[47] for changes to Australia's environmental law framework. The recommendations were outlined in an APEEL paper tabled by the Law Institute.[48]

9.46 Areas for reform were also identified beyond environmental law. It was argued that existing and future Commonwealth and state legislation and policies on climate change should be integrated into the management of state infrastructure, with a precautionary approach taken 'especially where there is high risk associated, such as with the National Electricity Market'.[49]

9.47 In addition, it was noted that there is no formal mechanism for collaboration between local, state and federal government on climate change adaptation and mitigation. The absence of a ministerial-level Council relating to climate change within the COAG framework was highlighted.[50]

Suggestions for change

9.48 Submitters proposed various changes to institutional arrangements to assist with the coordination of climate change issues across government and to improve how climate change issues are taken into account in decision-making. For example, representatives of Victorian local governments who participated in the Melbourne public hearing indicated support for the Australian Government to establish an independent climate change authority on a permanent basis.[51]

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46 Mr Hubert Algie, Law Institute of Victoria, *Committee Hansard*, 15 March 2018, p. 13.

47 As at March 2018, the members of APEEL include Adjunct Professor Rob Fowler, Emeritus Professor David Farrier, Professor Lee Godden, Professor Neil Gunningham, Dr Cameron Holley, Dr Hanna Jaireth, Dr Bruce Lindsay, Professor Jan McDonald, Professor Zen Makuch, Professor Paul Martin, Professor Jacqueline Peel, Professor Benjamin Richardson, Ms Rachel Walmsley and the Hon Murray Wilcox AO QC. APEEL, 'Meet the members of the expert panel', http://apeel.org.au/expert-panel (accessed 28 March 2018).

48 Australian Panel of Experts on Environmental Law (APEEL), *57 recommendations for the next generation of Australian's environmental laws*, 2017, p. 7; tabled by the Law Institute of Victoria, 15 March 2018.

49 New South Wales' Young Lawyers Environment and Planning Law Committee, *Submission 32*, p. 8.

50 Mr Alan Stokes, Executive Director, Australian Coastal Councils Association, *Committee Hansard*, 15 March 2018, p. 36. The Standing Council on Environment and Water was abolished in 2013 as part of a consolidation of the system of COAG Councils; however, Environment Ministers still meet regularly outside of the COAG system as part of the Meeting of Environment Ministers. Department of the Environment and Energy, 'Meeting of Environment Ministers', www.environment.gov.au/about-us/mem (accessed 30 April 2018).

51 See *Committee Hansard*, 15 March 2018, p. 37.

9.49 One of the specific suggestions is the creation of a National Panel on Climate Change modelled on the 'tried and trusted methodology' of the Intergovernmental Panel on Climate Change (IPCC). Doctors for the Environment Australia (DEA), which advocated for this change, argued that a national panel on climate change would provide Australia with 'one, overarching, stable organisation that can provide the up-to-date science, technology and assessment processes to assist Government and stakeholders'.[52]

9.50 In particular, the DEA argued that a national panel on climate change would ensure that scientific data relating to climate change would be 'assembled and interpreted on an ongoing basis to the public and to institutions and governments in a form that is easily understood'. The DEA argued that, to date, 'Australian governments have not understood the necessity for this'. The DEA explained:

> In the past 3 years decisive blows have been struck at the existing structure of climate analysis and research in Australia with the downsizing and re-organisation of CSIRO and the demolition of NCCARF. Existing research assessments, modest though they are, are distributed through a range of institutions without coordination. The Australian Academy of Science has reported on the inadequacy of climate change research and modelling resulting from CSIRO cutbacks and it has supported re-establishment of staffing in CSIRO. DEA supports this, but measures need to be developed to ensure that it is secure from political expediency so such expertise is always available.[53]

9.51 Like the IPCC, the DEA suggested that an Australian panel on climate change would 'still be intergovernmental' with the states and territories involved.[54]

9.52 Another suggestion for changing institutional arrangements to enhance how climate change issues are considered is the DEA's proposal for the creation of a national Environment Protection Authority (EPA). The DEA argued that a national EPA with legislated powers to act in all states would be 'the most appropriate delivery system for climate change policy and related matters'. The DEA commented that the case for a national EPA has been argued in many of its publications, however, it provide the following brief overview of how a national EPA could function by comparing it to the similarly named Environmental Protection Authority in the United States:

> Essentially the US EPA covers the regulation of air, water quality and environmental requirements related to health and delivers policy on environmental preventative health to the entire nation, for example, as with…[the Obama Administration's Clean Power Plan under the] Clean Air Act. In Australia, the intent would be similar, namely, the enactment and

52 Doctors for the Environment Australia, *Submission 41*, p. 10.

53 Doctors for the Environment Australia, *Submission 41*, pp. 10–11 (citation omitted).

54 Doctors for the Environment Australia, *Submission 41*, p. 11.

> delivery of clean air and water and the control of pollution etc, to all Australians, where-ever their abode.[55]

9.53 The 57 recommendations for change to Australia's framework of environmental laws developed by APEEL also contained suggestions for new regulatory and oversight institutions. APEEL argued that these proposed institutions 'replace and expand upon the functions currently exercised by the Minister and Department for [the] Environment and Energy and other existing Commonwealth statutory environmental authorities'. APEEL identified the following three bodies that it proposed could be established:

- A Commonwealth Environment Commission—APEEL envisaged a high-level and independent institution similar to the Reserve Bank of Australia that would:
  - administer a proposed system of Commonwealth Strategic Environmental Instruments (comprising national strategies, programs, standards and protocols, and regional environmental plans);
  - be responsible for 'a nationally coordinated system of environmental data collection, monitoring, auditing and reporting';
  - conduct 'environmental inquiries of a strategic nature'; and
  - provide advice to the Australian Government on environmental matters.
- A Commonwealth EPA—among other things, the EPA would be responsible for administering the Commonwealth's environmental assessment and approval system, and for regulating activities undertaken by Commonwealth authorities or on Commonwealth land.
- A Commonwealth Environmental Auditor—the Auditor would:
  - monitor and report on the performance of Commonwealth entities in the performance of their statutory environmental responsibilities, including the Minister, the Commonwealth EPA, Department for the Environment and Energy and other relevant Commonwealth bodies; and
  - make recommendations to the Commonwealth Environment Commission on the need to develop new strategic environmental instruments.[56]

55 Doctors for the Environment Australia, *Submission 41*, p. 12.

56 APEEL, *57 recommendations for the next generation of Australian's environmental laws*, 2017, p. 7; tabled by the Law Institute of Victoria, 15 March 2018.

Building resilience and betterment of infrastructure assets

9.54 This section addresses evidence received regarding the need for greater expenditure on pre-disaster resilience and the Commonwealth's role in funding the recovery of infrastructure following natural disasters.

Background information on natural disaster funding arrangements

9.55 The Australian Government's approach to recovery assistance is guided by the intergovernmental Natural Disaster Relief and Recovery Arrangements (NDRRA). Under the NDRRA, the Australian Government provides financial assistance to state and territory governments following a natural disaster or terrorist act if a coordinated multi-agency response was required and state expenditure exceeded a specified minimum threshold. State and territory governments determine the individuals and communities in their jurisdictions that will receive NDRRA assistance.[57]

9.56 In participating in the NDRRA, the Commonwealth recognises that natural disasters or terrorist acts may result in large-scale expenditure by state governments, and that the Commonwealth has a role to assist with this burden. In doing so, the Commonwealth's assistance is intended to complement other state government relief and recovery strategies (such as insurance and natural disaster mitigation planning), and is 'not intended to fund every possible relief and recovery assistance measure delivered by a state'.[58]

9.57 Two types of NDRRA assistance measures particularly relevant to this inquiry are the assistance that can be provided for:

- the restoration or replacement of an essential public asset;[59] and
- betterment of an essential public asset, which for the purposes of the NDRRA is defined as the 'restoration or replacement of an essential public asset to a more disaster-resilient standard than its pre-disaster standard'.[60]

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57 Australian Government, *Natural Disaster Relief and Recovery Arrangements: Determination 2017*, www.disasterassist.gov.au/Documents/Natural-Disaster-Relief-and-Recovery-Arrangements/NDRRA-determination-2017.PDF (accessed 28 March 2018), pp. 6, 9; Australian Government, 'Natural Disaster Relief and Recovery Arrangements', Disaster Assist, www.disasterassist.gov.au/Pages/related-links/Natural-Disaster-Relief-and-Recovery-Arrangements.aspx (accessed 27 March 2018).

58 Australian Government, *NDRRA Determination 2017*, pp. 13–14.

59 An 'essential public asset' must be considered by the Australian and state governments to be 'a necessary part of a state's infrastructure and is integral to the normal functioning of a community'. The asset must also be a transport or public infrastructure asset of a department or agency of a state government, or of a body established under state legislation for public purposes such as local governments, which provides services free of charge or at a rate that is 50 per cent or less of the cost to provide those services. See Australian Government, *NDRRA Determination 2017*, p. 6.

60 Australian Government, *NDDRA Determination 2017*, pp. 5, 20.

9.58 NDRRA funding for the betterment of an essential public asset may be provided if, after reviewing a betterment proposal submitted by a state government, the Commonwealth is satisfied with the cost-effectiveness of the proposal and that the betterment project will 'mitigate the impact of likely or recurring natural disasters of the same type'.[61]

9.59 The Australian Government funds up to 75 per cent of the NDRRA assistance made available to individuals and communities.[62] For 2017–18, it is estimated that the Commonwealth will make cash payments of $532.3 million as part of the NDRRA.[63]

9.60 The Commonwealth also provides funding to the states and territories to enhance national disaster resilience. The Attorney-General's Department[64] provided the following information about the funding provided by the Commonwealth for these efforts:

> …through the National Partnership Agreement on Natural Disaster Resilience, the Australian Government supports states and territories to invest in priority disaster resilience projects. The current Agreement provides $26.1 million in Commonwealth funding each year over the life of the agreement, which is matched by the states and territories through funding or in kind resources.[65]

9.61 Across governments, IAG noted that research completed by the Australian Business Roundtable (ABR) in 2016 found that, between 2002–03 and 2010–11, Australian governments spent more than $450 million per financial year restoring essential public infrastructure assets following extreme weather events. This equated to approximately 1.6 per cent of total public infrastructure spending.[66]

9.62 The NDRRA was reviewed by the Productivity Commission (PC) in 2014. The PC found that 'current government natural disaster funding arrangements are inefficient, inequitable and unsustainable', The PC made the following observations about how the NDRRA influences decision-making by state and local governments:

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61 Australian Government, *NDDRA Determination 2017*, pp. 21–22.

62 Australian Government, 'Natural Disaster Relief and Recovery Arrangements', Disaster Assist, www.disasterassist.gov.au/Pages/related-links/Natural-Disaster-Relief-and-Recovery-Arrangements.aspx (accessed 27 March 2018).

63 Australian Government, *Mid-Year Economic and Fiscal Outlook 2017–18*, December 2017, p. 79.

64 At the commencement of this inquiry, the Attorney-General's Department had responsibility for natural disaster relief, recovery and mitigation policy and financial assistance. The Department of Home Affairs gained these responsibilities in December 2017 following machinery of government changes.

65 Department of the Environment and Energy et al, *Submission 39*, p. 6.

66 IAG, *Submission 56*, p. 7.

> The NDRRA dilute the link between asset ownership, risk ownership and funding. This creates a financial disincentive for state and local governments to manage these risks (especially through land use planning) and a further disincentive to invest in mitigation or insurance. State and local governments generally must bear the full costs of these risk mitigators themselves, whereas they only pay a portion of the cost of restoring an asset damaged by a natural disaster under the NDRRA.[67]

9.63 To develop a framework that is 'more likely to be consistent with the safety-net policy objective of the funding arrangement', the PC argued that Australian Government mitigation funding should be increased while post-disaster support should be reduced. The PC noted that the current cost-sharing rate of 75 per cent under the NDRRA is 'much higher than in other service delivery areas that are principally the responsibility of states'. The PC argued that 'a case has not been made for the Australian Government to have a higher exposure to natural disaster fiscal risks than to other fiscal risks borne by state governments'.[68]

9.64 Key recommendations made by the PC included that:

- Commonwealth mitigation funding to states should increase to $200 million a year (to be matched by the states); and
- the threshold for Commonwealth assistance should be increased,[69] and the cost-sharing rate above this threshold reduced to 50 per cent.[70]

9.65 In its response to the PC's report, the Australian Government indicated that it did not intend to pursue these recommendations after state and territory governments raised 'significant concerns with any proposal to reduce the Australian Government's contribution to recovery funding'.[71]

Calls for greater attention to betterment and pre-disaster resilience

9.66 The approach taken to rebuilding efforts following natural disasters attracted significant comment. A common theme in many submissions is that government-funded reconstruction or rebuilding projects following natural disasters often only

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67 Productivity Commission, *Natural Disaster Funding Arrangements*, Report No. 74, Vol. 1, December 2014, p. 15.

68 Productivity Commission, *Natural Disaster Funding Arrangements*, pp. 17–18.

69 Furthermore, the PC argued that the threshold for Commonwealth assistance should be increased to $2 million to prevent the NDRRA being used for 'small, routine weather events'. Productivity Commission, *Natural Disaster Funding Arrangements*, p. 18.

70 Productivity Commission, *Natural Disaster Funding Arrangements*, pp. 2, 17, 18, 38.

71 Australian Government, *Response to the Productivity Commission Inquiry into Natural Disaster Funding Arrangements*, May 2015, www.ag.gov.au/Publications/Documents/Australian-Government-response-to-the-Productivity-Commission-Inquiry-into-Natural-Disaster-Funding-Arrangements.pdf (accessed 3 April 2018), p. 2.

fund work to return the infrastructure to its original specifications, rather than increasing the resilience of the asset.

9.67 Specific examples were provided. The South East Councils Climate Change Alliance advised that, following extreme rainfall events in March 2011 and May and June 2012, over 200 landslides occurred in the Baw Baw Shire area. The landslides resulting in road closures and loss of service, with some roads affected multiple times. However, recovery assistance received from the state government, which was supported by Commonwealth funding under the NDRRA, 'only covered "replacement to the same standard" and delays in reimbursements left council financially exposed'.[72]

9.68 The PC made similar observations about repeated repair projects in its 2014 report on natural disaster funding arrangements. The PC referred to 'Groundhog Day' projects where assets are rebuilt to the same standard on multiple occasions, such as the following anecdote:

> …a water intake plant in Queensland was damaged by floods in 2011. Soon after it was reconstructed to its pre-disaster state, it was damaged again by flooding in 2013.[73]

9.69 Evidence received by the committee explained that it can be difficult for governments to justify investing in more resilient buildings and infrastructure. The Northern Territory Government submitted that private infrastructure owners and operators should face sufficient incentives 'to decide for themselves whether constructing and maintaining economic infrastructure to a higher standard is in their economic interests'. However, in relation to publicly-owned infrastructure that does not produce a direct income, the Northern Territory Government submitted:

> There is a risk that cash-constrained governments at all levels limit their investment to what they can afford in the short-term, and in doing so forgo the advantages of a longer economic life achievable if higher, yet more expensive engineering and building standards were applied, in addition to more intensive maintenance.[74]

9.70 Consult Australia acknowledged that the cost of upgrades 'can be significant, especially following large-scale natural disasters'. However, it reasoned that the opportunity cost of electing not to upgrade damaged assets needs to be taken into account. Consult Australia argued that not investing in improvements 'means that the rebuilt infrastructure may be just as vulnerable…[which] in turn increases the risk that future natural disasters will cause even greater damage, with escalating reconstruction costs and disruption to the economy'.[75]

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72 South East Councils Climate Change Alliance, *Submission 30*, p. 2.

73 Productivity Commission, *Natural Disaster Funding Arrangements*, pp. 15–16.

74 Northern Territory Government, *Submission 17*, p. 4.

75 Consult Australia, *Submission 44*, p. 11.

9.71 Similarly, IAG argued that by not improving the resilience of essential public infrastructure assets following a natural disaster, 'individuals, communities, businesses and governments are left more vulnerable to widespread disruption and higher costs post disaster'. IAG noted that Australian governments spent over $450 million per financial year between 2002–03 and 2010–11 restoring essential public infrastructure assets following extreme weather events.[76]

9.72 The Western Australian Local Government Association (WALGA) also favours the betterment of assets 'to prevent a situation where, for example, valuable infrastructure is washed away and then identically replaced every few years'. WALGA argued that the projected increase in the frequency or intensity of many types of extreme weather events means that the benefits from increasing the resilience of assets are likely to be greater than has been the case.[77]

9.73 The PC found that betterment is rarely used under the NDRRA. The PC explained that this is because, under the NDRRA, betterment:

> …is subject to a lower reimbursement rate, a higher administrative burden and lack of a budget allocation by the Australian Government (which means that offsetting savings must be made elsewhere to fund betterment).[78]

9.74 Betterment programs that have been undertaken include two Betterment Funds jointly funded by the Australian and Queensland Governments in 2013 and 2015 under the NDRRA.[79]

9.75 In its submission, the Queensland Government noted that the Betterment Funds address the problem of NDRRA funding generally only enabling damaged infrastructure to be repaired to its pre-disaster standard (that is, governments have to 'build back the same vulnerable infrastructure "like for like" in the same vulnerable location'). The Queensland Government argued that the Betterment Funds reflects international best practice. In particular, the Queensland Government noted that many of the 295 betterment projects undertaken have faced and withstood subsequent natural disasters and it is estimated that reconstructions costs of approximately $104 million have been saved as a result.[80]

9.76 The FMA suggested that the Queensland betterment funds could be used as a model for a joint Commonwealth and state fund that could lead to 'more resilient

76 IAG, *Submission 56*, p. 7.

77 Western Australian Local Government Association, *Submission 57*, p. 10 (emphasis omitted).

78 Productivity Commission, *Natural Disaster Funding Arrangements*, p. 16.

79 Queensland Government, *Submission 58*, p. 6.

80 Queensland Government, *Submission 58*, p. 6.

recovery and reconstruction options' that factor in future climate change-related risks.[81]

9.77 More generally, it was noted that Commonwealth expenditure on post-disaster recovery and relief far exceeds expenditure on pre-disaster resilience. The FMA referred to a Deloitte Access Economics report which found that there is a ratio of 10:1 of post-disaster expenditure by the Commonwealth compared to pre-disaster resilience. The FMA highlighted this to support its argument that greater government investment is required in pre-disaster resilience; from the FMA's perspective, it is 'concerned about the insufficient government investment in flood risk mitigation generally and the worsening consequences that will be caused by climate change'. The FMA submitted:

> There is Australian and international evidence that increased investment in best practice flood risk management and mitigation measures would reduce the budget impact of recovering from floods for all levels of government. It would also reduce the economic and social cost of floods to individuals and businesses and improve the ability of communities to recover.[82]

9.78 The approach taken in Australia was contrasted to that in other countries with a high risk of natural hazards. On floods generally, Mr Grech from the FMA commented that the ratio of pre-disaster mitigation and post-disaster recovery in the Netherlands is essentially the reverse to Australia: 'They spend 90 per cent on mitigation and 10 per cent on post-disaster recovery'.[83]

9.79 The IGCC submitted that the Deloitte Access Economics analysis referred to by the FMA also found that 'carefully targeted programs of resilience investment in the order of $250 million/yr could see government spending reduce by more than 50% by 2050'.[84]

9.80 Since this evidence was received, there has been a development regarding the Australian Government's approach to these issues. In April 2018, the Minister for Law Enforcement and Cyber Security announced the creation of a National Resilience Taskforce to 'lead nation-wide reforms to reduce the impact and financial burden of disasters on our communities and economy'. The Minister explained that the taskforce, in consultation with the state and territory governments and the finance and insurance sectors, would 'develop a five-year national disaster mitigation framework to reduce the impact of disasters'.[85]

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81 Floodplain Management Australia, *Submission 35*, p. 5.

82 Floodplain Management Australia, *Submission 35*, p. 4.

83 Mr Paul Grech, Director, Land Use Planning, Floodplain Management Australia, *Committee Hansard*, 23 November 2017, p. 7.

84 IGCC, *Submission 55*, p. 8.

85 The Hon Angus Taylor MP, Minister for Law Enforcement and Cyber Security, 'Reforms to reduce impact of natural disasters in Australia', *Media release*, 10 April 2018.

Chapter 10

Local government

10.1 The actions undertaken by local governments in response to the risks climate change present to buildings and infrastructure were of great interest to the committee. As the Northern Alliance for Greenhouse Action (NAGA)[1] observed:

> Local governments are on the frontline when dealing with the risks and impacts of climate change. The impacts of climate change are already taking their toll on local governments ability to deliver critical services to their community.[2]

10.2 NAGA argued that there is a 'strong community expectation that local governments are preparing for climate change'. Effective climate change adaptation by local governments could benefit their residents by facilitating improved health and wellbeing outcomes, lower energy bills and reductions in local government expenditure (such as lower maintenance costs). In the long-term, investments by local governments in climate change adaptation now could avoid greater expenditure in future.[3] As outlined in previous chapters, state governments have also required local governments to respond to climate change in matters such as land-use planning. However, local governments also face the risk of their planning decisions being subject to legal challenges, issues regarding rising insurance premiums, and limited resources.

Overview of strategies being pursued by local governments

10.3 An example of a local government's climate change strategy is the City of Melbourne's Climate Change Adaptation Strategy (2009), which the City of Melbourne described as 'the first of its kind in Australia'. The Strategy was updated in 2017. It supports the City's broader aim of zero net emissions by 2020.[4]

10.4 The Strategy focuses on addressing risks associated with an insufficient water supply; inundation from flooding, storm surge, sea level rise and flash flooding; heatwave impacts; and storm events.[5] Since the 2009 edition of the strategy was released, the City has pursued numerous projects to address the identified key risks. These projects include stormwater harvesting, increasing green space and canopy

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1 The NAGA is a network of nine northern Melbourne metropolitan councils.

2 Northern Alliance for Greenhouse Action, *Submission 19*, p. 1.

3 Eastern Alliance for Greenhouse Action, *Submission 13*, p. 2.

4 City of Melbourne, *Submission 43*, p. 2.

5 City of Melbourne, *Climate Change Adaptation Strategy Refresh*, 2017, www.melbourne.vic.gov.au/sitecollectiondocuments/climate-change-adaptation-strategy-refresh-2017.pdf (accessed 22 February 2018), p. 16.

cover, and enhanced biodiversity. The City has spent in excess of $50 million over five years on these projects.[6]

10.5 The City of Melbourne is also using international experience to inform its strategies and decisions. Mr Gavin Ashley from City of Melbourne advised that Melbourne is a member of the C40 Cities Climate Leadership Group, which is a global network of over 90 major cities focused on addressing climate change issues. Mr Ashley explained that membership of this group 'allows us to make city-to-city connections quite well'. Mr Ashley explained that this collaboration works:

> …because it's city based, and, as large international cities, we're facing similar challenges. In effect that collaboration, for us at least, has jumped beyond the national level in search of answers.[7]

10.6 Despite providing an overarching strategy relating to climate change, the 2017 edition of the strategy illustrates the scale of the challenge local governments face in incorporating climate change considerations into their planning and decision-making practices. The various strategies and actions the City of Melbourne is involved in regarding key climate risks are listed at Box 10.1.

Box 10.1: City of Melbourne strategies and actions relevant to climate risks

- Resilient Melbourne Strategy
- Melbourne Strategic Statement
- City of Melbourne Design Standards
- Urban Forest Strategy
- Green Infrastructure Framework
- Zero Net Emissions Strategy
- Elizabeth Street Catchment Integrated Water Cycle Management Plan
- Beyond the Safe City Strategy
- Growing Green Guide
- Open Space Strategy
- Emergency Management Planning (collaborative effort between government agencies)
- Inner Melbourne Climate Adaptation Network
- Transport Strategy
- Planning Policy 22.19: Energy, water and waste
- Planning Policy 22.23: Stormwater management
- Arts Strategy
- Total Watermark: City as a Catchment
- Tourism Action Plan
- Nature in the City Strategy
- Building Prosperity Together
- CitySwitch and 1200 Buildings
- Melbourne for all People Strategy
- Assess Management Strategy
- Heatwave and Homelessness Action Plan
- City of Melbourne Heatwave Response Plan.

Source: City of Melbourne, *Climate Change Adaptation Strategy Refresh*, 2017, p. 19.

6 City of Melbourne, *Climate Change Adaptation Strategy Refresh*, p. 24.

7 Mr Gavin Ashley, Team Leader, Climate Resilience, City of Melbourne, *Committee Hansard*, 15 March 2018, p. 37.

10.7 Other examples of local government strategies include:

- statements published by the City of Darwin regarding its approach to managing climate risk;[8] and
- the climate change risk assessment and action plan developed by the Eastern Alliance for Greenhouse Action, a group of seven councils located to the east of Melbourne.[9]

10.8 Overall, the Australian Local Government Association (ALGA) provided the following insights into the changing approach being taken by local governments to climate risks:

> In recent years, the focus of local government has turned toward boosting the capacity of the sector to support communities deal with the impacts of climate change that cannot be avoided.
>
> These include threats to valuable coastal infrastructure, such as roads, parks, harbours as well as residential and commercial land, due to the risk of increasing sea-levels and storm-surges from more powerful weather systems. As the level of government closest to communities and responsible for most local infrastructure, this is core business and fundamental due diligence.[10]

10.9 However, the committee received anecdotal evidence indicating that a significant number of local governments are not implementing strategies to address climate change risks. Mr Paul Grech from Floodplain Management Australia (FMA) advised that work he was involved in to audit planning policies and planning controls revealed that only around 20 per cent of the approximately 40 coastal councils in New South Wales had climate change-related controls. Mr Grech added that it was also 'very difficult' to identify and understand the councils' policies.[11]

Challenges local governments face responding to climate change

10.10 This section discusses some of the key challenges local governments encounter in planning for, and responding to, the implications of climate change for houses, other buildings and infrastructure.

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8 See City of Darwin, 'Climate Change', www.darwin.nt.gov.au/live/welcome-to-darwin/climate-change/reducing-impact (accessed 26 March 2018).

9 Eastern Alliance for Greenhouse Action, *Climate change adaptation roadmap for Melbourne's east: A guide for decision makers in the EAGA Councils.* Eastern Alliance for Greenhouse Action, *Submission 13*, p. 2.

10 Australian Local Government Association, *Submission 12*, p. 3.

11 Mr Paul Grech, Director, Land Use Planning, Floodplain Management Australia, *Committee Hansard*, 23 November 2017, p. 5.

Resources available to local governments

10.11 The Local Government Association of Queensland (LGAQ) argued that the resources available to local governments to build and maintain infrastructure are inadequate. A particular concern is that vertical fiscal imbalance results in local governments encountering the greatest relative disparity between public sector revenue and non-financial asset responsibilities.[12] Similarly, the Australian Coastal Councils Association (ACCA) highlighted the apparent mismatch between the amount of local government infrastructure exposed to climate change risks, and the resources that local government have to carry out effective adaptation to manage these risks. The ACCA commented:

> Responsibility for planning and managing coastal assets to minimise climate risks to a major portion of Australia's population and assets is largely left to local councils. The local government sector is the level of government with least resources available to undertake such an enormous task, both in terms of funding and a shortage of appropriate professional resources.[13]

10.12 Local governments have limited revenue-raising ability. The LGAQ explained that, under state legislation, the sources of revenue available to local governments in Queensland are 'largely limited to what the local community can bear in terms of rates and fees for services'.[14] Ms Emma Herd from the Investor Group on Climate Change (IGCC) noted that many local governments 'do not have the ability to raise rates because state governments have capped their rate raising ability'. Ms Herd commented:

> So even if they have identified the potential for measures that they can take to increase the resilience of their area, they don't have the ability to raise the capital because they are not allowed to raise rates so then it becomes a state issue, which was what we were saying before about the levels of responsibility.[15]

10.13 During the committee's public hearing in Melbourne, representatives of multiple Victorian local governments provided examples quantifying the burden of climate change-related infrastructure projects for their councils. Mr William Millard from Hobsons Bay City Council advised that, in 2017, $1.5 million out of the council's total annual capital works budget of $35 million was spent on revetment works to defend against storm surge and extreme weather events.[16]

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12 Local Government Association of Queensland, *Submission 11*, p. 9.

13 Australian Coastal Councils Association (ACCA), *Submission 61*, p. 5.

14 Local Government Association of Queensland, *Submission 11*, p. 8.

15 Ms Emma Herd, Chief Executive Officer, Investor Group on Climate Change (IGCC), *Committee Hansard*, 23 November 2017, p. 19.

16 Mr William Millard, Director, Strategic Development, Hobsons Bay City Council, *Committee Hansard*, 15 March 2018, p. 22.

10.14 Mr Millard noted that 'there is a lot more that needs to be done, of course'. He added:

> We've just invested in some research on our drainage elements and the current status of those assets. We spent $1 million just on the review of all the drains so that we have an understanding of where those hot spots are, if you like, and where we need to invest. If you take a trip along Pier Street, Altona, along the foreshore, you'll see a number of quite significant drainage works that we've done to cater for better release of floodwaters from on land. It's an ongoing and significant battle in a resourcing sense.[17]

10.15 Councillor Richard Ellis from East Gippsland Shire Council noted that the cost of repairing or upgrading a seawall that protects a town of around 7000 people in Gippsland, Victoria, ranges from $2500 to $4000 per cubic metre. Accordingly, Councillor Ellis advised that repairing two seawalls of around 30 metres and 85 metres will cost the local government 'hundreds of thousands of dollars'.[18]

10.16 Mr Brett Walters from the City of Port Phillip informed the committee that works to change drainage infrastructure to relieve flooding risks in four local government jurisdictions would cost $500 million.[19]

10.17 Councils' limited financial resources have flow-on consequences for the number of staff members who can be allocated to climate change-related issues. Mr Andrew Petersen from Sustainable Business Australia noted that often councils have one climate resilience officer at most in their planning department, and those officers can still have other responsibilities.[20] It was also noted that local governments in rural areas are at a disadvantage when considering allocating resources for sustainability officers, compared to local governments that serve more densely populated urban areas.[21]

10.18 The LGAQ reasoned that the current financial arrangements impede the timely adaptation of infrastructure to climate change. The LGAQ argued that addressing this would require the Australian Government to recognise that the tax revenue share available to local governments needs to increase relative to the value of assets for which they are responsible.[22]

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17 Mr William Millard, Hobsons Bay City Council, *Committee Hansard*, 15 March 2018, p. 22.

18 Councillor Richard Ellis, Committee Member, ACCA, *Committee Hansard*, 15 March 2018, p. 23.

19 Mr Brett Walters, Manager, Sustainability and Transport, City of Port Phillip, *Committee Hansard*, 15 March 2018, pp. 22–23.

20 Mr Andrew Petersen, Chief Executive Officer, Sustainable Business Australia, *Committee Hansard*, 23 November 2017, p.12.

21 Mr Brett Walters, City of Port Phillip; Ms Dominique La Fontaine, Executive Officer, South East Councils Climate Change Alliance (SECCCA), *Committee Hansard*, 15 March 2018, p. 37.

22 Local Government Association of Queensland, *Submission 11*, p. 9.

Comments on allocation of responsibilities

10.19 Councils also highlighted how the unclear division of responsibilities between state and local governments has implications for climate change adaptation. For example, the South East Councils Climate Change Alliance (SECCCA) advised that, in Victoria, it is not clearly defined where responsibility lies for the protection of coastal assets.[23]

10.20 In arguing for a national approach to climate change adaptation (see Chapter 9), Ms Emma Herd from the IGCC commented that local governments have used scientific research and tools to undertake planning and risk assessment work, however, after identifying the risks it often becomes evident that they 'don't have the capacity to then take the next step and respond'. Ms Herd stated:

> So I think part of that national framework is that we need to bring it all together and to have that clear line of sight of who does which part of the puzzle and then which agency or which private industry sector then picks up the next part and has the responsibility for the next part of it in a much more integrated way.[24]

10.21 Local governments also argued that they need to be involved in policy development in order to assist the policies to achieve their objectives and so that their obligations are clearly understood. The LGAQ argued that if the Australian Government decides to develop climate change adaptation legislation and policies, extensive consultation with local governments should be undertaken 'to ensure obligations on local governments are reasonable and implementable'.[25]

Concerns about exposure to liability

10.22 Local governments expressed concerns about the risk of legal liability they might face due to climate change. The LGAQ explained that local governments 'carry exposure to increased risk of legal liability should they fail to take reasonable steps to consider and mitigate the effects of climate change on their communities'.[26]

10.23 Dr Karl Mallon from Climate Risk noted that local governments could face claims for compensation based on 'injurious affection' based on changes to planning schemes. For example, Dr Mallon commented that:

> …if the council puts out a report that shows the flood plain with climate change and you are on the wrong side of that line you can sue. You can say

23 SECCCA, *Submission 30*, p. 3.

24 Ms Emma Herd, IGCC, *Committee Hansard*, 23 November 2017, p. 17.

25 Local Government Association of Queensland, *Submission 11*, p. 7.

26 Local Government Association of Queensland, *Submission 11*, p. 5.

> that your property has gone down in value and you have to pay me the difference.[27]

10.24 Dr Mallon added that a potential consequence of this is that councils could undertake work on climate change risks but refuse to release their findings to utilities to assist them with planning. Dr Mallon suggested that providing councils with clear legal protection to share information with utilities could help to protect future infrastructure and property buyers.[28]

10.25 Mr Alan Stokes from the ACCA advised that a concern shared by members of his organisation is 'the legal position faced by councils when they're addressing development applications for a building or a house that they realise might be affected and vulnerable to inundation in the future'. Mr Stokes explained that councils are 'caught in a dilemma' because:

> …if they refuse the development application then the chances are it'll be taken straight to the Land and Environment Court or the Administrative Appeals Tribunal; if they approve it, and the construction goes ahead, then there's a potential liability down the track if it is inundated. So, in a sense, they're damned if they do and they're damned if they don't.[29]

10.26 Evidence given by Mr Brett Walters from the City of Port Phillip supported this observation. Mr Walters commented:

> If local governments are required to address climate risk in that way, there's a nexus with the planning scheme. Council makes decisions on allowing a development to occur based on the requirements of the planning scheme and, if the planning scheme is silent on the ability to refuse a building application because there's a known inherent climate risk, council doesn't have the ability to rule against it because it's not in the planning scheme. It's a catch 22.[30]

10.27 Mr Stokes explained that section 733 of the *Local Government Act 1993* (NSW) can indemnify local governments that make planning decisions based on good faith relating to flood liable land, land subject to bushfire risks and land in the coastal zone. Mr Stokes advised that similar provisions do not exist in equivalent legislation in other state and territory jurisdictions.[31] Similarly, the Housing Industry Association (HIA) commented that the Australian and state governments could legislate to

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27 Dr Karl Mallon, Director, Science and Systems, Climate Risk Pty Ltd, *Committee Hansard*, 23 November 2017, p. 6.

28 Dr Karl Mallon, Climate Risk Pty Ltd, *Committee Hansard*, 23 November 2017, p. 6.

29 Mr Alan Stokes, Executive Director, ACCA, *Committee Hansard*, 15 March 2018, p. 24.

30 Mr Brett Walters, City of Port Phillip, *Committee Hansard*, 15 March 2018, p. 33.

31 Mr Alan Stokes, ACCA, *Committee Hansard*, 15 March 2018, p. 25.

'give local government comfort' about planning decisions regarding the construction of new buildings when climate change is a consideration.[32]

10.28 Representatives of the Law Institute of Victoria were questioned by the committee about the liability of government authorities to climate change issues. In response, they advised that the issue is 'complex'. Dr Leonie Kelleher explained:

> There is a difference between the corporation and the government entity in law…There's a principle of reasonableness: if one is suing a government entity, has that government entity acted reasonably? If one is suing for negligence, for example, was it a foreseeable risk, and did the authority act reasonably? There's a recent body of law…which is that, if there's a financial constraint on a government authority that applies across all government authorities, the authority may not have acted unreasonably in not doing something about it. Here in Australia, with the concerns of that body of precedent law, it would be extremely important in any new legislation to, if you like, kill that and not allow that defence to apply. Where you've got your company directors and your corporations, that issue of whether a reasonable authority constrained by financial constraints is able to do X, Y and Z does not apply, or may not apply, in that situation. But it's an increasingly problematic issue when one's seeking to take action against an authority.[33]

10.29 Dr Kelleher emphasised that when considering legal implications for local government, there is 'major distinction between a duty—the authority must do X or Y—and a power, where it may do A, B or C, depending on certain discretions'. Dr Kelleher suggested that these issues should be considered as part of comprehensive reform of Australia's environmental laws, noting that it is open to governments and parliaments to reduce complexity by creating 'crystal clear' legislation and policy settings.[34]

10.30 From the perspective of Queensland local governments, the LGAQ called for indemnity from liability under the *Local Government Act 2009* (Qld).[35] The committee was also advised that a review of local government legislation in Victoria is considering whether councils should be specifically required to have regard to mitigation and planning for climate risk.[36]

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32 Ms Kristin Brookfield, Chief Executive, Industry Policy, Housing Industry Association, *Committee Hansard*, 22 March 2018, p. 10.

33 Dr Leonie Kelleher, Member, Environmental Issues Committee, Law Institute of Victoria, *Committee Hansard*, 15 March 2018, p. 16.

34 Dr Leonie Kelleher, Law Institute of Victoria, *Committee Hansard*, 15 March 2018, p. 16.

35 Local Government Association of Queensland, *Submission 11*, p. 4.

36 Ms Dominique La Fontaine, SECCCA, *Committee Hansard*, 15 March 2018, p. 33.

10.31 Finally, the link between legal obligations and resourcing was also noted. It was suggested that if a state government imposes a statutory obligation on local governments to plan for and act on climate risk, the state government then needs to ensure that local governments are provided with adequate 'resourcing and capacity' to comply with this obligation.[37]

Other factors that might deter action

10.32 Based on his experience dealing with local governments, Mr Paul Grech from the FMA advised the committee that councils are generally hesitant to develop climate change policies for two key reasons. The first is to avoid being the 'bearer of bad news' to property owners in their jurisdiction. The second reason is due to concerns about competition between different council regions—that is, councils are disinclined to take actions that neighbouring councils are not taking if doing so could affect land values or make their region less competitive for new development. To overcome this, Mr Grech reasoned that mandatory requirements imposed by state governments are needed so that all councils are required to identify risks, develop strategies and implement actions to improve resilience to climate change.[38]

10.33 Likewise, Professor Lesley Hughes of the Climate Council of Australia commented that, without clear signals from higher levels of government, neighbouring local governments facing similar risks can respond in significantly different ways, often simply because of 'the views of the particular councillors at the time'.[39]

10.34 It was also noted that constituents of local governments might not support actions being taken by their council. Ms Kristin Brookfield from the HIA provided the following example illustrating this potential outcome:

> Lake Macquarie City Council in New South Wales invested a significant amount of time and money to map their area—obviously this week they've been subject to flooding—and then they went down the path of developing a new construction code for properties which they deemed would be affected. They implemented that for a few months and, in the end, their own constituents came back to them and said: 'No, we think you've overstepped. We think you're trying to make us do too much, too soon.' So they went back some time later and changed that code. I'm not saying whether that's right or wrong, but that's the response that was given by those constituents to that council.[40]

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37 Ms Dominique La Fontaine, SECCCA, *Committee Hansard*, 15 March 2018, p. 33.

38 Mr Paul Grech, Floodplain Management Australia, *Committee Hansard*, 23 November 2017, p. 5.

39 Professor Lesley Hughes, Councillor, Climate Council of Australia, *Committee Hansard*, 23 November 2017, p. 31.

40 Ms Kristin Brookfield, Housing Industry Association, *Committee Hansard*, 22 March 2018, p. 11.

Conclusion

10.35 This report has presented an overview of the various challenges and potential policy options relating to the current and future impacts of climate change on housing, buildings and infrastructure. The committee considers that this report, and the detailed evidence taken during this inquiry, will be a valuable resource that assists senators, policymakers and others to understand the issues at hand.

10.36 As noted in Chapter 1, members of the committee have expressed their own views in additional comments attached to this report. The committee thanks all the individuals and organisations that participated in this inquiry.

Senator Janet Rice
Chair

Australian Greens' additional comments

1.1 Climate change will have severe consequences that will intensify in the coming years and decades. However, these developments are not all in the distant future. For example, as recent summers in Australia have shown, hot days and heatwaves are already more frequent and more severe.

1.2 This inquiry has clearly established that climate change is putting substantial numbers of Australia's buildings and infrastructure assets at risk. Damage and disruption to these assets will have significant implications for the liveability of our communities and cities, and for our economy.

Need for mitigation

1.3 The Australian Greens have developed a range of recommendations focused on how the Australian Government can guide the built environment sector and infrastructure owners to become more climate-resilient, taking into account the various interdependencies that are key features of critical infrastructure systems.

1.4 However, without strong global action being taken urgently to reduce greenhouse gas emissions there is an appreciable risk of catastrophic consequences to which we will be unable to adapt. While adaptation is critical, there are clear dangers in assuming that all climate scenarios of capable of being adapted to. The existential risk to society as we know it, both in Australia and globally, is real and must be faced. Therefore, the Australian, state and territory governments must ensure that both effective mitigation and adaptation measures are taken.

1.5 Accordingly, the Australian Greens urge the Australian Government to:

- commit to Australia reaching net zero greenhouse gas emissions by 2040;
- adopt additional negative emissions goals to drawdown greenhouse gas emissions; and
- implement effective policy measures to achieve the net zero target and negative emissions goals.

1.6 A national target for reaching net zero greenhouse gas emissions would follow the examples set by states such as New South Wales, Victoria, Queensland and Tasmania.

Recommendation 1

1.7 That the Australian Government commit to a target of net zero greenhouse gas emissions for Australia by 2040 and the actions necessary to achieve this target.

Informing better decision-making

1.8 To enable communities, business and governments to make informed decisions about climate change adaptation, it is of critical importance for up-to-date assessments of climate risks to infrastructure to be available, including estimates of the value of the assets at risk. Current figures relating to risk from sea level rise are from 2011 and based on 2008 values—this is not adequate for decision-making today.

1.9 Accordingly, the Australian Government should fund the preparation of a National Climate Change Risk Assessment, which would be updated at regular intervals. The newly established ARC Centre for Excellence for Climate Extremes could support the development of the risk assessment. Furthermore, Infrastructure Australia would be well placed to undertake a national audit of at-risk infrastructure.[1]

1.10 In undertaking a climate risk assessment, however, it is essential to consider extreme risks and worst-case scenarios. There is a consistent pattern of projections underestimating climate risks. Fundamentally, it is better for adaptation measures to be capable of withstanding the gravest scenarios rather than risking that the measures will be insufficient. To provide clear guidance to decision-makers, planners and policymakers that they should ensure their adaptation measures are capable of being resilient in the worst of the possible foreseeable circumstances, the Australian Government should acknowledge that IPCC scientific assessments are conservative and might underestimate the extent and of climate risks. As a related matter, Australian Government policies and actions relating to climate change should reflect the possibility that current projections might not account for the speed or extent of climate change.

1.11 Finally, the Australian Greens urge the Australian Government to review the allocation of funding providing for climate change research, with a view to providing ongoing support to the NCCARF and increasing funding to key agencies such as CSIRO for research into climate extremes.

Recommendation 2

1.12 That the Australian Government fund the preparation of a National Climate Change Risk Assessment that includes assessments of extreme risks and worst-case scenarios for Australia's built environment. This assessment should be updated regularly, such as every five years.

1 Infrastructure Australia's statutory functions include conducting audits to determine the adequacy, capacity and condition of nationally significant infrastructure, taking into account forecast growth as well as economic, social and environmental sustainability. *Infrastructure Australia Act 2008*, s. 5.

Recommendation 3

1.13 That the Australian Government commission and fund Infrastructure Australia to lead a national audit of at-risk infrastructure including, but not limited to, the following areas:

- **road and rail networks;**
- **ports and airports;**
- **water, stormwater and irrigation infrastructure;**
- **electricity generation, transmission and distribution infrastructure;**
- **telecommunications infrastructure;**
- **housing and building infrastructure, including the policies and standards underpinning the planning, development and construction of buildings and communities; and**
- **coastal defences.**

Recommendation 4

1.14 That the Australian Government provide:

- **ongoing funding to support the National Climate Change Adaptation Research Facility; and**
- **additional funding to CSIRO and other relevant Commonwealth agencies to support further research into climate extremes.**

Urban and coastal planning

1.15 In considering the evidence received about urban and coastal planning, it is clear that taking measures to adapt to climate change in the near-term will ultimately be fairer and more cost effective than delaying action. All levels of government can promote this by developing planning strategies and taking planning decisions that are appropriate given the known risks of climate change. The Australian, state and territory governments should also ensure that statutory frameworks governing planning decisions require climate change to be considered.

1.16 Evidence received during this inquiry strongly supports the development of nationally consistent and authoritative benchmarks and guidelines regarding key climate change risks, such as sea level rise, rainfall and the management of flood-risk. Regional variations will be required and nationally consistent guidance should not impede effective local responses. However, key stakeholders presented a compelling argument that a more consistent approach to these issues would encourage more effective planning and adaptation.

1.17 Furthermore, the Australian Greens question some of the current assumptions used in planning, particularly the projected sea level rise of 0.8 metres by 2100. Assumptions such as this appear inadequate for risk management. As discussed above, for climate change adaptation to be effective there is a need for governments and other

decision-makers to plan for extreme or worst case scenarios. The current approach taken in Australia is in contrast to the scenarios used to inform planning elsewhere, such as the US Army Corps of Engineers' recommendation that a global mean sea level rise scenario of 1.5 metres by 2100 be used for planners, with a 2.0 metre rise being a 'credible upper bound'.[2]

Recommendation 5

1.18 That the Australian Government lead the development of nationally consistent benchmarks and guidelines on climate risks, particularly sea level rise, for use as part of state and local government planning decisions. The benchmarks and guidelines should be based on comprehensive scientific assessments and include consideration of worst-case scenarios and climate extremes.

Recommendation 6

1.19 That an overarching objective regarding the need to effectively plan for climate change be included in all state and territory planning legislation.

1.20 Including specific references to climate change in planning legislation should encourage better outcomes in a range of matters; however, there is also a need for governments to take specific actions regarding land-use planning and climate risks in the urban environment.

1.21 There is a range of options available to governments that can be taken immediately, including planting trees to reduce urban heat, setting targets for cities to reuse rainwater, and considering innovative approaches such as the use of lighter coloured building and road surface materials. State, territory and local governments are taking such actions—the Australian Greens urge governments to continue pursuing successful urban design features such as these and that successful programs be replicated across the country. The Australian Government should support improved outcomes in this area by funding research to identify and quantify the benefits associated with measures to address urban heat.

Recommendation 7

1.22 That the Australian Government commission research to enhance the information available to policymakers regarding the full range of social and economic costs associated with heat stress.

1.23 In particular, the Australian Government should commission research to estimate the potential health system savings and other economic benefits that

2 Center for Climate and Security, *Military Expert Panel Report Sea Level Rise and the US Military's Mission*, 2nd edition, February 2018, https://climateandsecurity.files.wordpress.com/2018/02/military-expert-panel-report_sea-level-rise-and-the-us-militarys-mission_2nd-edition_02_2018.pdf (accessed 2 May 2015), p. 16 (citation omitted).

could be realised by taking measures to reduce the severity of the urban heat island effect.

1.24 Finally, it is necessary to address retreat as a means to manage key climate risks, particularly sea level rise. Managed retreat, such as requiring new development to occur further away from the shore, is an effective form of adaptation to minimise the costs that will ultimately be incurred. It is acknowledged that the concept of retreat is a difficult subject for local and state governments to consider. However, it would be negligent of these governments not to contemplate and plan for this contingency.

1.25 The Australian Government also has an interest in ensuring that managed retreat strategies are developed. In particular, this is due to the financial support it provides as part of the Natural Disaster Relief and Recovery Arrangements—it follows that there is an incentive for the Australian Government to ensure that natural hazard risks are minimised. In addition, the Australian Government can support decisions in this policy area by involving national scientific institutions such as CSIRO. Accordingly, the Australian Government should initiate discussions with state, territory and local governments about planning for managed retreat (it is noted that some jurisdictions, such as Western Australia, have published strategies addressing this issue).

Recommendation 8

1.26 That the Australian Government request state and territory governments to ensure effective coastal retreat strategies are developed in their jurisdictions. To inform the development of these strategies, the Australian Government should ensure that the state and territory governments have ready access to expert advice from relevant Australian Government departments and agencies.

Building design

1.27 As this report has established, climate change presents an array of risks to the structural integrity of dwellings and commercial buildings in Australia. Extreme heat events and other natural hazards linked to climate change also risk the health of building occupants. Although minimum building requirements have been enhanced at various times for new buildings, it is clear that the overwhelming majority of dwellings in Australia could be more resilient to climate risks. Taking effective action to address these issues now is necessary for the health and safety of building occupants, as well as to minimise the extent of change that will inevitably be required in future.

1.28 Heatwave events are of particular concern. Policymakers and homeowners take measures to reduce risks associated with extreme events such as bushfires, flooding and cyclones. However, heatwaves are Australia's deadliest natural hazard and the number of deaths from heatwaves (such as the 374 deaths associated with the 2009 Melbourne heatwave) is not widely recognised. Similarly, inadequate attention appears to be given to how the internal temperatures in many buildings can reach unsafe levels for sustained periods.

1.29 Australians are fortunate to have a robust framework for ensuring that new buildings and new building work on existing buildings are subject to appropriate minimum requirements. To help guide effective climate change adaption, the Australian Greens have developed recommendations intended to assist the development of appropriate enhancements to building standards. In particular, additional research should be commissioned urgently to better understand the connections between heat stress and building design to inform evidence-based policy development.

Recommendation 9

1.30 That the Australian Government request that the Australian Building Codes Board develop minimum requirements for the National Construction Code that are specifically designed to address heat stress risks associated with internal temperatures.

1.31 To facilitate the development of amendments to the National Construction Code, it is further recommended that the Australian Government provide funding for research into:

- **how overheating in highly rated energy efficient dwellings can be created where there can be inadequate ventilation; and**
- **the behaviour of building occupants during heatwave periods.**

Recommendation 10

1.32 As part of the research into the full range of social and economic costs associated with heat stress called for in recommendation 7, estimates should be developed of the potential health system savings and other benefits that could be realised through enhanced building standards. In particular, the research should consider the benefits associated with retrofitting low efficiency dwellings to keep internal temperatures within safe ranges during extreme heat events.

1.33 Governments have a key role in ensuring adequate information is available to assist informed decision-making by homeowners and tenants. This includes developing programs to encourage retrofitting of existing dwellings. For the jurisdictions that already have such programs, given the scale of the challenge climate change presents for Australia's dwelling stock, further work could be undertaken to encourage greater participation in them.

1.34 In addition, governments should ensure that prospective owners of dwelling and tenants are provided with information to assist them to understand and compare the energy efficiency of different buildings. Disclosure of such information is already required in the Australian Capital Territory and should be mandatory across Australia.

Recommendation 11

1.35 That all state and territory governments develop educational resources and introduce or expand existing financial incentive programs designed to

encourage homeowners to undertake cost-effective retrofitting of existing dwellings.

Recommendation 12

1.36 That all state and territory governments legislate to require that an energy rating measuring passive energy performance must be disclosed to prospective buyers and tenants when a residential property is offered for sale or is available to rent.

1.37 The Australian Greens have also considered whether governments should identify a target date by which all existing dwellings would be required to be of a suitable standard for addressing any significant heat risks associated with their local climate. Given the projections available about the increased frequency of heatwave events in Australia's major urban centres, such a response would be appropriate for ensuring adaptation efforts keep pace with the changing climate.

1.38 The preceding recommendations about building standards, research and education should be implemented as a starting point. As a next step, policymakers should then identify an appropriate measurement of heat stress in residential buildings and how comparisons about heat stress can easily be made, either through existing building rating systems or as part of a new system. Following this, an appropriate deadline for building owners and the building industry to reach an identified minimum rating could be developed, with exemptions potentially available for certain types of buildings such as heritage buildings. Given that governments know that millions of homes across Australia are not suitable for extreme heat events, it would be irresponsible for those governments not to take all reasonable actions to ensure their citizens' living spaces are safe in a warming climate.

Recommendation 13

1.39 That state and territory governments consider whether to set a deadline by which all residential properties for sale or rent in their jurisdiction must meet a prescribed energy rating.

1.40 Finally, government should lead by example. For example, governments can contribute to climate change adaptation through procurement decisions, such as by requiring new office space to meet higher standards than the minimum required under the National Built Environment Rating System. Other buildings managed by the government should also be retrofitted to make them more resilient to climate risks. There is a particular need to assist people in public housing who rely on governments to provide safe living conditions.

Recommendation 14

1.41 That the Australian, state and territory governments require that new office space used in the public sector meet high standards of climate resilience and sustainability, including higher energy efficiency standards than the minimum required under the National Built Environment Rating System.

Recommendation 15

1.42 That state and territory governments invest in measures to improve energy efficiency and to reduce heat stress risk in public housing.

Transport and utilities

1.43 Decisions about transportation and utilities infrastructure involve all levels of government. Given the long economic lives intended for these assets, and the recovery of costs from customers, decisions about these types of infrastructure have implications for generations of Australians. Accordingly, these decisions need to be taken with care, following best practice approaches and informed by the most up-to-date scientific information available about climate change projections.

1.44 As discussed above, a key role for the Australian Government is ensuring that reliable information about climate risks is available to inform decision-making. However, the Australian Government could also perform a leadership role in promoting a best practice approach to infrastructure projects. In particular, the Australian Government should engage with key organisations in the built environment sector to encourage effective post-project reviews to be conducted in order to learn from decisions made about climate-related risks.

Recommendation 16

1.45 That the Australian Government work with organisations representing the built environment sector to identify options for ensuring that robust post-project reviews of infrastructure projects are conducted.

Transport

1.46 Given the significant amounts of funding provided by the Australian Government for transportation projects, the Government is well placed to guide the development of climate resilient transportation networks throughout Australia. As a first step, the Australian Government should develop a national transportation plan to guide a transition to net zero emissions transportation. This would also support recommendation 1 regarding net zero emissions by 2040 for all sectors of the economy.

1.47 Although examples such as the Brisbane Airport Parallel Runway Project are encouraging, other evidence received during this inquiry suggests that climate risks are generally not well accounted for as part of transportation projects. Developing a national transportation plan would provide an opportunity to ensure best practice decision-making around climate risks occurs for all transportation projects. Ideas for how the climate risks that existing assets face could be managed more effectively could also be progressed as part of the development of the plan.

Recommendation 17

1.48 That the Australian Government develop a national plan for passenger and freight transport that:

- **outlines a transition to net zero emissions transport; and**
- **ensures decision-making and planning processes for transportation infrastructure projects are appropriate in the face of climate change.**

Water infrastructure

1.49 It is acknowledged that state and territory governments have given attention to the need to secure climate resilient water supplies. It is also recognised that water infrastructure in Australia generally provides a reliable and suitable service. Nevertheless, climate change will present further challenges that state and territory governments will need to address. With ageing water infrastructure assets in many cities and the need to build and maintain infrastructure assets to service a growing population, it is timely to consider these issues.

1.50 Growing urban populations and the expectation of more intense rainfall events due to climate change will require a different approach to planning water infrastructure assets and systems. In particular, it is no longer appropriate to rely on historical rainfall events when designing water infrastructure. Future climate projections need to influence asset design requirements.

1.51 State and territory governments should also ensure that state-owned water corporations and local governments have the resources necessary to undertake effective maintenance of existing water, sewage and stormwater assets. In addition, state governments should develop an overarching plan to ensure that adequate renewal of these assets occurs.

1.52 To support state governments to achieve better outcomes in the water sector, there is also a role for the Australian Government, through agencies such as CSIRO and the Bureau of Meteorology, to ensure state governments and entities designing water sector assets have access to reliable climate-related information to inform infrastructure design.

Recommendation 18

1.53 That state and territory governments:

- **require the design of new water supply, sewerage, sewage treatment and stormwater assets to be informed by reliable climate projections as well as historical data; and**
- **ensure state-owned water corporations and local governments have the resources and support necessary to undertake effective maintenance of water supply, sewerage, sewage treatment and stormwater assets.**

Recommendation 19

1.54 That the Australian Government support state governments to ensure that water sector assets are climate resilient by offering ongoing access to advice from Commonwealth scientific agencies on relevant climate risks.

Electricity infrastructure

1.55 It is clear that a transformation has been underway for some time in the electricity sector with the growth of renewable energy. The implications of climate change are also easier to imagine in this sector compared to others—heatwaves and bushfires already cause significant disruption and pressure governments to act. Consequently, the implications of climate change for the energy market have received significant attention. Government policy, however, has not been consistent—this lack of policy certainty has understandably attracted criticism.[3]

1.56 The electricity sector is undergoing fundamental change through the growth of renewable energy generation and the successful introduction of supporting technologies such as large-scale energy storage. Although clean energy and reform of the electricity sector is essential for addressing climate change and reducing electricity costs, it is also a necessary response to the matters examined by this inquiry. For example, a more decentralised electricity network would help overcome many of the climate change-related risks to existing electricity infrastructure, such as how extreme weather events can damage key transmission or distribution assets and cause widespread outages. It is critical that regulatory arrangements are updated to facilitate the development of a clean energy system, including by facilitating decentralisation.

1.57 As a first step, the National Electricity Objective contained in the National Electricity Law should be amended to progress the transition of the energy market to clean energy and to support Australia's obligations under the Paris Agreement. At present, the Objective focuses on the long-term interests of electricity consumers regarding price, quality, safety, reliability and security of supply.[4] It is, however, also in the long-term interests of energy consumers that the electricity sector responds effectively to climate change in a way that guarantees a secure and affordable supply of electricity.

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3 See, for example, Investor Group on Climate Change, 'Investors need certainty on carbon policy for the energy sector', *Media release*, 9 October 2017, https://igcc.org.au/wp-content/uploads/2017/10/IGCC-MR-Response-to-CET.pdf (accessed 24 April 2018); Business Council of Australia, 'Energy and climate change', www.bca.com.au/policy-agenda/energy-and-climate-change (accessed 24 April 2018).

4 At present, the National Electricity Objective states: 'The objective of this Law is to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to: (a) price, quality, safety, reliability and security of supply of electricity; and (b) the reliability, safety and security of the national electricity system'. *National Electricity (South Australia) Act 1996* (SA), s. 7.

1.58 Referring to clean energy in the National Electricity Objective would provide a clear statement of the Australian, state and territory governments' intentions for the electricity sector to support the reduction of Australia's emissions. This would provide the sector with the long-term certainty needed to inform business investment decisions. The Australian Greens believe that the Objective should be amended to require the sector to transition to net zero emissions by 2030, with this revised Objective supported by strategies to encourage a transition to 100 per cent renewable energy across Australia.

1.59 The Australian Greens also consider that an overarching national transition plan for Australia's electricity system is also urgently required. The Government should prioritise the development of a national transition plan that includes consideration of innovative approaches to support renewable energy and the decentralisation of the electricity networks, such as local energy trading.

Recommendation 20

1.60 That the Australian Government pursue, through the Council of Australian Governments Energy Council, amending the National Electricity Objective to require the electricity sector to reach net zero emissions by 2030.

Recommendation 21

1.61 That the Australian Government develop a comprehensive energy transition plan that includes:

- **reform of the National Electricity Market rules and revised tariffs to support the growth of renewable energy and ensure networks are prepared to efficiently respond to changes in the energy market;**
- **a mechanism for the orderly retirement of coal fired power stations; and**
- **innovative approaches to enable peer-to-peer energy trading.**

Recommendation 22

1.62 That the Australian Government:

- **continue and expand the Renewable Energy Target beyond 2020 and consider adopting renewable energy reverse auctions, such as those adopted by the Australian Capital Territory and Victoria, to bring more new generation into the National Electricity Market;**
- **adopt a National Energy Storage Target of 20 gigawatts of multi-hour storage by 2030;**
- **ensure regulatory arrangements support the continuing deployment of grid level battery storage and household solar and battery storage technologies; and**
- **commit to not providing any direct funding, subsidies or other support for the construction of new coal fired power stations in Australia.**

Health, education and public recreation

1.63 Many of the preceding recommendations are relevant to addressing the issues discussed in this chapter. In particular:

- addressing fundamental issues with building design and urban planning will relieve some of the climate-related adaptation pressures that the health, education and other sectors face;
- the research called for in recommendation 7 to enhance the information available to policymakers regarding the full range of social and economic costs associated with heat stress should include an assessment of the potential savings to the health system; and
- actions to address the urban heat island effect would also be beneficial for public health.

1.64 In addition, there is a need for an overarching national strategy for managing the implications of climate change for human health. The strategy should support planning to enable the health system to adapt and meet the increasing demands it will face due to climate change. As part of this strategy, particular consideration should be given to ensuring that health services are resilient to extreme events, and to the resources the health care sector will require to cope with extreme heat events.

Recommendation 23

1.65 That the Australian Government work with the state and territory governments to develop a national climate change and health strategy.

1.66 The Australian Greens have also developed recommendations relating to health, education and public recreation infrastructure for state and territory governments to consider. The first is straightforward—state and territory governments should require that new health and education facilities not be built in at-risk areas and that the new buildings are highly resilient to climate risks such as extreme temperatures. Similarly, when existing facilities in at-risk areas require replacement, they should be relocated.

1.67 State and territory governments also should develop dedicated programs to ensure that vulnerable populations with specific health needs live in dwellings that can provide safe internal temperatures. In addition to supporting better health outcomes for residents, such programs could reduce the costs incurred in the health system. The Victorian Government's Healthy Homes Program potentially provides a useful model that could be expanded on and adopted elsewhere.

Recommendation 24

1.68 That state and territory governments require proposals for new health and education facilities to be subject to rigorous assessment of climate-related risks, including the risks associated with the proposed location and building design.

1.69 It is further recommended that state and territory governments commence planning to ensure that facilities in high-risk locations that are nearing the end of their useful life are replaced with new facilities in more suitable locations.

Recommendation 25

1.70 That:

- **the Victorian Government's Healthy Homes Program be expanded to cover all of Victoria; and**
- **other state governments introduce programs similar to the Healthy Homes Program to reduce the climate-related health risks faced by low-income individuals with complex healthcare needs.**

Recommendation 26

1.71 That state and territory governments work with local governments and water authorities to increase the use of rainwater, stormwater, recycled water and other water sources to maintain the green infrastructure used for public recreation.

Government decision-making frameworks

1.72 As this report has established, climate change presents significant and inevitable risks for many buildings and infrastructure assets in Australia. It is incumbent on the Australian, state and territory governments to ensure that legislation relating to environmental and planning decisions is appropriate to account for the inevitable consequences of climate change. Furthermore, effective strategies and policy measures need to be in place to facilitate successful mitigation and adaptation.

1.73 Some state and territory governments have developed comprehensive responses to climate change through legislation, strategies, planning policies and grants programs. Nevertheless, there is much more work to be done. Both state government strategies and many submissions to this inquiry have identified the same areas of concern. This suggests that action taken to date is insufficient. In particular, as discussed above, changes to planning frameworks will be required, including the need for planning decisions to account for worst-case scenarios rather than conservative projections. Ensuring that state and territory government actions are effective will also require ongoing commitment by these governments and regular critical assessment of progress.

1.74 Regrettably, the approach taken at the Commonwealth level has clearly been inadequate for meeting the challenge that climate change presents. Successive Australian governments have varied significantly in their approach to climate change. Ratification of the Paris Agreement is a promising development, but overall it appears we are in a lost decade of national climate policy. Most notably, the repeal of the price on carbon pollution and the abolition of the independent Climate Commission by the

Abbott Government are standout examples of the Australian Government failing to secure a safe, clean future for future generations.

1.75 There is an urgent need for the Australian Government to provide strong, consistent leadership on climate change mitigation and adaptation. Actions by state and local governments, business and communities are impeded by the lack of a comprehensive national response.

1.76 In particular, the Australian Government can provide much-needed leadership by replacing the ineffective National Climate Resilience and Adaptation Strategy with a comprehensive and ambitious national strategy. To ensure the new strategy is developed effectively, the Department of the Prime Minister and Cabinet should lead a whole-of-government approach to its preparation. In many respects, this process would be akin to that underway to develop Australia's first Voluntary National Review on the 2030 Agenda for Sustainable Development and the Sustainable Development Goals.

1.77 National leadership and coordinated action on climate change across all areas of government policy and the economy could also be facilitated by establishing a COAG Council on climate change. A permanent multijurisdictional body is needed to coordinate action by all Australian governments. As climate change is an issue of critical national importance, it is appropriate for this body to be part of the COAG framework.

1.78 Other initial steps that the Australian Government should take include:

- reinstating an independent and adequately funded climate change commission to ensure decision-makers have access to authoritative advice on how to effectively adapt to climate change;
- committing funding to research activities needed to inform effective climate change adaptation; and
- ensuring that Commonwealth programs and payments such as those for natural disaster recovery build community resilience rather than simply restoring infrastructure to its previous standard.

Recommendation 27

1.79 That the Australian Government replace the National Climate Resilience and Adaptation Strategy with a comprehensive and ambitious national climate change mitigation and adaptation strategy.

1.80 This new whole-of-government strategy should contain sector-based national targets and timeframes for emissions reductions against which performance can be measured. The strategy should also incorporate strategies relating to transport (recommendation 17), energy (recommendation 21) and health (recommendation 23).

Recommendation 28

1.81 That, in addition to recommendation 6 on state and territory planning legislation, the Australian, state and territory governments review all environmental legislation to ensure that adequate consideration of the effects of climate change is expressly required as part of assessment and decision-making processes.

1.82 In particular, the introduction of a greenhouse trigger should be a key issue for consideration as part of the upcoming independent review of the *Environment Protection and Biodiversity Conservation Act 1999*.

Recommendation 29

1.83 That the Australian Government pursue the creation of a COAG Climate Change Council.

Recommendation 30

1.84 That the Australian Government establish an independent statutory authority to:

- **provide Australians with an independent and reliable source of information about climate change science; and**
- **assist stakeholders to understand and implement effective adaptation techniques, including by acting as a 'one stop shop' that can direct stakeholders to relevant Commonwealth departments and agencies.**

Recommendation 31

1.85 That the Australian Government's National Resilience Taskforce develop recommendations for the Government to consider that would facilitate more frequent betterment of assets that need to be reconstructed or repaired following natural hazards.

Local government

1.86 The Australian Greens are grateful to the local governments that participated in this inquiry for the valuable evidence they provided. This evidence has greatly informed our recommendations and emphasises the need for all governments to ensure climate risks to buildings and infrastructure are managed appropriately.

1.87 As local governments are at the frontline of responding to climate change, it is essential that they have the resources and knowledge necessary to carry out effective planning and adaptation activities. Certain local governments, such as the City of Melbourne, have developed comprehensive strategies and are taking a range of actions to improve the climate resilience of their jurisdiction. Generally, however, local governments do not have the financial resources and ready access to expert evidence needed to address climate risks. They can also face realistic threats of legal action by those dissatisfied with their decisions regarding climate risks. Furthermore, local

governments are in the unenviable position of needing to consider the short-term and long-term interests of their current constituents and future residents.

1.88 Many of the above recommendations are intended to assist local governments to develop successful climate change adaptation measures. However, questions regarding funding and liability are primarily matters for state governments to address. Under New South Wales legislation, exemptions for liability exist regarding decisions made by councils in good faith regarding flood liable land, land that might be affected by a coastline hazard and land that is subject to the risk of bushfire. Other state governments should introduce similar exemptions for their local governments.

1.89 Finally, the provision of sufficient financial resources for local governments to act on climate risks is of vital importance for enabling timely and least-cost adaptation. Local governments face practical and statutory restrictions on the revenue they can raise to pay for their activities. State governments must ensure local governments have adequate financial resources to address the threat of climate change. In addition, the Australian Government should provide specific purpose payments to the states to support local governments to adequately maintain and build climate resilient infrastructure. The new COAG Climate Change Council recommended above could consider an intergovernmental agreement to provide policy and operational guidance on the payments.

Recommendation 32

1.90 That state governments provide local governments with exemption from liability for decisions made in good faith relating to the use of land that is subject to climate change risks, such as flooding, coastal hazards and bushfires.

Recommendation 33

1.91 That the Australian Government provide specific purpose payments to the states to assist local governments to improve the resilience of infrastructure assets most at risk to climate change.

Conclusion

1.92 Unmitigated climate change will radically alter life in Australia, so it is vital that we prepare effectively and avoid a too-little-too-late response.

1.93 Without strong global action being taken urgently to reduce greenhouse gas emissions, there is an appreciable risk of catastrophic consequences to which we will be unable to adapt. While adaptation is critical, there are clear dangers in assuming that all climate scenarios are capable of being adapted to. The existential risk to society, both in Australia and globally, is real and must be faced.

1.94 Accordingly, it is essential that the Australian Government commit to stronger climate change mitigation. The current commitment to reduce emissions by 26 to 28 per cent below 2005 levels by 2030 is inadequate. Strong mitigation is essential, as

there are limits to the extent of climate change to which we can adapt, and many natural systems will not be able to evolve or adapt at the rate that would be required.

1.95 In addition to being ambitious in reducing emissions, we must ensure that our houses, communities, cities and infrastructure are more resilient to climate risks.

1.96 It is easy to envisage decision-makers falling into the trap of not prioritising adaptation because they are overwhelmed by, or have formed a fatalistic attitude towards, climate risks. Others might pursue limited measures based on conservative projections of climate risk. Both of these courses of action are irresponsible and unacceptable. Thoroughly planning for climate risks, particularly those that will be most severe in decades to come, is difficult when governments, businesses and individuals face other immediate pressures—but doing so is vital. Delaying action simply shifts the burden on to future generations, who will be forced to pursue more dramatic and costly adaptation measures.

1.97 The built environment sector, local governments and civil society have taken actions in response to climate risks. Several state and territory governments have also developed targets and strategies. It is time for the Australian Government to assist these efforts by providing greater leadership on how to adapt to climate change.

1.98 This inquiry has demonstrated the need for urgent action. With what is known about climate change, governments across Australia have a responsibility to their citizens to take effective action now. Business as usual is not acceptable.

Senator Janet Rice
Chair

Coalition Senators' additional comments

1.1 Coalition Senators note the content of the report and consider that the evidence provided will help inform consideration of these issues in the future.

1.2 Australia is well positioned to meet the challenge of climate change. Australia has mature financial, welfare and regulatory systems, well-governed institutions and internationally-recognised scientific expertise.

1.3 Coalition Senators make the following additional comments:

- The Australian Government is committed to playing its role in global efforts to reduce emissions. Australia has a strong track record of meeting its international emissions reduction commitments. We successfully beat our first Kyoto target by 128 million tonnes and are on track to meet and beat our 2020 target of five per cent below 2000 levels by 294 million tonnes.
- As part of the Paris Agreement, Australia has committed to reduce emissions by 26 to 28 per cent below 2005 levels by 2030. This will see Australia's emissions per person halve and the emissions intensity of our economy reduce by two-thirds. These reductions are among the largest of any major economy.
- The 2017 review of climate change policies concluded that the current policy suite, with some adjustments, provides the right approach to meeting Australia's 2030 target and Paris Agreement Commitments.
- As part of the 2017 climate change review, the Australian Government has agreed to develop a long-term emissions reduction strategy by 2020. In the 2018–19 Budget the Government provided $900,000 over two years to develop the long-term whole-of-economy emissions reduction strategy.

Climate Information and Guidance

1.4 Coalitions Senators note the Australian Government has a comprehensive range of initiatives and support mechanisms to ensure information and guidance is made available to decision-makers to manage risks from a changing climate. This was reflected in a range of submissions to the Inquiry. Some of the measures noted during the Inquiry include:

- The Australian Government has funded the $145 million National Environmental Science Program, which is delivered through six research hubs. The Earth Systems and Climate Change Hub supports research to help address the challenges posed by a changing climate across multiple sectors, including the built environment. Other hubs, such as the Clean Air and Urban Landscape hub, are supporting research into climate change adaptation, with a more specific and practical focus on Australia's urban areas.
- The independent National Climate Science Advisory Committee, established by the Australian Government in April 2016, is informing the future direction

of Australia's climate science capability and research priorities. The Advisory Committee is developing a national climate science strategy to assist Australian scientists address research questions including observed and projected changes to climate variables such as sea level and storm surge intensity, air temperature and precipitation and the frequency of extreme weather, including heatwaves, bushfires, floods, and cyclones.

- In the 2017–18 Budget, the Australia Government announced an Adaptation Partnership comprising the National Climate Change Adaptation Research Facility, CSIRO and the Department of the Environment and Energy. The Partnership is developing targeted products which allow decision-makers to manage risks from a changing climate.
- The National Climate Change Adaptation Research Facility is publishing information products from its research projects including synthesis summaries, climate change adaptation briefing notes, policy guidance briefs and an adaptation library for policymakers and decision-makers. The Inquiry heard how the CoastAdapt online tool, developed by the Facility is providing access to locally-relevant coastal climate projections data. In addition, the tool provides guidance on how to use that information to manage associated impacts, such as erosion and flooding caused by sea level rise.

Climate Policies

1.5 Coalition Senators note the Government's climate policies are working. The $2.55 billion Emissions Reduction Fund is successfully supporting Australian businesses, communities and landholders to reduce emissions. It is supporting practical projects, including projects such as improving energy efficiency, capturing methane from landfills and storing carbon in forests and soils. So far it has secured more than 190 million tonnes of emissions reduction at a price of less than $12 per tonne. This is the largest ever emissions reduction commitment by Australian businesses and landholders.

1.6 The Government is also supporting a transition in the energy sector, which is the largest source of Australia's emissions.

1.7 In addition, to supporting the renewable technologies of today, the Government is also investing in the renewable energy technologies, energy storage and the infrastructure of the future. For example:

- Funding through the Australian Renewable Energy Agency is supporting CSIRO and major Australian universities undertake 20 solar R&D projects to reduce costs, increase efficiency and create new breakthroughs.
- Investments in pumped hydro energy storage projects in Queensland, South Australia and Snowy Hydro 2.0, which will be the biggest battery in the Southern Hemisphere, will help make wind and solar more reliable.

1.8 Coalition Senators note the Government's approach is to deliver a secure and affordable energy system as it transitions to a lower emissions future.

1.9 The Government is also strongly supporting investment in clean energy innovation through the Clean Energy Finance Corporation (CEFC) and the Australian Renewable Energy Agency (ARENA). The $10 billion CEFC uses debt and equity funding to promote investment in clean energy technologies. ARENA provides research, development and deployment grant funding to improve the affordability and supply of renewable energy in Australia.

The National Energy Guarantee

1.10 Coalition Senators note that the Government has accepted the recommendation of the independent expert Energy Security Board for a new National Energy Guarantee to deliver more affordable and reliable electricity while meeting our international commitments.

1.11 The National Energy Guarantee has been welcomed by a broad and diverse cross section, including energy users, energy suppliers, energy consumers groups, industry groups, and farmers.

1.12 Under the Guarantee the transition towards renewables will continue but importantly, electricity retailers will need to also have enough dispatchable electricity generation capacity available. This is essential to ensure the grid can supply power to households and businesses at all times of the day and night which is affordable.

1.13 Dispatchable capacity includes technologies and fuels which can be controlled independent of the weather, for example, gas, hydro, biomass, coal, batteries, and pumped hydro storage.

Infrastructure

1.14 Coalition Senators also note that climate change is considered as part of the Australian Government's support for infrastructure development.

1.15 Infrastructure Australia (IA) is required to assess business cases of projects seeking greater than $100 million in Government funding against an Assessment Framework which includes consideration of disaster risk. For example:

- Robust cost benefit analysis assists with quantifying the additional costs incurred by addressing uncertainties (i.e. higher capital costs) or by accepting a degree of risk that can be managed in other ways through the project life-cycle (for example, higher maintenance and operational costs). This is an important part of ensuring a balanced approach to considering a range of risks—including climate risks—without unnecessary 'gold plating' of infrastructure.

1.16 A range of other examples include:

- Funding Austroads to develop road design principles to ensure roads are built to a standard. For example, Austroads released the new Australian Bridge

Code in March 2017 to consider changes in the Australian climate, sustainability and safety-in-design.

- Funding flood mitigation projects through the Infrastructure Investment Program, such as the upgrade of the Yeppen Floodplain crossing on the Bruce Highway, to duplicate the Highway on an elevated carriageway.
- Managing the Critical Infrastructure Resilience Strategy—a policy statement and a plan for practical implementation to ensure the continued operation of critical infrastructure in the face of all hazards.
- Implementing the National Strategy for Disaster Resilience, which continues to provide high-level strategic direction for all governments to build the nation's resilience to natural disasters.
- Coordinating Australia's implementation of, and reporting against, the Sendai Framework for Disaster Risk Reduction 2015–2030. Agreed by United Nations Member States in 2015, the Framework emphasises management of disaster risk, as opposed to focusing solely on disaster response or recovery. Progress in implementing the Framework also represents progress towards meeting the Sustainable Development Goals, ten of which relate to disaster risk reduction and climate action.
- As a priority, the National Resilience Taskforce, working with all levels of government and with key private (including insurance and finance) and community partners, is leading the development of a national, five year, risk reduction framework (The Framework). The Framework will deliver strategic national guidance on how all levels of government and non-government sectors (including the critical infrastructure sector) can take a coordinated and targeted approach to reduce climate influenced disaster risk, in an effort to prevent or limit the physical, social and economic impact of hazards. The National Resilience Taskforce will also progress the development of a national disaster risk information services capability to equip decision-makers and Australians with the knowledge they need to prepare for disasters.
- New disaster recovery arrangements to take effect on 1 November 2018. The new arrangements introduce a funding model for the rebuilding of essential public assets that gives the states and territories greater autonomy to rebuild their infrastructure in a way that best suits the needs of disaster-affected communities. The arrangements also provide incentives to spend savings from the efficient delivery of reconstruction projects on disaster mitigation activities, such as building more disaster-resilient infrastructure to withstand future disasters.

Senator Jonathon Duniam
Deputy Chair
Senator for Tasmania

Labor Senators' additional comments

Introduction

1.1 Labor Senators thank all organisations and individuals that made submissions to this inquiry and gave evidence at hearings, and the Secretariat for their ongoing research and administrative support.

Australia's changing climate and its implications for the built environment

1.2 Labor Senators recognise the challenges and dangers posed by climate change which will require new infrastructure to be built to withstand extreme weather events and strengthened infrastructure will be needed to deal with sea level rises, particularly in built up areas.

1.3 Labor Senators recognise Australia is particularly vulnerable to climate change and as such there is an urgent need to take meaningful action on climate change by reducing greenhouse gas emissions.

1.4 Given Australia's vulnerability, Labor Senators urge federal, state and territory governments ensure that both effective mitigation and adaptation measures are undertaken.

1.5 Accordingly, Labor Senators urge the Australian Government to:

- commit to Australia reaching net zero greenhouse gas emissions by 2050;
- ensure that at least 50 per cent of the nation's electricity is sourced from renewable energy by 2030; and
- enact an emissions reduction target of 45 per cent below 2005 levels by 2030.

Recommendation 1

1.6 Labor Senators recommend that the Australian Government commit to a target of net zero greenhouse gas emissions for Australia by 2050 and the actions necessary to achieve this target.

Understanding risk and informing decisions

1.7 Labor Senators recognise the transition to a low pollution economy will affect workers, communities and businesses.

1.8 To enable workers, communities, business and governments to make informed decisions about climate change adaptation it is of critical importance for up-to-date assessments of climate risks to infrastructure to be available, including estimates of the value of the assets at risk.

1.9 Labor Senators support the view that it is essential to consider extreme risks or worst-case scenarios and recognise that it is better for adaptation measures to be capable of withstanding the gravest scenarios rather than risking that the measures will be insufficient.

1.10 Accordingly, Labor Senators recognise the potential for a National Climate Change Risk Assessment (NCCRA), which could be updated at regular intervals. Labor Senators acknowledge the suggestion that the newly established ARC Centre of Excellence for Climate Extremes could support the development of the risk assessment and that Infrastructure Australia would be well placed to undertake a national audit of at-risk infrastructure.

1.11 Labor Senators support reviewing the allocation of funding provided for climate change research, with a view to providing ongoing support to the National Climate Change Adaptation Research Facility (NCCARF) and other key agencies such as CSIRO and the Climate Change Authority for research into climate extremes and impacts.

Recommendation 2

1.12 Labor Senators recommend that the Australian Government consider funding the preparation of a NCCRA that includes assessments of extreme risks and worst-case scenarios for Australia's built environment.

1.13 Labor Senators recommend that an assessment such as the NCCRA should be updated regularly, such as every five years.

Recommendation 3

1.14 Labor Senators recommend that the Australian Government consider commissioning and funding Infrastructure Australia to lead a national audit of at-risk infrastructure including, but not limited to, the following areas:

- **road and rail networks;**
- **ports and airports;**
- **water, stormwater and irrigation infrastructure;**
- **electricity generation, transmission and distribution infrastructure;**
- **telecommunications infrastructure;**
- **housing and building infrastructure, including the policies and standards underpinning the planning, development and construction of buildings and communities; and**
- **coastal defences.**

Recommendation 4

1.15 Labor Senators recommend that the Australian Government consider providing:

- **ongoing funding to support the National Climate Change Adaptation Research Facility; and**
- **additional funding to CSIRO and other relevant Commonwealth agencies to support further research into climate extremes and impacts.**

Urban and coastal planning

1.16 In considering the evidence received about urban and coastal planning, Labor Senators acknowledge that taking measures to adapt to climate change in the short-term will ultimately be fairer and more cost effective than delaying action.

1.17 Labor Senators acknowledge the evidence received by the committee which strongly supports the development of nationally consistent and authoritative benchmarks, and guidelines regarding key climate change risks, such as sea level rise, rainfall and the management of flood-risk.

1.18 Furthermore, Labor Senators acknowledge that regional variations will be required and nationally consistent guidance should not impede effective local responses. However, key stakeholders did present a compelling argument that a more consistent approach to these issues would encourage more effective planning and adaptation.

1.19 Labor Senators also note there is some concern with current climate change assumptions used in planning and recognise that for climate change adaptation to be effective there is a need for governments and other decision-makers to plan for extreme or worst case scenarios.

Recommendation 5

1.20 Labor Senators recommend that the Australian Government lead the development of nationally consistent benchmarks and guidelines on climate risks, particularly sea level rise, for use as part of state and local government planning decisions. The benchmarks and guidelines should be based on comprehensive scientific assessments and include consideration of worst-case scenarios and climate extremes.

Recommendation 6

1.21 Labor Senators recommend that an overarching objective regarding the need to effectively plan for climate change be included in all state and territory planning legislation.

Recommendation 7

1.22 Labor Senators recommend that the Australian Government consider commissioning research to enhance the information available to policymakers regarding the full range of social and economic costs associated with heat stress.

1.23 Labor Senators also recommend that the Australian Government consider commissioning research to estimate the potential health system savings and other economic benefits that could be realised by taking measures to reduce the severity of the urban heat island effect.

Recommendation 8

1.24 Labor Senators recommend that the Australian Government request state and territory governments ensure effective coastal retreat strategies are developed in their jurisdictions. To inform the development of these strategies, the Australian Government should ensure that the state and territory governments have ready access to expert advice from relevant Australian Government departments and agencies.

Insurance and property finance

1.25 Labor Senators note that numerous reviews have considered the issue of insurance affordability and coverage in areas at heightened risk of extreme weather events. Labor Senators also note the ACCC is currently conducting an inquiry into insurance in northern Australia which will provide valuable guidance on this issue in the future.

1.26 Labor Senators note that the Government has indicated support for consumer education campaigns and efforts to improve transparency in the insurance sector. These efforts are welcome; however, they likely will be insufficient to deal with the issues the insurance market will face due to climate change.

Residential and commercial building design

1.27 Labor Senators note that while minimum building requirements have been enhanced at various times for new buildings, it is clear that the majority of dwellings in Australia could be more resilient to climate change risks.

Recommendation 9

1.28 Labor Senators recommend that the Australian Government request that the Australian Building Codes Board develop minimum requirements for the National Construction Code that are specifically designed to address heat stress risks associated with internal temperatures.

1.29 To facilitate the development of amendments to the National Construction Code, Labor Senators further recommend that the Australian Government consider providing funding for research into:

- **how overheating in highly rated energy efficient dwellings can be created where there can be inadequate ventilation; and**
- **the behaviour of building occupants during heatwave periods.**

Recommendation 10

1.30 Labor Senators recommend that estimates be developed of the potential health system savings and other benefits that could be realised through enhanced building standards. In particular, the research should consider the benefits associated with retrofitting low efficiency dwellings to keep internal temperatures within safe ranges during extreme heat events.

1.31 Labor Senators also consider that governments have a key role in ensuring adequate information is available to assist informed decision-making by homeowners and tenants. This includes developing programs to encourage retrofitting of existing dwellings. For the jurisdictions that already have such programs, given the scale of the challenge climate change presents for Australia's dwelling stock, further work could be undertaken to encourage greater participation in them.

1.32 In addition, governments should ensure that prospective owners of dwelling and tenants are provided with information to assist them to understand and compare the energy efficiency of different buildings.

Recommendation 11

1.33 Labor Senators recommend that all state and territory governments develop educational resources and introduce or expand existing financial incentive programs designed to encourage homeowners to undertake cost-effective retrofitting of existing dwellings.

Recommendation 12

1.34 Labor Senators recommend that all state and territory governments legislate to require that an energy rating measuring passive energy performance must be disclosed to prospective buyers and tenants when a residential property is offered for sale or is available to rent.

1.35 Labor Senators note the committee's consideration of whether governments should identify a target date by which all existing dwellings would be required to be of a suitable standard for addressing any significant heat risks associated with their local climate.

1.36 Labor Senators accept that given the projections available about the increased frequency of heatwave events in Australia's major urban centres, such a response

would be appropriate for ensuring adaptation efforts keep pace with the changing climate.

1.37 Labor Senators note the preceding recommendations about building standards, research and education should be implemented as a starting point. As a next step, policymakers should then identify an appropriate measurement of heat stress in residential buildings and how comparisons about heat stress can easily be made, either through existing building rating systems or as part of a new system. Following this, an appropriate deadline for building owners and the building industry to reach an identified minimum rating could be developed, with exemptions potentially available for certain types of buildings such as heritage buildings.

Recommendation 13

1.38 Labor Senators recommend that state and territory governments consider whether to set a deadline by which all residential properties for sale or rent in their jurisdiction must meet a prescribed energy rating.

1.39 Labor Senators note that governments can contribute to climate change adaptation through procurement decisions, such as by requiring new office space to meet higher standards than the minimum required under the National Built Environment Rating System and that other buildings managed by the government should also be retrofitted to make them more resilient to climate risks.

1.40 However, Labor Senators support emphasis being placed on supporting people in public housing who rely on governments to provide safe living conditions.

Recommendation 14

1.41 Labor Senators recommend that the Australian, state and territory governments require that new office space used in the public sector meet high standards of climate resilience and sustainability, including higher energy efficiency standards than the minimum required under the National Built Environment Rating System.

Recommendation 15

1.42 Labor Senators recommend that state and territory governments invest in measures to improve energy efficiency and to reduce heat stress risk in public housing.

Transport and utilities

1.43 Labor Senators note that decisions about transportation and utilities infrastructure involve all levels of government and that given the long economic lives intended for transport and utility assets these decisions should be taken with care, following best practice approaches and informed by the most up-to-date scientific information available about climate change projections.

1.44 As such Labor Senators recognise a key role for the Australian Government is ensuring that reliable information about climate risks is available to inform decision-making. However, Labor Senators considers that the Australian Government could also perform a leadership role in promoting a best practice approach to infrastructure projects and engage with key organisations in the built environment sector to encourage effective post-project reviews to be conducted in order to learn from decisions made about climate-related risks.

Recommendation 16

1.45 Labor Senators recommend that the Australian Government work with organisations representing the built environment sector to identify options for ensuring that robust post-project reviews of infrastructure projects are conducted.

1.46 Given the significant amounts of funding provided by the Australian Government for transportation projects, Labor Senators also support recommendations that the Australian Government develop a national transportation plan to guide a transition to net zero emissions transportation.

1.47 Labor Senators note that generally the evidence received during this inquiry suggests that climate risks are generally not well accounted for as part of transportation projects.

Recommendation 17

1.48 Labor Senators recommend that the Australian Government develop a national plan for passenger and freight transport that:

- **outlines a transition to net zero emissions transport; and**
- **ensures decision-making and planning processes for transportation infrastructure projects are appropriate in the face of climate change.**

1.49 Labor Senators acknowledge that state and territory governments have given attention to the need to secure climate resilient water supplies. It is also recognised that water infrastructure in Australia generally provides a reliable and suitable service however climate change will present further challenges that state and territory governments will need to address.

1.50 Labor Senators note that growing urban populations and the expectation of more intense rainfall events due to climate change will require a different approach to planning water infrastructure assets and systems.

1.51 Labor Senators also urge state and territory governments to ensure state-owned water corporations and local governments have the resources necessary to undertake effective maintenance of existing water, sewage and stormwater assets. In addition, state governments should develop an overarching plan to ensure that adequate renewal of these assets occurs.

1.52 To support state governments to achieve better outcomes in the water sector, Labor Senators accept there is a role for the Australian Government, through agencies such as CSIRO and the Bureau of Meteorology, to ensure state governments and entities designing water sector assets have access to reliable climate-related information to inform infrastructure design.

Recommendation 18

1.53 Labor Senators recommend that state and territory governments:

- **require the design of new water supply, sewerage, sewage treatment and stormwater assets to be informed by reliable climate projections as well as historical data; and**
- **ensure state-owned water corporations and local governments have the resources and support necessary to undertake effective maintenance of water supply, sewerage, sewage treatment and stormwater assets.**

Recommendation 19

1.54 Labor Senators recommend that the Australian Government support state governments to ensure that water sector assets are climate resilient by offering ongoing access to advice from Commonwealth scientific agencies on relevant climate risks.

1.55 With regards to the energy market, it is clear climate change has significant implications for the sector and that a transformation has been underway for some time with the growth of renewable energy.

1.56 It is clear that the electricity sector is undergoing fundamental change through the growth of renewable energy generation. This growth is aided by the introduction of supporting technologies such as large-scale energy storage.

1.57 Labor Senators note that a more decentralised electricity network would help overcome many of the climate change-related risks to existing electricity infrastructure, such as how extreme weather events can damage key transmission or distribution assets and cause widespread outages.

1.58 Labor Senators note the National Electricity Objective contained in the National Electricity Law currently focuses on the long-term interests of electricity consumers regarding price, quality, safety, reliability and security of supply. However, it is in the long-term interests of energy consumers that the electricity sector responds effectively to climate change in a way that guarantees a secure and affordable supply of electricity.

1.59 Labor Senators note that amending the National Electricity Objective would provide a clear statement of the Australian, state and territory governments' intentions for the electricity sector to support the reduction of Australia's emissions. This would

provide the sector with the long-term certainty needed to inform business investment decisions.

1.60 Labor Senators consider that an overarching national transition plan for Australia's electricity system is also urgently required. Labor Senators recommend that the Government prioritise the development of a national transition plan, which would include consideration of innovative approaches to support renewable and other low carbon energy, energy storage and the decentralisation of the electricity networks, such as local energy trading.

Recommendation 20

1.61 Labor Senators recommend that the Australian Government pursue, through the Council of Australian Governments Energy Council, amending the National Electricity Objective to include decarbonisation of the electricity sector.

Recommendation 21

1.62 Labor Senators recommend that the Australian Government develop a comprehensive energy transition plan that includes:

- **reform of the National Electricity Market rules to support the growth of renewable energy, new energy technologies, and ensure networks are prepared to efficiently respond to changes in the energy market;**
- **a mandated notice period for the retirement of coal fired power stations as well as a detailed plan for a just transition for coal fired power station workers and their communities; and**
- **innovative approaches to enable peer-to-peer energy trading as well as other innovative models such as community renewable projects.**

Recommendation 22

1.63 Labor Senators recommend that the Australian Government:

- **implement a national electricity investment mechanism that supports the continued transition to renewable energy, consistent with expert advice on the electricity decarbonisation needed to meet Australia's obligations under the Paris Accords;**
- **adopt policies to support investment in electricity storage to support continued growth in renewable energy;**
- **ensure regulatory arrangements support the continuing deployment of grid level battery storage and household solar and battery storage technologies; and**
- **commit to not providing any direct funding, subsidies or other support for the construction of new coal fired power stations in Australia.**

Health, education, social services, recreation and tourism

1.64 Labor Senators acknowledge there is a need for an overarching national strategy for managing the implications of climate change for human health and note that that Labor has already committed to developing a climate change health strategy. The strategy should support planning to enable the health system to adapt and meet the increasing demands it will face due to climate change. As part of this strategy, particular consideration should be given to ensuring that health services are resilient to extreme events, and to the resources the health care sector will require to cope with extreme heat events.

Recommendation 23

1.65 Labor Senators recommend that the Australian Government work with the state and territory governments to develop a national climate change and health strategy.

1.66 Labor Senators support the recommendations for state and territory governments to require that new health and education facilities not be built in at-risk areas and that the new buildings are highly resilient to climate risks such as extreme temperatures. Similarly, when existing facilities in at-risk areas require replacement, they should be relocated.

1.67 Labor Senators also support recommendations that state and territory governments should develop dedicated programs to ensure that vulnerable populations with specific health needs live in dwellings that can provide safe internal temperatures. In addition to supporting better health outcomes for residents, such programs could reduce the costs incurred in the health system.

Recommendation 24

1.68 Labor Senators recommend that state and territory governments require proposals for new health and education facilities to be subject to rigorous assessment of climate-related risks, including the risks associated with the proposed location and building design.

1.69 Labor Senators also recommend that state and territory governments commence planning to ensure that facilities in high-risk locations that are nearing the end of their useful life are replaced with new facilities in more suitable locations.

Recommendation 25

1.70 Labor Senators recommend that the Victorian Government's Healthy Homes Program be expanded to cover all of Victoria.

1.71 **Labor Senators further recommend that other state governments introduce programs similar to the Healthy Homes Program to reduce the**

climate-related health risks faced by low-income individuals with complex healthcare needs.

1.72 Labor Senators recognise there are measures that readily can be taken to improve the climate resilience of recreation areas, such as the increased use of alternative water sources to maintain parks and sporting fields.

Recommendation 26

1.73 Labor Senators recommend that state and territory governments work with local governments and water authorities to increase the use of rainwater, stormwater, recycled water and other water sources to maintain the green infrastructure used for public recreation.

Commonwealth, state and territory climate change policies

1.74 Labor Senators commend the state and territory governments that have developed comprehensive responses to climate change through legislation, strategies, planning policies and grants programs however there is more work to be done.

1.75 The approach taken at the Commonwealth level has clearly been inadequate for meeting the challenge that climate change presents. The repeal of the price on carbon pollution and the abolition of the independent Climate Commission by the Abbott Government are standout examples of the Australian Government failing to secure a safe, clean future for future generations.

1.76 There is an urgent need for the Australian Government to provide strong, consistent leadership on climate change mitigation and adaptation. Actions by state and local governments, business and communities are impeded by the lack of a comprehensive national response.

1.77 In particular, the Australian Government can provide much-needed leadership by replacing the ineffective National Climate Resilience and Adaptation Strategy with a comprehensive and ambitious national strategy.

1.78 Labor Senators support the notion that national leadership and coordinated action on climate change across all areas of government policy and the economy can be facilitated by establishing a COAG Council on climate change. A permanent multijurisdictional body is needed to coordinate action by all Australian governments. As climate change is an issue of critical national importance, it is appropriate for this body to be part of the COAG framework.

Recommendation 27

1.79 Labor Senators recommend that the Australian Government replace the National Climate Resilience and Adaptation Strategy with a comprehensive national climate change mitigation and adaptation strategy.

1.80 This whole-of-government strategy should contain sector-based national targets and timeframes for emissions reductions against which performance can be measured.

Recommendation 28

1.81 Labor Senators recommend that the Australian, state and territory governments review all environmental legislation to ensure that adequate consideration of the effects of climate change is expressly required as part of future assessment and decision-making processes.

Recommendation 29

1.82 Labor Senators recommend that the Australian Government investigate the creation of a COAG Climate Change Council.

Recommendation 30

1.83 Labor Senators recommend that the Australian Government's National Resilience Taskforce develop recommendations for the Government to consider that would facilitate more frequent betterment of assets that need to be reconstructed or repaired following natural hazards.

Local government

1.84 Labor Senators are grateful to the local governments that participated in this inquiry for the valuable evidence they provided. This evidence has greatly informed Labor Senator's recommendations and emphasises the need for all governments to ensure climate risks to buildings and infrastructure are managed appropriately.

1.85 As local governments are at the frontline of responding to climate change, it is essential that they have the resources and knowledge necessary to carry out effective planning and adaptation activities. Labor Senators note that generally local governments do not have the financial resources and ready access to expert evidence needed to address climate risks. They can also face realistic threats of legal action by those dissatisfied with their decisions regarding climate risks. Furthermore, local governments are in the unenviable position of needing to consider the short-term and long-term interests of their current constituents and future residents.

1.86 Many of the recommendations in this report are intended to assist local governments to develop successful climate change adaptation measures. However, questions regarding funding and liability are primarily matters for state governments to address. Labor Senators note that under New South Wales legislation, exemptions for liability exist regarding decisions made by councils in good faith regarding flood liable land, land that might be affected by a coastline hazard and land that is subject to the risk of bushfire. Labor Senators encourage other state governments to consider introducing similar exemptions for their local governments.

1.87 Finally, the provision of sufficient financial resources for local governments to act on climate risks is of vital importance for enabling timely and least-cost adaptation. Local governments face practical and statutory restrictions on the revenue they can raise to pay for their activities. Labor Senators urge state governments to ensure local governments have adequate financial resources to address the threat of climate change.

Recommendation 31

1.88 Labor Senators recommend state governments consider providing local governments with exemption from liability for decisions made in good faith relating to the use of land that is subject to climate change risks, such as flooding, coastal hazards and bushfires.

Recommendation 32

1.89 Labor Senators recommend that the Australian Government consider providing specific purpose payments to the states to assist local governments to improve the resilience of infrastructure assets most at risk to climate change.

Conclusion

1.90 Labor Senators reiterate the acceptance of the science that human activity has increased average global temperatures, leading to climate change and endorses the commitment by the world's nations in Paris in 2015 to keep global warming well below two degrees Celsius as well as a more qualified commitment in the agreement around a 1.5 degree threshold.

1.91 Labor Senators acknowledge the overwhelming advice from scientists that global warming beyond two degrees Celsius will be particularly damaging to economies and ecosystems, and impose a huge burden on future generations.

1.92 Labor Senators emphasize the consequences of refusing to take real action on climate change will be devastating for Australia and our economy as a result of more extreme weather events.

1.93 While it is clear climate change will have increasingly severe consequences in the coming years and decades there are clear examples of increasingly frequent and severe weather events already occurring as a result of climate change.

1.94 Labor Senators acknowledge the inquiry's findings that that climate change is putting substantial numbers of Australia's buildings and infrastructure assets at risk and that damage and/or disruption to these assets will have significant implications for the liveability of our communities and cities, and for our economy.

1.95 Labor Senators acknowledge that many individuals, groups and organisations in the built environment sector, local governments, state and territory governments and civil society have already taken action in response to climate risks however there

is a clear need for the Australian Government to assist these efforts by providing greater leadership on how to adapt to climate change.

1.96 Accordingly, Labor Senators have outlined a range of recommendations focused on how the Australian Government can guide the built environment sector and infrastructure owners to become more climate-resilient, taking into account the various interdependencies that are key features of critical infrastructure systems.

1.97 It is also essential that the Australian Government commit to the Paris Agreement. While mitigation is essential, there are limits to the extent of climate change to which we can adapt, and many natural systems will not be able to evolve or adapt at the rate that would be required.

1.98 Unmitigated climate change will radically alter life in Australia, so it is vital that we prepare effectively and avoid a too-little-too-late response. We must be ambitious in reducing emissions and ensure that our houses, communities, cities and infrastructure are more resilient to climate risks.

1.99 Without strong global action being taken urgently to reduce greenhouse gas emissions, there is an appreciable risk of catastrophic consequences to which we will be unable to adapt.

1.100 Labor Senators support the need for urgent action to tackle the climate change and the need for the Australian government to lead mitigation and adaptation policy.

Senator Anthony Chisholm
Senator for Queensland

Senator the Hon Kristina Keneally
Senator for New South Wales

Senator Anne Urquhart
Senator for Tasmania

Appendix 1

Submissions, tabled documents, additional information and answers to questions on notice

Submissions

1	Householders' Options to Protect the Environment Inc.
2	Fraser Island Defenders Organisation
3	Dr Leo Dobes
4	Tasmanian Government
5	Wide Bay Burnett Environment Council Inc.
6	Professor Jon Barnett
7	Hobsons Bay City Council
8	National Insurance Brokers Association of Australia
9	Swinburne University of Technology
10	Queensland Tourism Industry Council
11	Local Government Association of Queensland
12	Australian Local Government Association
13	Eastern Alliance for Greenhouse Action
14	Institute of Public Works Engineering Australasia and Northern Beaches Council
15	Regional Development Australia – South West
16	Climate and Health Alliance
17	Northern Territory Government
18	National Health and Medical Research Council
19	Northern Alliance for Greenhouse Action
20	Wesfarmers
21	Standards Australia
22	Insurance Council of Australia
23	Australian Health Economics Society
24	City Futures Research Centre
25	Infrastructure Sustainability Council of Australia
26	Australian Sustainable Built Environment Council

27	AGL Energy Limited
28	National Climate Change Adaptation Research Facility
29	Lake Macquarie City Council
30	South East Councils Climate Change Alliance
31	Mr Neville Hughes
32	New South Wales' Young Lawyers
33	Sydney Airport
34	Australian Medical Association
35	Floodplain Management Australia
36	Environment Institute of Australia and New Zealand
37	Associate Professor Seth Westra, University of Adelaide
38	Green Cross Australia
39	Department of the Environment and Energy, Bureau of Meteorology, Great Barrier Reef Marine Park Authority, Attorney-General's Department, Department of Agriculture and Water Resources, and Geoscience Australia
40	Climate Council of Australia
41	Doctors for the Environment Australia
42	Name Withheld
43	City of Melbourne
44	Consult Australia
45	Commonwealth Scientific and Industrial Research Organisation
46	Planning Institute of Australia
47	Housing Industry Association Ltd
48	Dr Phillip Jordan, Mr Michael Wrathall, Dr Richard Cresswell, Dr Katherine Daniell, Ms Penelope Springham, Dr William Glamore and Mr Andrew Herron
49	Dr Lauren Rickards
50	Green Building Council Australia
51	Peron Naturaliste Partnership
52	Sustainable Business Australia
52.1	Supplementary to Submission 52
53	Professor Peter Newman
54	Water Services Association of Australia
55	Investor Group on Climate Change

56 Insurance Australia Group

57 Western Australian Local Government Association

58 Queensland Government Department of Environment and Heritage Protection

59 Law Institute of Victoria

60 Australian Coastal Society

61 Australian Coastal Councils Association

62 Breakthrough – National Centre for Climate Restoration

63 Ms Lauren Bayliss, Mr Isaac Buckland, Ms Emily Cummings and Ms Rachael Murdock

64 Australian Meteorological and Oceanographic Society

65 Ms Fiona Bullivant

Tabled documents

Dr Karl Mallon, Water Services Association of Australia – Cross Dependency initiative case studies (public hearing, Sydney, 23 November 2017)

Centre for Sustainable Infrastructure, Swinburne University of Technology – Presentation, 'Impact of Climate Change on Occupants' Health' (public hearing, Melbourne, 15 March 2018)

Centre for Sustainable Infrastructure, Swinburne University of Technology – M Alam et al, 'Mitigation of Heat Stress Risks through Building Energy Efficiency Upgrade: A Case Study of Melbourne, Australia' (public hearing, Melbourne, 15 March 2018)

Centre for Sustainable Infrastructure, Swinburne University of Technology – M Alam et al, 'Modelling the correlation between building energy ratings and heat-related mortality and morbidity' (public hearing, Melbourne, 15 March 2018)

Environment Institute of Australia and New Zealand – extract from Hundloe et al, 'The Gold Coast Transformed: From Wilderness to Urban Ecosystem' (public hearing, Melbourne, 15 March 2018)

City of Melbourne – Climate Change Adaptation Strategy Refresh 2017 (public hearing, Melbourne, 15 March 2018)

Law Institute of Victoria – Australian Panel of Experts on Environmental Law (APEEL), '57 recommendations for the next generation of Australia's environmental laws' (public hearing, Melbourne, 15 March 2018)

Australian Building Codes Board – 'Resilience of Buildings to Extreme Weather Events' (public hearing, Canberra, 22 March 2018)

Additional information

Professor Lesley Hughes – Bowman et al, 'Renewal ecology: conservation for the Anthropocene', 2017

Australian Coastal Councils Association – Gurran et al, 'Planning for climate change: Leading Practice Principles and Models for Sea Change Communities in Coastal Australia', 2008

Australian Coastal Councils Association – Gurran et al, 'Planning for climate change adaptation in Coastal Australia: State of Practice', 2011

Centre for Sustainable Infrastructure, Swinburne University of Technology – Melbourne School of Design, 'Living Well: Apartments, Comfort and Resilience in Climate Change', March 2017

Centre for Sustainable Infrastructure, Swinburne University of Technology – Department of Human Services (Victoria), 'January 2009 Heatwave in Victoria: an Assessment of Health Impacts', 2009

Answers to questions on notice

Floodplain Management Australia – Answer to question taken on notice, public hearing, Sydney, 23 November 2017 (received 12 December 2017)

City of Melbourne – Answer to question taken on notice, public hearing, Melbourne, 15 March 2018 (received 3 April 2018)

Appendix 2

Public hearings

Thursday, 23 November 2017 – Sydney

Water Services Association of Australia

Mr Stuart Wilson, Deputy Executive Director
Dr Karl Mallon, Director, Science and Systems, Climate Risk Pty Ltd

Floodplain Management Australia

Mr Paul Grech, Land Use Planning Director
Mr Dwayne Honor, Queensland Director

Sustainable Business Australia

Mr Andrew Peterson, Chief Executive Officer

Investor Group on Climate Change

Ms Emma Herd, Chief Executive Officer

Consult Australia

Ms Megan Motto, Chief Executive

Climate Council of Australia

Professor Lesley Hughes, Councillor

Australian Sustainable Built Environment Council

Ms Kirsty Kelly, Representative

Standards Australia

Mr Varant Meguerditchian, General Manager, Stakeholder Engagement
Dr Jed Horner, Policy Manager

Insurance Australia Group

Mr Mark Leplastrier, Senior Manager, Natural Perils
Mr Ramana James, Head of Group, Shared Value

Insurance Council of Australia

Mr Karl Sullivan, General Manager, Policy Risk and Disaster

National Insurance Brokers Association of Australia

Mr Tim Wedlock, President
Mr Dallas Booth, Chief Executive Officer

Thursday, 15 March 2018 – Melbourne

Centre for Sustainable Infrastructure, Swinburne University of Technology

Dr Morshed Alam, Senior Research Fellow
Professor Patrick Zou, Professor of Construction

Environment Institute of Australia and New Zealand

Professor Tor Hundloe, Chair, Climate Change Special Interest Section

Law Institute of Victoria

Mr Hubert Algie, Chair, Environmental Issues Committee
Mr Jamie Bedelis, Chair, Property and Environmental Law Section Executive Committee
Dr Leonie Kelleher, Member, Environmental Issues Committee

Australian Coastal Councils Association Inc.

Mr Alan Stokes, Executive Director
Councillor Richard Ellis, Committee Member

City of Melbourne

Mr Gavin Ashley, Team Leader, Climate Resilience

Hobsons Bay City Council

Mr William Millard, Director Strategic Development

South East Councils Climate Change Alliance

Ms Dominique La Fontaine, Executive Officer

City of Port Phillip

Mr Brett Walters, Manager Sustainability and Transport
Mr Steven McKellar, Senior Project Manager, Climate Adaptation and Sustainability

Thursday, 22 March 2018 – Canberra

Commonwealth Scientific and Industrial Research Organisation

Dr Craig James, Research Program Director
Dr Russell Wise, Senior Research Scientist

Bureau of Meteorology

Mr Neil Plummer, General Manager, Community Forecasts
Dr Aurel Moise, Principal Research Scientist

Housing Industry Association Ltd

Ms Kristin Brookfield, Chief Executive, Industry Policy
Mr Michael Roberts, Executive Director, Planning and Environment

Australian Building Codes Board

Mr Neil Savery, Chief Executive Officer