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';

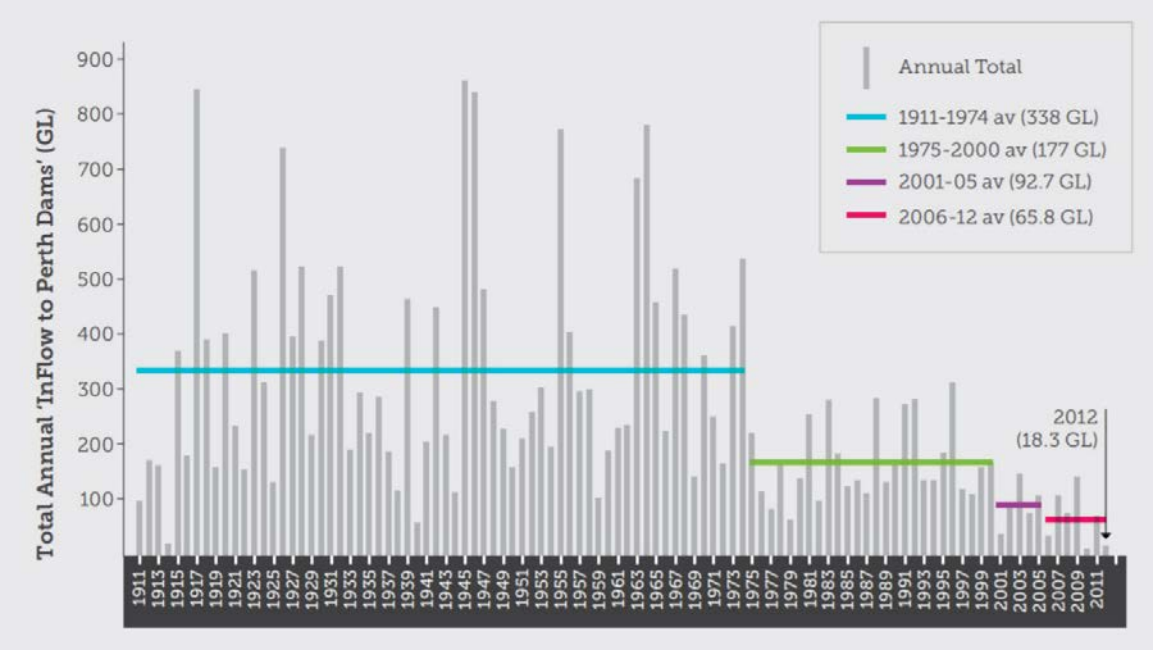
- sewerage infrastructure—damage 'can lead to sewage overflows and human exposure to unsafe concentrations of microbial pathogens and chemicals'; and
- recycled water infrastructure—when used to supply recycled water for the irrigation of food crops, damage 'can result in the ingress of pathogens and 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.