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September 2016

Keeping the lights on

Lessons from South Australia's power shock

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Grattan Institute Support

Grattan Institute Report No. 2016-12, September 2016

This report was written by Tony Wood, Grattan Institute Energy Program Director, and David Blowers, Grattan Institute Energy Fellow. Greg Moran and James Button provided extensive research assistance and made substantial contributions to the report.

We would like to thank the members of Grattan Institute's Energy Reference Group for their helpful comments, as well as numerous industry participants and officials for their input.

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This report may be cited as:
Wood, T., Blowers, D., and Moran, G., 2016, *Keeping the lights on: lessons from South Australia's power shock*, Grattan Institute

ISBN: 978-1-925015-91-1

Overview

On the night of 7 July, the wind was hardly blowing in South Australia and the sun had gone down. Two coal plants had closed earlier that year, and an electricity connection that provides power from Victoria was effectively closed for upgrades. As a result, gas was supplying nearly all the state's power needs. At 7.30pm, the wholesale price of electricity shot up to $8900 per megawatt hour, a staggering sum when wholesale prices in the eastern states average about $50 per megawatt hour.

Price spikes are a fact of life in the electricity market. Far more troubling was South Australia's average wholesale price for the month of July - $229 per megawatt hour, more than three and a half times that of the eastern states. The news started a furious blame game. Some commentators attacked renewable energy for becoming a vital power source for the state, others the operation of the electricity market, others the behaviour of gas generators.

None of these narrow criticisms is fair. In fact, the market worked as it was meant to and the lights stayed on. Yet the incident exposed potential threats to the price and reliability of power in South Australia. Even more importantly, it revealed Australia's urgent need to create climate change and energy policies that combine to produce reliable, affordable and sustainable power.

Since 1998, a wholesale market has supplied electricity needs to Australia's east coast. It has mostly enabled large, centralised generators to dispatch reliable, affordable power. Short-term price volatility provided incentives for plants to meet peak demand periods, and periods of sustained high prices attracted new investment to meet growing demand.

Wind power now delivers about 40 per cent of South Australia's electricity. Once a wind farm is built, the energy is effectively free. Wind's ability to cut the wholesale spot price has put huge financial pressure on coal and gas generators, leading to mothballing and closure of plants. The full impact for reliability and cost of forcing a high proportion of intermittent and low running-cost electricity into the system was never fully considered.

Two big problems remain. Electricity contributes about a third of Australia's greenhouse gas emissions. Yet there is no credible policy to reduce emissions in the sector and enable Australia to meet its international climate change commitments. Absence of such a policy also discourages investment in new power plants. Second, the wholesale market, as it is designed, may not provide the secure and reliable power that Australians take for granted.

Governments need to do three things. The 2017 review of federal policy must deliver a credible climate change policy that all states support and that works with, not outside, the electricity market. Second, there must be a separate review of the market to ensure that power flows reliably and affordably. Third, governments must explain that a transition to a low-emissions future will happen and that it will cost money.

The events of July in one state were a canary in the coalmine, warning of the risks in Australia's power future. It is time to listen.

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1 What happened in South Australia

Conditions in South Australia's wholesale electricity market created a media storm in the middle of 2016. During July, wholesale prices spiked to very high levels a number of times. Some large industrial consumers that had not taken out contractual protection were exposed to these prices. These widely-reported events provoked a barrage of commentary criticising state and federal renewable energy policies and even broad action against climate change.[1] At least one politician called for a ban on new wind farms.[2]

But much reporting of the July prices failed to recognise the range of interrelated factors behind the price spikes, the fact that these sorts of price spikes had occurred many times in the past, and that the growth of renewable energy is essential to Australia meeting its long-term, international commitments on climate change. Understanding these and other important considerations is crucial to properly diagnosing the short- and long-term problems and to prescribing solutions.

The good news is that the market worked as designed, reliability was maintained and the high prices affected only a small number of consumers, and only in the short term.

[1] For example: Moran (2016); Owen (2016); Penberthy (2016); and Sloan (2016).

[2] Booth and Uren (2016)

1.1 The sudden spike in spot prices explained

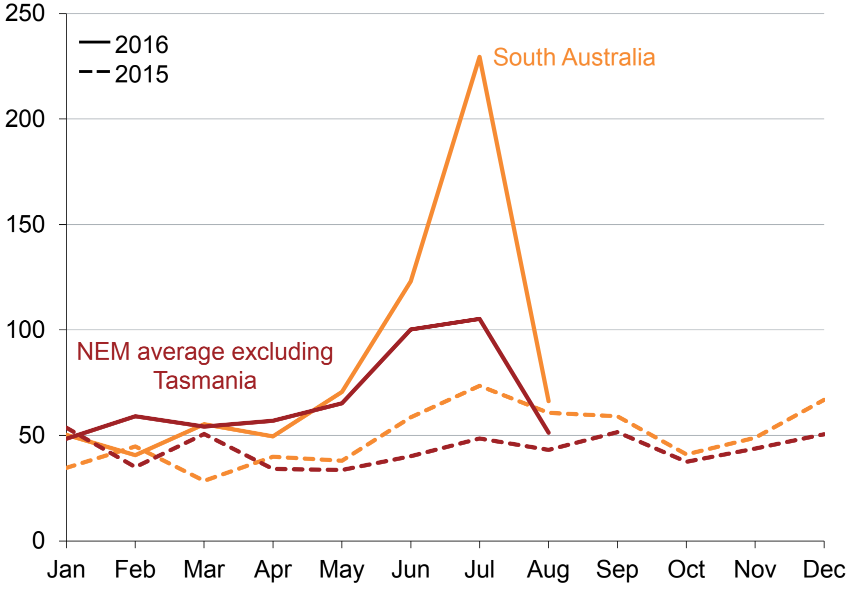
Wholesale electricity prices – the prices paid to generators for the electricity they produce – have been noticeably higher across the east coast of Australia during 2016. Figure 1 shows that spot prices in the National Electricity Market (NEM) were higher in the early months of 2016 than they were in the previous year. The problem was not especially acute in South Australia. Although higher than those of the previous year, prices up until May tended to be lower than the average of all mainland states in the NEM.

From May, prices in South Australia began rising beyond the average NEM price. In June the average price went above $100 per megawatt hour. But it wasn't until July that the wholesale spot market saw a number of rapid price spikes. Spot prices during one five-minute interval hit $14,000 a megawatt hour, although this was not the price eventually paid.[3]

[3] The price paid for all electricity consumed during a 30-minute period is a simple average of six five-minute dispatch prices that are determined during the 30-minute period. This is explained in more detail in Box 1.

Figure 1: Prior to August, wholesale electricity prices had been going up across Australia in 2016

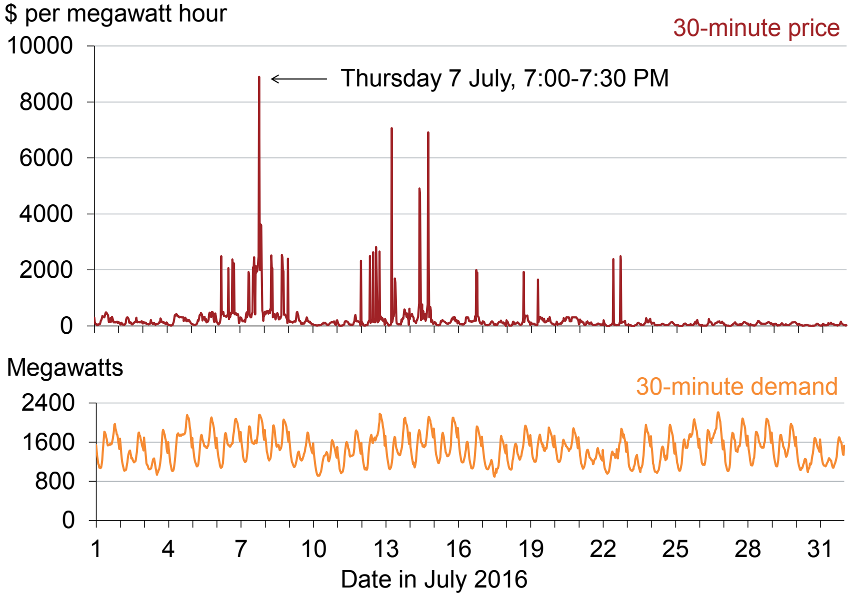
Wholesale electricity price, time-weighted average, $ per megawatt hour



Notes: Tasmania is not included in this analysis as it would skew the results. Tasmania had significant generation problems during the first half of 2016 that led to very high prices. The dams that supplied the hydro power plants were at record low levels and the connection between Tasmania and the mainland was out for six months.
Sources: Australian Energy Market Operator data; Grattan analysis

Figure 2 shows prices and demand over the month. The 30-minute price jumped above $1500 per megawatt hour on 53 occasions and at one time reached as high as $8898.

Figure 2: The wholesale price spiked a number of times in South Australia in July 2016, but this was not driven by significant changes in demand



Source: Australian Energy Market Operator data

The simple average of 30-minute prices over the month was $229 per megawatt hour, almost double that of the previous month and three times higher than July in the previous year.

1.2 Why the price spikes were so high

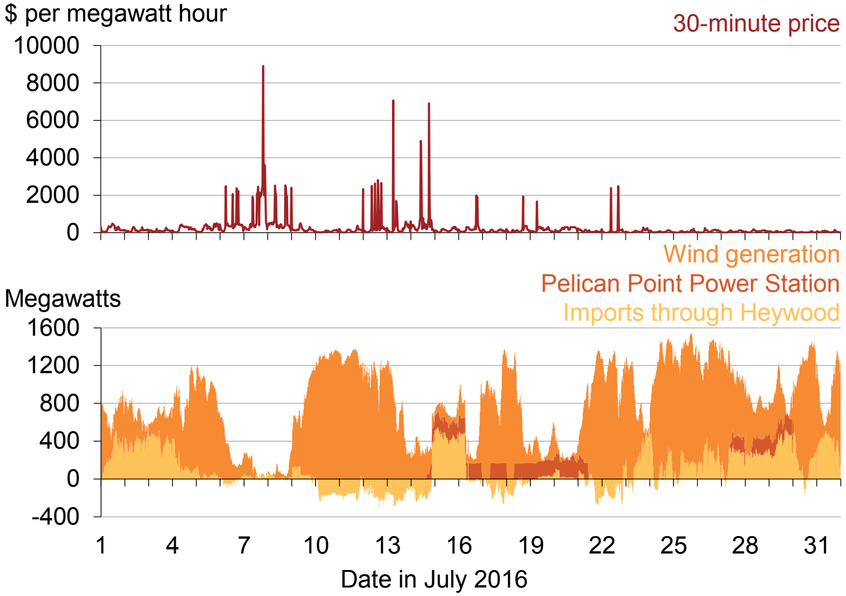
A unique set of circumstances combined to produce the high price spikes in the spot market. Four factors affected the supply side of the market – no significant changes in demand drove the price spikes, as Figure 2 shows.

The first springs from the intermittent nature of wind energy. While it accounts for about a third of South Australia's generation capacity, when the wind doesn't blow it doesn't generate electricity. Although wind power can be managed well when the wind is blowing, there can be times, as in July, when all of the wind farms in the state are effectively off-line. This is far less likely to happen with multiple fossil fuel generators.

The second is that South Australia is only connected to generation in one other state. It has two connections with Victoria, known as interconnectors, through which electricity can flow to help meet demand. But during July the main connection between the states – the Heywood Interconnector – was undergoing maintenance work to increase its capacity to transmit power. Between the 5th and 15th of July, in particular, its ability to supply electricity to South Australia was severely constrained.

Figure 3 shows the impact of these first two factors. The price spikes tended to occur when there was low output from South Australia's wind farms, low imports from Victoria through Heywood, or both. Price spikes fell away in the second half of the month as wind and imports picked up and the previously mothballed Pelican Point Power Station was restarted.

Figure 3: The price spikes in July 2016 occurred at times of low wind generation or reduced imports of electricity from Victoria



Sources: Australian Energy Market Operator data; Grattan analysis

When the price hit its peak between 7:00pm and 7:30pm on 7 July, demand was also near its daily peak. But South Australian wind turbines were only producing 13 megawatts from their total installed capacity of around 1500 megawatts.[4] It was dark, so

[4] There was 1,473 megawatts of fully installed capacity, while it appears only some of the 102 megawatts from Stage One of the Hornsdale Wind Farm was installed at the time: see Australian Energy Market Operator (2016a) and Spence (2016).

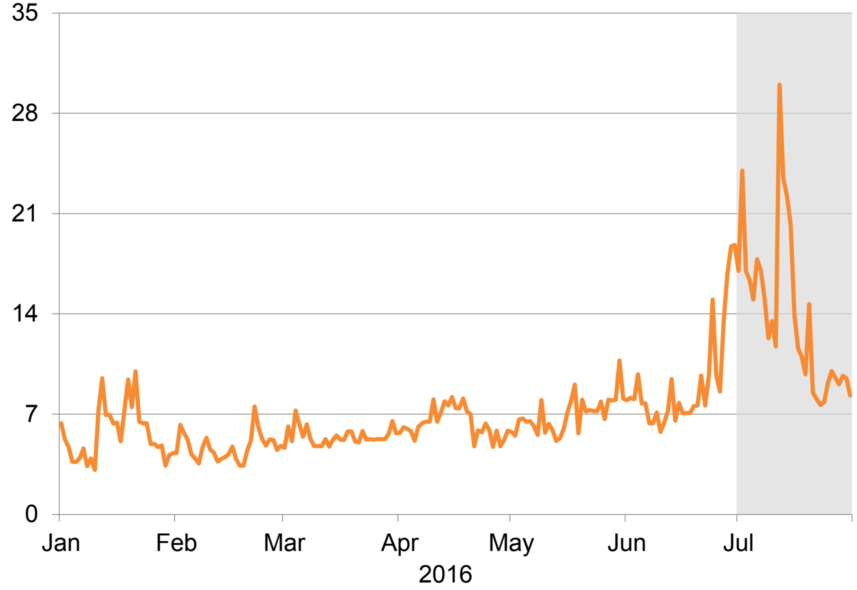
there was no production from rooftop solar, and little supply from Heywood due to the upgrade works.[5]

The third factor driving up spot prices came from a lack of alternatives within the state. During periods in July when Heywood was effectively down and there were low levels of wind, South Australia relied on diesel and gas-fired generation. The closure of the 546 megawatt Northern coal plant at Port Augusta a couple of months earlier had reduced the state's sources of supply. This enabled gas and diesel generators to charge more for their power than they would have been able to otherwise. While the bidding behaviour of gas generators has been blamed by some for July's high prices, sometimes market power does arise and is used.[6]

The fourth factor is that wholesale gas prices in South Australia in July spiked to more than double their levels over the first half of 2016, as Figure 4 shows. The higher cost of gas increased gas generators' operating costs.

Figure 4: Gas-fired generation was impacted by high wholesale gas prices in the first half of July 2016

Short-term Trading Market, Adelaide ex post price, $ per gigajoule



Source: Australian Energy Market Operator data

Increases in gas prices were driven by increases in demand for gas across Australia. South Australian generators were competing for gas against three sources: liquefied natural gas (LNG) plants in Queensland; gas generators across the NEM that were needed because of outages at a number of coal plants; and residential consumers who wanted more gas for heating due to the cold.[7]

[5] Australian Energy Market Operator (2016c)

[6] A number of reports have (at least partly) attributed the events of July to strategic behaviour by some gas generators. For example, see: McConnell and Sandiford (2016); CME (2016); and Stock and Stock (2016).

[7] Australian Energy Regulator (2016)

The result was that, for some periods of time in July, electricity in South Australia was supplied almost exclusively by gas generation at a time when gas prices were very high.[8] Further, in at least one of these periods, almost 80 per cent of supply was provided by generators owned by just three companies. How did South Australia come to rely almost solely on gas?

1.3 South Australia's supply mix has changed

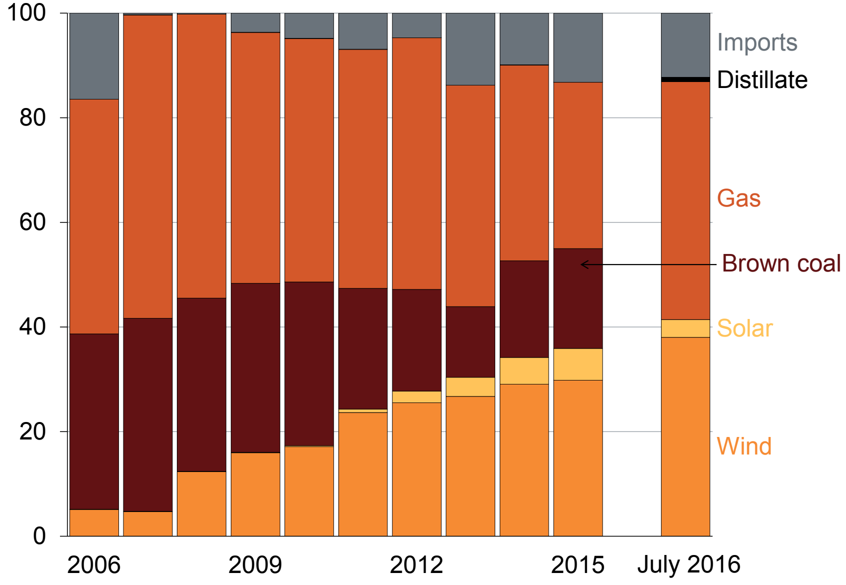
A decade ago, South Australia's electricity supply came mainly from brown coal and gas generators. This has changed dramatically as Figure 5 shows. Wind now supplies 40 per cent, interconnectors provide about 10 to 15 per cent and gas much of the rest. The South Australian power story is dominated by the rise of wind and the fall of coal.

1.3.1 Growth in wind generation

In 2005 there was little wind generation in South Australia. Today the state has about 1500 megawatts of wind capacity and more than 650 megawatts of solar photovoltaics (PV), mostly on household rooftops.[9]

Figure 5: Coal-fired generation has decreased the most in South Australia as wind and solar generation has grown

Per cent of supply



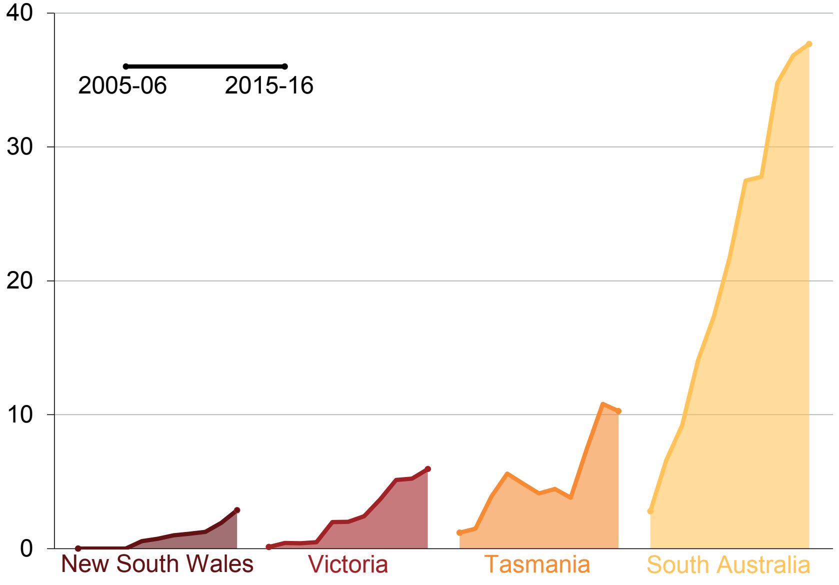
Notes: Imports = supply from South Australia's interconnectors with Victoria
Sources: Australian Energy Market Operator data; McConnell and Sandiford (2016); Grattan analysis

Wind now accounts for a greater share of generation capacity than the largest generator operating in the state over the past decade: the gas power station Torrens Island A/B with a capacity of 1280 megawatts.

[8] Just under 10 per cent of South Australian electricity was supplied from Victoria through the Murraylink interconnector.
[9] Clean Energy Council (2015)

Figure 6: Almost 40 per cent of electricity generation in South Australia now comes from wind farms

Per cent of regional output



Notes: Wind generation in Queensland has to date been negligible and therefore does not appear on the figure.
Source: Australian Energy Regulator data

Figure 6 shows South Australia's unique position in the NEM, with wind providing a much higher share of generation than in other NEM states.

1.3.2 The decline in coal

Increasing amounts of wind generation in the South Australian market over the past decade have made life difficult for conventional fossil fuel generators by eating into their market share and pushing down prices. Lower prices and lower output have meant lower revenues.

The 'merit order effect'

Increasing supply in any market when demand is falling or flat will push down prices. But a further characteristic of wind power suppresses wholesale electricity prices in the short run.

The marginal cost of wind generation – the amount it costs to generate an additional unit of power – is near zero. In fact, if a wind generator chooses not to generate, it will effectively lose money since it will not generate a subsidy under the Federal Government's Renewable Energy Target (RET) scheme – see Chapter 2. This is why, at times, a wind generator may bid into the market at a negative price – it is prepared to pay the market to take its electricity because it knows it will get revenue from the subsidy.

Intermittent generators must also either dispatch or dump the electricity they create. When the wind blows, power is generated. If wind generators are to dispatch, they need to make sure that their electricity gets bought or that they pay someone to take it.

For these two reasons – low marginal cost and the need to dispatch – wind generation typically bids into the market at zero. Bidding into the market at low prices ensures that this power, when available, will be bought.

Increasing the supply of low marginal cost generation leads to changes in the ‘merit order’, reducing the price that all generators are paid in the NEM. This is known as the merit-order effect (the merit order and how prices are set in the NEM are described in Box 1).[10]

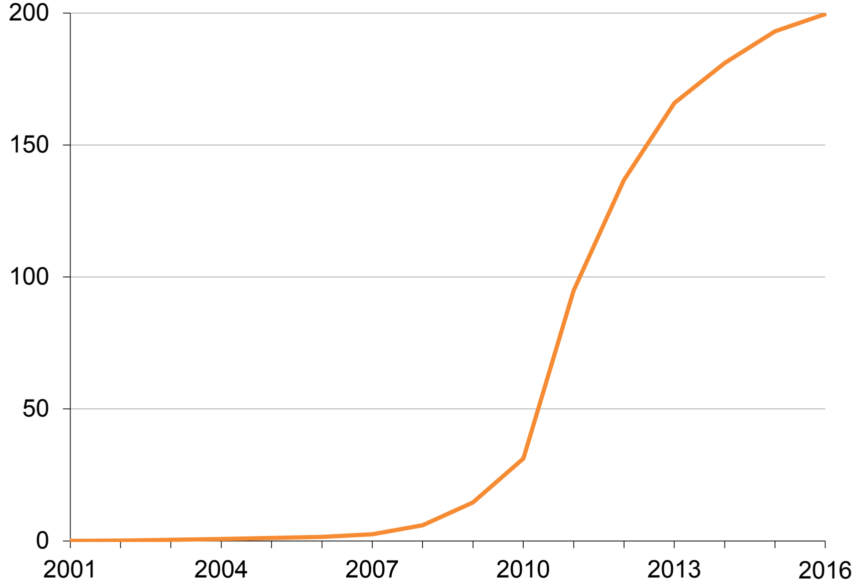
But these lower wholesale spot prices will not cover wind farms’ long-term costs. The long-term cost of wind generation is around $100 per megawatt hour, although this can vary with individual projects.[11] This cost is very much higher than today’s average NEM prices of around $50 per megawatt hour. Consumers must eventually pay to cover the long-term costs of all generation.

Falling demand at a time of increasing supply

At the same time that wind generation was growing rapidly in South Australia, so was demand for rooftop solar panels, while overall power consumption was falling across the Australian market.[12] Figure 7 shows that there were almost 200,000 small scale solar PV systems in South Australia on 1 September, 2016.[13] Generous subsidies to households drove this growth.

Figure 7: Along with large-scale wind generation, small-scale solar generation has also grown strongly in South Australia

Number of systems as at 1 September 2016, thousands



Sources: Clean Energy Regulator (multiple years); Grattan analysis

Today, more than 40 per cent of owner-occupied houses have installed solar PV in South Australia.[14]

[10] For more discussion on the merit order effect, see Appunn (2015) and McConnell and Sandiford (2016).
[11] CO2CRC (2015)
[12] Wood, *et al.* (2013)
[13] Clean Energy Regulator (multiple years)
[14] Wood, *et al.* (2015)

Box 1: The merit order and how electricity is priced in the NEM

Generators make offers to supply electricity for nominated five-minute intervals, 288 times a day. These bids are sent to the Australian Energy Market Operator (AEMO) – the body responsible for managing the NEM – by 12:30pm the day before. Generators bid an amount of generation and the price for that generation.

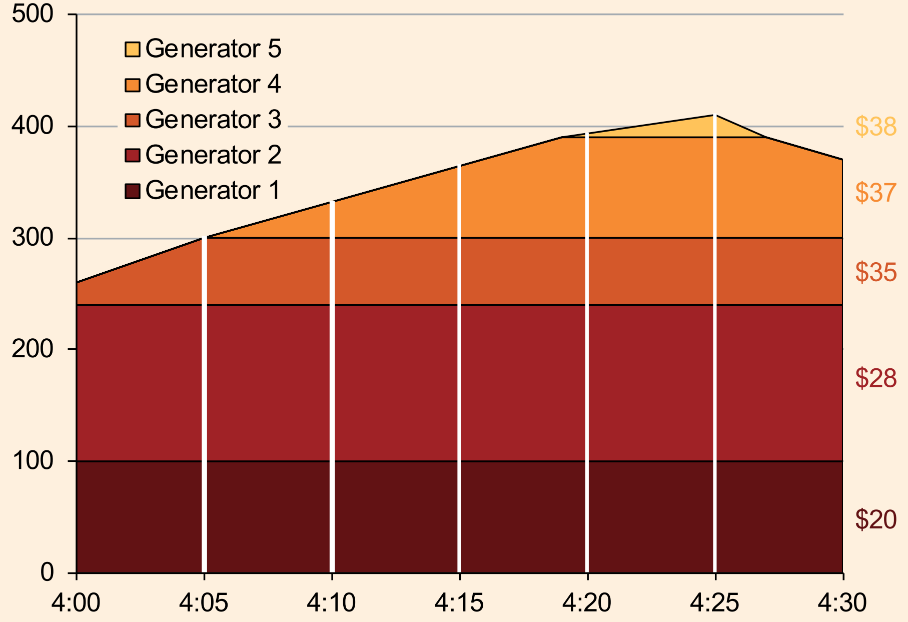
The bids are then stacked according to price – known as the merit order. AEMO then dispatches this generation, from cheapest first, to meet demand during every five-minute interval. The dispatch price of electricity for the five-minute interval is determined by the cost of the last unit of electricity dispatched to meet demand.

This five-minute dispatch price is not what the generators receive, however. They are paid a simple average of the six five-minute dispatch prices over the 30-minute trading period. Any electricity produced during that 30-minute period is paid the 30-minute spot price.

Figure 8 provides a simplified example of pricing during a 30-minute period. At 4:05, demand is 300 megawatts. Generators One, Two and Three are required to be fully dispatched to meet this demand. The dispatch price is $35 per megawatt hour. Generators One and Two bid into the market at $20 and $28 respectively. Generator Three, because it provides the last unit of electricity dispatched to meet demand, sets the price. This process is repeated throughout the 30-minute period. But $35 is not the amount Generators One, Two and Three receive for the electricity they generate during that five-minute period. Instead, they are paid the average of the six dispatch prices ($35 plus $37 plus $37 plus $38 plus $38 plus $37 per megawatt hour divided by six, or $37 per megawatt hour).

Figure 8: Scheduling of NEM generators

Output dispatched to meet demand, megawatts



Source: Reproduced from Australian Energy Market Operator (2010).

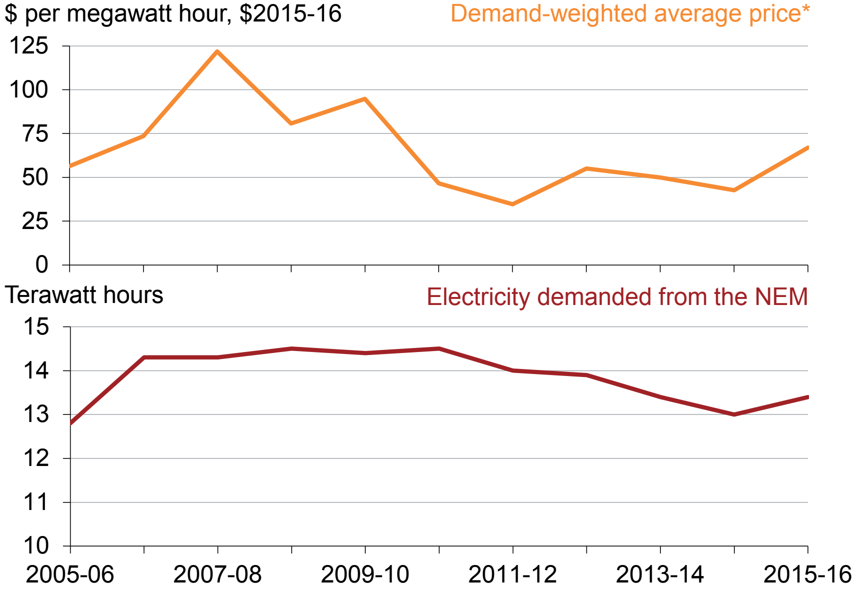
All generators receive this price for production during this period. The price also determines what wholesale market customers – electricity retailers and large industrial businesses – pay for the electricity they consume from the pool during this period.

It is the bid stack – or merit order – that allows generators to make money and recover their fixed costs. So Generator One receives significantly more than the $20 per megawatt hour it bid.

The increase in solar PV has helped to reduce South Australian electricity demand from the NEM. Solar PV enables consumers to use electricity generated on their own premises rather than buy it from the NEM.[15] Figure 9 shows that between 2009 and 2011, NEM demand in South Australia was about 14.5 terawatt hours a year. By 2014-15 the figure had fallen to 13 terawatt hours. Real prices were broadly steady over this period at about $50 per megawatt hour (excluding the effect of the carbon price), but were far higher in the three to four years before that.

A range of factors can affect wholesale electricity prices and it is hard to be precise as to how much each factor may have contributed. A number of studies have concluded that increased penetration of renewables into the market has contributed to lower wholesale prices and revenue.[16] For example, Forest and MacGill estimate that the introduction of wind generation helped to reduce wholesale prices by $8.05 a megawatt hour between 2009 and 2011.[17]

Figure 9: NEM demand in South Australia fell in the four years to 2014-15, while real carbon-price-adjusted wholesale prices were broadly flat over the same period



Notes: Demand-weighted price adjusted for carbon price in 2012-13 and 2013-14. Impact of carbon price assumed to be $22.1 per megawatt hour in 2012-13 and $19.6 per megawatt hour in 2013-14, consistent with Australian Energy Market Commission (2013) and Australian Energy Market Commission (2014).
Sources: Australian Energy Market Commission (2013); Australian Energy Market Commission (2014); Australian Energy Regulator data; Grattan analysis

Falling prices and output resulted in the exit of brown coal

As Box 1 shows, the highest price accepted for any trading period is the price received by all generators. But in South Australia, wind's capacity to bid at zero or negative prices forced coal

[15] Electricity generated from rooftop solar is used both within the premises and exported back into the grid. As none of this electricity is traded through the NEM it shows up as a reduction in NEM demand.
[16] For example, see: Commonwealth of Australia (2014); McConnell and Sandiford (2016); and Nelson, *et al.* (2015).
[17] Forrest and MacGill (2013)

generators to take lower prices for their electricity and reduced wholesale prices overall. The result was significantly reduced profitability for South Australia's brown coal generators and their eventual closure.

Table 1 shows that by mid-2016 the state's four largest generators had either announced the reduction of capacity or had withdrawn from the market altogether.

The closure of Northern has perhaps had the biggest impact on overall capacity. Its neighbour Playford B – which was mothballed in 2012 – also closed in May 2016. The owners, Alinta, stated at the time of the closure announcement that "there can be no expectation that the Flinders [Northern and Playford B] business can return to profitability".[18]

Interestingly, AGL reversed its decision to withdraw capacity from its Torrens Island gas generator, perhaps in anticipation of higher future prices following the closure of Northern.

1.4 The market did not fail

Discussing the events of July, South Australian Energy Minister Tom Koutsantonis described the high wholesale prices as "another example of the failure of the so-called national energy market".[19]

Table 1 – Withdrawal of capacity in South Australia

Power station	Capacity (MW)	Fuel Type	Status
Torrens Island A/B	1280	Gas	480MW announced for withdrawal in 2017 – recently reversed
Northern	546	Brown coal	Closed May 2016
Playford B	240	Brown coal	Closed May 2016
Pelican Point	239	Gas	Half capacity available for service

Sources: Australian Energy Market Operator; Donoghue (2016)

But higher prices themselves do not mean the market failed. On the contrary, in July the electricity market did what it was designed to do. As the market regulator noted, high prices were not unexpected "given a demand forecast peaking at around 2220 MW and around 2400 MW of thermal generation available in South Australia."[20]

The clearest sign that the market worked was that there were "no system security or supply reliability issues in South Australia during the month" and "no departures from normal market rules and procedures," according to the Australian Energy Market Operator (AEMO).[21]

[18] Alinta Energy (2015)
[19] Koutsantonis (2016)
[20] Australian Energy Regulator (2016)
[21] Australian Energy Market Operator (2016c)

Those generators operating during July will have made a lot of money. But whether this revenue constitutes a windfall profit or the recovery of costs after a period of low prices is less clear.

In addition, some of the factors that pushed up electricity prices were short-term. July's very high gas prices of $20 to $30 per gigajoule – caused in part by cold weather – have already eased. As the LNG trains in Queensland become more established they will strengthen the flow of gas from local coal seam gas plants and further ease pressures in the domestic gas market.

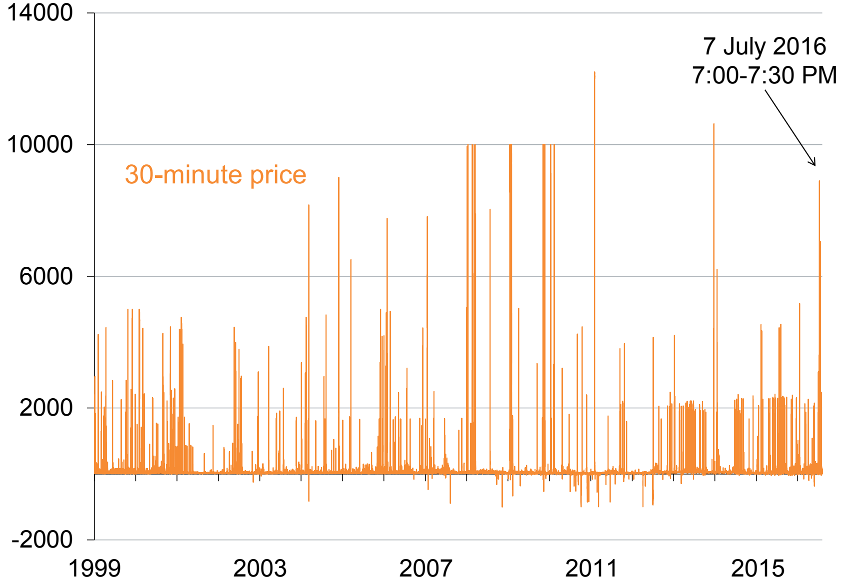
1.5 The impact on consumers

Most households and businesses in South Australia were not directly exposed to the spikes in the wholesale price. The prices they pay for electricity reflect pre-determined rates and charges in contracts they have with their electricity retailers – companies such as AGL, Energy Australia and Origin Energy. In turn, retailers protect themselves against volatility in the wholesale price through hedging – in other words, they can smooth their costs of purchasing electricity by making contractual arrangements outside the wholesale market. Box 2 explains hedging in detail.

While the spikes in the wholesale price were significant, they are not unheard of. Figure 10 shows that over the past 20 years the wholesale price of electricity in South Australia has spiked to the levels seen in July, and higher.

Figure 10: Price spikes in South Australia are not unheard of

$ per megawatt hour



Source: Australian Energy Market Operator data

Rather than short-term price spikes, it is the long-term outlook for wholesale prices that is likely to increase consumer prices. The higher prices of the first half of 2016, plus the expectation that these prices will be sustained in future, have driven increases in retail electricity prices.[22]

[22] ABC News (2016)

Box 2: Hedging

Retailers can smooth their costs, and generators their revenues, by entering into hedging arrangements with each other.

Hedging arrangements are complex and vary based on the circumstances of different retailers and generators. Broadly, three types of hedging contract are used in the Australian electricity market.

First, for the minimum level of demand over an entire day, base load generators and retailers can agree to swap the price paid and received on the spot market for a specified price. These contracts are known as base load futures, and are bought and sold on the Australian Securities Exchange (ASX) under a set of standardised contract terms.

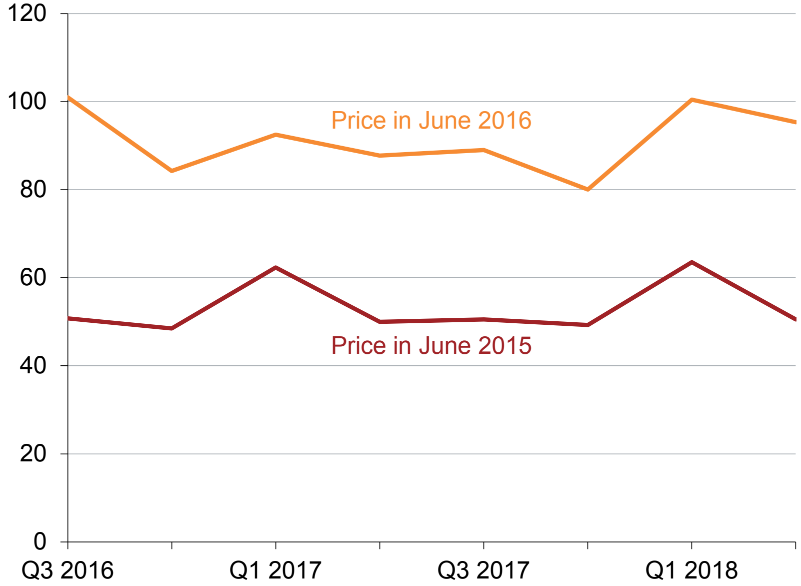
Second, for the higher demand between 7am and 10pm on business days, generators operating at those times can arrange a similar swap with retailers. These are known as peak load futures, and also trade on the ASX.

Third, when the spot price exceeds a specified price, a generator can agree to pay a retailer the difference. The retailer will pay the generator a premium for this contract. As such, these contracts insure retailers against high spot prices. The contracts are known as caps and the threshold price usually specified in these contracts is $300 per megawatt hour.

Sources: McConnell and Sandiford (2016); Productivity Commission (2013)

Figure 11: Expectations of future wholesale prices in South Australia are a lot higher than they were last year

South Australian base load futures price, $ per megawatt hour



Sources: Australian Energy Regulator data; dCypha Trade; ASX

Figure 11 shows that the prices of base load futures contracts were substantially higher in June 2016 than a year earlier. The market now expects much higher wholesale prices in the next few years than it did last year.

As a result, the costs of hedging or purchasing electricity from a retailer have increased. Because of higher hedging costs some large businesses might have chosen not to hedge their electricity and were therefore exposed to the price spikes.

So while the scenario South Australia faced in July 2016 was unusual in some respects, high prices and volatility are likely to continue for some time. Generation capacity that was removed from the market has not returned, except for Pelican Point's re-opening in the short term. High levels of intermittent supply are expected to increase over time and gas prices will remain higher than historical levels of about $3 to $4 per gigajoule. As a result, South Australia will rely more on the Heywood Interconnector. Although its capacity has increased, any outage could create new problems.[23]

High prices are not necessarily a bad thing. They help the state attract the investment that will ensure enough power generation in future. But high prices may not be enough to generate investment when a high level of power generation is intermittent and comes at low marginal cost. The question is will the structure of the NEM create efficient incentives for the necessary new investment? Chapter 3 explores this question.

Yet the market has not been the main driver of changes to electricity supply over the past decade. The catalyst behind the transformation of South Australia's supply mix has been policies to reduce greenhouse gas emissions, a factor that will continue to shape Australia's electricity sector for many years to come. Before examining the role of the NEM we must consider a higher priority issue: Australia's unstable and unpredictable climate change policies.

[23] Australian Energy Market Operator (2016a)

2 The need for better climate change policy

Policies aimed at reducing Australia's greenhouse gas emissions have changed South Australia's supply mix over the past decade. The RET has played the key role in making South Australia a world leader in the adoption of renewable energy, mainly from wind.

This also makes it a global experiment. By separating climate change policy from energy policy, Australia has caused changes in South Australia that are not as economically efficient or as environmentally effective as they could be. Moreover, the instability of climate change policy may deter future investment in the right mix of low-emissions generation, storage and demand response.

2.1 The RET's role in South Australia

The RET is designed to reduce greenhouse gas emissions in Australia's electricity sector by subsidising renewable generation.[24] It requires buyers of wholesale electricity – mainly electricity retailers – to include minimum amounts of renewable energy in their purchases. The requirement creates a separate market for renewable electricity. Renewable generators create renewable energy certificates when they generate electricity and these certificates can be sold to retailers or traded as a separate market commodity.

[24] Technically, the RET policy covers two schemes: one that incentivises large-scale generation – the LRET – and the other which incentivises rooftop solar – the SRES. In this report when we talk about the RET we are referring to just the LRET.

Renewable generators therefore receive two sources of revenue: the first from electricity they sell through the NEM; the second from the sale of certificates.

The RET provides a direct incentive for lowest-cost renewable generation. South Australia proved to be the ideal location to capitalise on this incentive for three reasons:

- It has large areas of high average wind speeds, both along the coast and inland.[25] These wind resources are considerably larger than those on Australia's eastern coast.[26]
- Historically, it has tended to have higher wholesale electricity prices than other states, because of its dependence on gas. The price of renewable energy certificates is nationally consistent, so the revenue received by a renewable generator will be the same regardless of where it is in Australia. But the wholesale price differs from state to state. The result is wind generators could earn more money in South Australia than in other states.
- The South Australian Government streamlined its planning framework for wind farms, created a payroll tax rebate scheme for wind farm investors and established a body to promote growth in the state's renewable energy industry.[27]

[25] RenewablesSA
[26] Ibid.
[27] Rann (2011)

The result was a wind rush, which had the consequences described in Chapter 1. The first of these was the shutdown of the Northern and Playford coal plants and mothballing of half the Pelican Point gas generation plant.

As Chapter 1 discusses, the switch from gas and coal to gas and wind power shaped the events of July. At times, the intermittent nature of wind forces South Australia to rely on gas generation plus transmission interconnections to bring electricity from other places. At these times gas generators set the price of electricity in the market.

The removal of fossil fuel generation also reduced the competition among generators offering hedge contracts. Many renewables will not offer hedge contracts as their revenue is secured through contractual arrangements with electricity retailers. Renewables that don't have these contractual arrangements in place cannot offer 'firm' hedges because of the intermittent nature of the generation – they cannot guarantee that the wind will be blowing at the time the generation is contracted for. But the closure of Northern meant that the supplier of low-cost hedge contracts to the market was no longer there, increasing the cost of hedging.

2.2 The RET is not suited to be Australia's only electricity emissions reduction policy

Emissions from electricity generation account for about a third of Australia's greenhouse gas emissions. Policies aimed at tackling climate change will therefore have a significant impact on the electricity sector. Since the abolition of the carbon price in 2014, the RET is now the only national policy reducing emissions in the electricity sector.

The RET was not designed to play this role. If an economy-wide carbon price had been effectively implemented and sustained, the RET would have acted as a complementary industrial policy increasing the level of generation from renewable sources but having no impact on Australia's overall emissions.

Without a carbon price, Australia has effectively decided that wind energy – along with rooftop solar – is the way to reduce emissions in the electricity sector. This is because the large-scale RET gives incentives to the lowest-cost form of renewable energy, which has turned out to be wind, while the small-scale target has given incentives to solar PV. And while a market mechanism determines the price of renewable energy certificates, the RET itself is a government intervention to ensure that 33,000 gigawatt hours of electricity is produced by 2020. This is regardless of whether the electricity market needs additional supply. But, with demand falling across the NEM from 2009, Australia did not need additional supply.

The fact that renewable projects gain a substantial part of their revenue from outside of the NEM can distort the market. For example, negative prices should encourage generators to halt production. Yet renewables keep operating, since any unit of energy they produce will generate certificates and therefore revenue.

A price on carbon is a better policy. It would make the cost of producing electricity from high emissions generators more expensive than from low emissions generators. Fossil fuel generators would bid into the NEM at a higher price to cover the cost of paying for their emissions. Because the cost of emitting would be factored into the costs of emissions-intensive power stations, the emissions reduction policy would be integrated with the NEM.[28]

Under a carbon price, it is left to the market to determine the appropriate amount and type of renewable energy that enters the grid. By increasing the cost of fossil fuel generation, a carbon price would make renewables more competitive. With a high enough carbon price and demand for new generation – either through the closure of existing generation or an increase in electricity consumption – new low-emissions generation would be built.

Investment in renewables – and therefore emissions reduction in the electricity sector – faces an uncertain future. Under current policy no renewable energy certificates will be created beyond 2030. Wind or solar farms, like most forms of generation, are long-life assets and need predictable revenue streams. But with no revenue generated from certificates after 2030 and no carbon price to drive up wholesale prices, revenue as early as 14 years away is uncertain, and this is likely to discourage businesses looking to make investments now.

[28] There are different mechanisms for pricing carbon. Under a cap and trade scheme, all generators that emit must purchase a permit for all their emissions, while renewables do not. Under an emissions intensity scheme, high emitting generators have to purchase permits, while low emitting generators and renewables generate credits that they can sell.

2.3 Policy certainty is important

Investing in new generation is expensive. Its costs need to be recovered over several decades. Such investment decisions therefore require a degree of predictability about future market conditions. More than most industry sectors, the energy market has been highly politicised and influenced by policy and regulation.

Unfortunately, stability and predictability in climate change policy has been in short supply for the electricity sector over the past decade.

The impact of this uncertainty has already been seen in relation to the carbon price and the RET. Both policies should have encouraged investment in low emissions technology. When their future was under threat – which was the case for the entire life of the fixed price on carbon and during 2014 and 2015 for the RET – little or no investment in these technologies was made.

Policy uncertainty can also lead to poor decisions by existing power generators. There have been suggestions that uncertainty has prompted generators to stay in business when it was economic to close them, because they were waiting for the government to scrap the RET or to pay them to close.[29] Such delayed decisions, if they were made, would have reduced the revenue received by other generators in the market.

[29] Nelson, *et al.* (2015)

Unpredictability can also induce generation businesses to cut back on maintenance expenditure, increasing the risk of a power station being unavailable at short notice, or even closing.

2.4 Credibility and stability are critical

Under the Paris Agreement, the Federal Government has committed to reduce emissions by 26 to 28 per cent below 2005 levels by 2030. The Government remains committed to the Direct Action policy with its two central elements: the Emissions Reduction Fund (ERF) and the Safeguard Mechanism. The first purchases emissions reductions, but is poorly suited to investment decisions that would change the power generation mix and generators are not obliged to take part in it. The second places a sector-wide emissions cap on electricity generation of 198 million tonnes of carbon. Forecasts suggest this cap is unlikely to be breached in the next few years and is therefore unlikely to have any impact on reducing emissions in the sector.[30]

In order to reach its emissions target, the Government is committed to reviewing its domestic policies in detail in 2017-18.[31] Neither the ERF nor the Safeguard Mechanism provides any effective binding constraint on emissions in the power sector. The result is unmanageable uncertainty for investors.

The uncertainty is not helped by state governments progressing with their own renewable energy targets.[32] The frustration of state and territory governments is understandable, as is their desire to help shape federal climate change policies. But the introduction of these policies can lead to unforeseen consequences in the national market. For example, policies to increase the level of renewable generation within a state could lead to higher costs for taxpayers and/or consumers in that state with no impact on national emissions. Renewable targets will not have any impact on emissions under any national policy that sets a limit or cap on annual emissions. They will just distort where and in what sector those emissions reductions will occur, which will increase costs.

Politicians at all levels of government need to decide what they want: whether to increase the amount of renewables in the system, or to reduce emissions. They are not necessarily the same thing. Policies aimed at reducing emissions should target the cheapest emissions reduction opportunities. These opportunities may or may not be in the electricity sector.

The government has several options for providing a credible pathway for meeting the current 2030 target and others that may be set in the future, while also encouraging investors.[33] The 2017-18 review cannot come too soon. It is only when a credible, predictable climate change policy has been established that policy makers can then turn to the design of the electricity market. The market must be set up to dispatch generation capacity efficiently and provide pricing signals for the investments and divestments that will be needed in coming decades.

[30] Department of Environment (2015)
[31] Commonwealth of Australia (2015)
[32] These include South Australia's target of net zero emissions by 2050, Victoria's target for 40 per cent renewable electricity by 2025, Queensland's target of 50 per cent renewable electricity by 2030 and the Australian Capital Territory's reverse auction program.
[33] For example, see Wood, *et al.* (2016).

3 The need for better energy policy

Much media coverage has focussed on whether increased levels of renewable energy in South Australia caused the high prices of the winter of 2016. In fact, a wide range of factors produced these extreme price events. Identifying a single cause misses the point, and could lead to bad policy responses.

Australia's electricity market did what it was designed to do during July. But the events have raised concerns that high levels of wind and solar power are being introduced too rapidly into our electricity supply with little consideration of the consequences for reliability, security of supply or price. If and when Australia adopts a stable and predictable climate change policy, the potential consequences for the electricity system must be understood and managed.

3.1 How the NEM is designed to work

From its inception in 1998, the NEM has provided a market to sell electricity from generators to retailers and other end-users. The market initially covered the four eastern states of Queensland, New South Wales (and the ACT), Victoria and South Australia. Tasmania joined in 2005.

It works by instantaneously matching supply of electricity to demand. All electricity is traded through this market. Australia's NEM is an energy-only market. Generators bid a price for the electricity they propose to deliver and are paid for that energy. Generators, retailers and large consumers use hedge contracts to manage their exposure to extreme price volatility. By contrast, the UK has a capacity market alongside its energy-only market. In a capacity market, generators receive payments for being available to dispatch. AEMO also operates markets for a number of ancillary services that help to maintain system stability.

Prevailing demand and supply conditions in each of the five regions of the NEM determine prices in those regions. The NEM maintains a price cap of $14,000 per megawatt hour and a minimum price of -$1000 per megawatt hour. Generators must bid within these two prices. Limits are placed on wholesale prices to contain extreme volatility in the market and reduce financial risk. Varying prices reflect the constant matching of supply with demand that varies across hours, days and seasons.

To encourage new investment, the average price that generators receive for the power they supply needs to be enough to cover their running costs (the costs of producing electricity) and their long-run costs (including the cost of financing the plant's construction). The NEM provides a mechanism for doing that.

The minimum price that a generator will bid will be the marginal cost of producing the volume concerned or the avoided cost of shutting down (see also Box 1). During periods of low demand for electricity, the price that generators typically receive is close to their marginal costs but does not cover their long-run costs. Generators with low running costs, such as coal plants, will still operate at these times.

At periods of higher demand, more expensive generation will start being dispatched. This will increase the price received by all generators and cover more of the long-run costs of low-marginal cost generation. At times of peak demand, very expensive generators, known as peaking plants, will begin to operate. They tend to be fuelled by gas and have relatively high running costs, but lower capital costs.

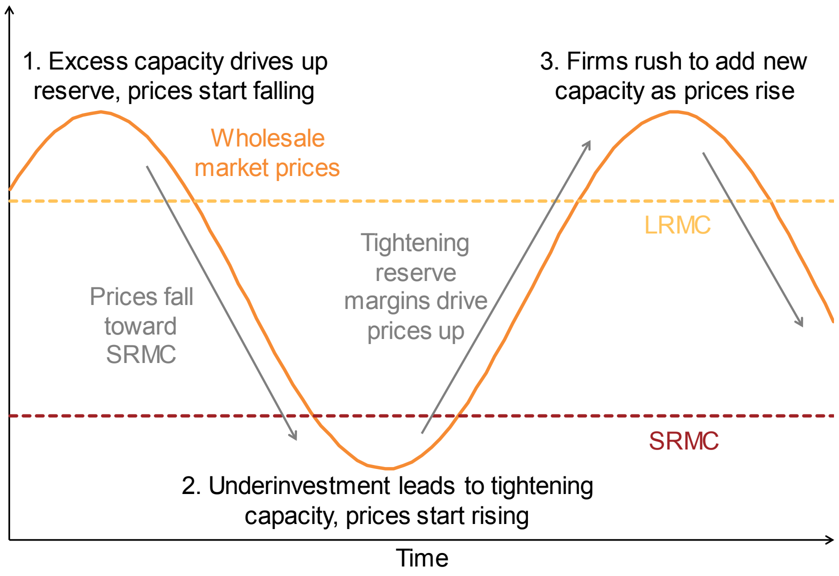
Peaking generators may operate infrequently during the year. Their investors have calculated that there will be periods when the spot price is high enough to enable them to switch on, bid into the market and make a profit. These variations in price, which only the generators, retailers and large industrial consumers typically see, are fundamental to the effective operation of the electricity market.

Since generators are long-term investments, they can cope with relatively long periods of depressed prices. Yet eventually they will need to recover their long-run costs or shut down. Shutting down of capacity or rising demand can lead to prolonged periods of high prices.

3.2 Prices in the NEM act as a signal for new investment

The capacity cycle outlined in Figure 12 shows how the market goes through periods of high prices that lead to new investment.

Figure 12: The generation capacity cycle
Average wholesale market price



Notes: LRMC = Long-run Marginal Cost; SRMC = Short-run Marginal Cost
Source: Reproduction of Steed and Laybutt (2011) in McConnell and Sandiford (2016).

When prices are high, new generation will enter the market. As more generation is added to the market, the price starts to fall. Lower prices mean lower revenues, and hence less investment, either through the upkeep of existing generation or building new generation.

While some generators can manage lower revenues in the short term, in the longer term they will struggle to keep operating. Eventually generation will leave the market. This will constrain supply and enable other generators to take advantage of market power and push up prices. If the market is allowed to work, the higher prices encourage new investment. The cycle begins again.

3.3 Wind could challenge the reliability of the energy-only market

The major sources of non-hydro, renewable electricity in Australia are wind and solar PV. This chapter focuses on wind power, but many of the issues are also relevant to solar PV.

The nature of wind energy is different to the types of generation that have dominated Australia's electricity system to date. Wind power is intermittent and has close to zero marginal cost. It also does not have the same properties as fossil fuel generation. More wind generation poses challenges for the stability of the grid. These characteristics have the potential to affect the reliability and security of the system.

Electricity reliability has not been a concern in Australia for many years. Generation capacity has been and is forecast to be enough to meet demand. If anything, the bigger risk has been oversupply.[34] With the recent closure and mothballing of some generation, supply has been tightening.

A transition from high to low greenhouse gas emitting plants is necessary, yet presents a problem if reliability is threatened. The market must be flexible enough to respond to changes in the demand-supply balance caused by the sudden unavailability of wind. And the market needs to be able to send the right price signals that lead to efficient new investment or divestment. The presence of wind, which is low marginal cost and gains a significant part of its revenue through the RET, may distort price signals.

3.3.1 Flexible supply becomes very important

At times in South Australia, wind generation has already been able to supply 100 per cent of demand.[35] At other times, it hardly contributes at all, as Chapter 1 outlines. While coal and gas plants can experience times of unavailability, these can often be planned and they would be extremely unlikely to occur concurrently. During these times the market must provide alternatives. These include: generation that can respond flexibly; payments to large industrial customers to reduce demand; storage, such as hydro or batteries; or supply from interstate. All these alternatives are possible, but only if they receive higher prices.

The market's performance in South Australia indicates that it is doing what a market should do. In July, when supply was limited from wind farms and Heywood, flexible generation was needed. High price volatility – on 53 occasions the spot price was above $1500 a megawatt hour – was the result.

But July was just one month and the events in that time do not mean that high wind penetration has either suppressed or exacerbated price volatility. There have been plenty of periods of high price volatility this century, as Figure 10 in Chapter 1 shows. Price volatility can provide the signals for new investment but

[34] Nelson, *et al.* (2015)

[35] Parkinson (2014)

volatility characterised by infrequent, very high prices for very short periods can mean too much risk.

Developments suggest that the market is in delicate balance. Flexible generators will continue to be available only if they can get enough revenue from the spot market or from retailers and large consumers who would be exposed to even higher prices if they were unavailable. In the future the amount of intermittent generation will only increase, further depressing wholesale spot prices. The costs of flexible gas generators are also likely to rise if there is a carbon price. The market's delicate balance is likely to come under further pressure.

3.3.2 Investment in new generation needs the right price signals

New generation investment might be needed soon. AEMO forecasts that reliability will start falling below the accepted standard from 2019 in South Australia and from 2025 in Victoria and New South Wales – that is, there may not be enough generation available to meet predicted maximum demand.[36] The current reliability standard is that the amount of electricity expected to be at risk of not being supplied to consumers ('unserved energy') should not exceed 0.002 per cent of consumption in any region (state) in any financial year. Assuming constant demand over time, this equates to around 11 minutes of unserved energy per year – or 11 minutes where there will not be enough supply to meet demand.

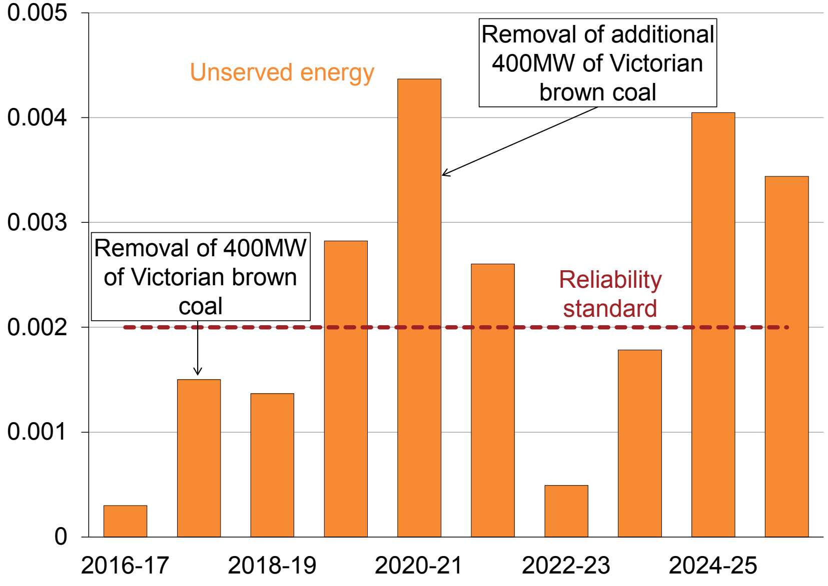
To understand the implications of Australia meeting its commitments under the Paris Agreement, AEMO modelled a scenario in which some of Victoria's brown coal generation capacity leaves the market in 2017-18 and again in 2020-21. As Figure 13 shows, in this scenario the amount of unserved energy is forecast to exceed the reliability standard in 2019-20, and then four more times in the following six years.

The forecast does not mean there will be blackouts. Even if a shortfall does occur it could be resolved without the need for new generation, since reduction in demand from some large industrial users of electricity could meet the reliability standard. But the situation shows that after a period of overcapacity, the market is tightening. New generation could be needed in the not-too-distant future.

Wind power with its low marginal cost tends to suppress wholesale electricity prices, particularly when demand is low. New, flexible generation will need to earn revenue through volatility in the price. For peaking plants, price spikes can be less often but would need to be very high.

[36] Australian Energy Market Operator (2016a)

Figure 13: Removal of brown coal capacity in Victoria could contribute to supply shortfalls in South Australia
Per cent of unserved energy



Source: Australian Energy Market Operator (2016a)

The data are unclear on whether the introduction of significant wind generation in the market has created lower or higher price volatility.[37] Without long-term volatility, revenue for flexible generation is uncertain. The fact that the removal of gas-fired generation from the market had been planned is evidence that price volatility wasn't enough to encourage flexible, gas-fired generation to stay in the market.

[37] For example, see Ketterer (2014) and Parkinson (2016).

The 2009 Tamblyn Review looked at how Australia's electricity market framework would cope with Australia's climate change policies. At that time, the policies were the proposed Carbon Pollution Reduction Scheme and the RET. The Review found that the electricity market was "generally capable of accommodating the impacts of climate change policies efficiently and reliably".[38] The Review also found that the "need for more peaking generation to complement intermittent wind-powered generation may require significant upward adjustment of the market price cap over time to ensure that the necessary new entrant plant is economically viable".[39]

The price cap is currently set at $14,000 per megawatt hour. One 2016 study looked at what the price cap should be under an extreme scenario with 100 per cent intermittent generation and no demand response. It estimated the required level at between $60,000 to $80,000 per megawatt hour, indicating that wholesale prices could well oscillate between negative amounts to $80,000 per megawatt hour.[40]

High volatility in spot market prices and therefore in revenue will make financiers nervous, particularly when such a large proportion of peaking generators' revenue will rely on relatively few, and unpredictable, periods of high pricing.

Politicians will not like such periods of high prices, and are unlikely to be able to resist intervening. Either they will prevent the

[38] Australian Energy Market Commission (2009)
[39] Ibid.
[40] Riesz, *et al.* (2016).

market cap from increasing sufficiently or they will try to directly intervene in the market. Either will further deter investment.

There is an alternative to generators depending on such volatility in the wholesale spot price. Generators could rely more heavily on the hedging market to guarantee their revenue. Retailers and large consumers would be prepared to pay generators more for hedging contracts, providing new entrant generators with the revenue they need. Such contracts, alongside existing hedging arrangements, would relieve investors from having to rely only on prices in the NEM spot market to make their investment decisions. But again, considerable uncertainty lies around this alternative.

A number of national and international studies have questioned whether an energy-only market such as Australia's can work when large amounts of energy are generated intermittently at low marginal cost.[41] There is mixed real world evidence that wholesale spot markets must be replaced or supplemented, or even what effective alternatives might be.

The challenge is not unique to Australia. Many countries with a high proportion of renewable energy are looking at how their markets work.

As recently as June this year, Germany announced that it would introduce a new 'capacity reserve'.[42] Under this process, the Government would purchase capacity – equivalent to five per cent of maximum demand – that would not operate in the market, but sit in reserve in case it was needed or "when all market based options on the power market are exhausted".[43]

In 2013, the UK Government recognised a "risk to security of electricity supplies in the future, as around a fifth of existing capacity is expected to close over the next decade and more intermittent (wind) and less flexible (nuclear) generation is built to replace it. These changes to our market could lead to under-investment and uncomfortably low levels of reliable capacity. If we don't act, a central scenario we have modelled suggests that in some years we could see blackouts affecting up to 2.5 million homes."[44] The UK responded by introducing its own version of a capacity market. It is still evolving and some criticism has been fierce.[45]

The introduction of capacity markets – in which generation is paid to be there just in case – seems to be a costly way to ensure reliability. Western Australia has such a market. Between 2007-8 and 2015-16, the state is estimated to have paid $1 billion more for capacity than it actually needed.[46] Capacity markets open up the likelihood of a centrally planned system, in which investment risk is shifted to taxpayers and consumers.

It is a particularly tricky problem. At present there is insufficient evidence that Australia's electricity market will not cope with the low-emissions transition. But such evidence is likely to appear only when it is too late to resolve the problem.

41 For example, see: Browne*, et al.* (2015); Nelson*, et al.* (2015); and Nelson and Orton (2016).
42 German Federal Ministry for Economic Affairs and Energy (2016)
43 Amelang and Appunn (2016)
44 UK Department of Energy & Climate Change (2012)
45 For example, see: Evans (2013) and Orme (2016).
46 Western Australia Department of Finance (2014)

To quote the Tamblyn Review, "ongoing review of market development generally, and the consequences of climate change policy in particular, will be required".[47] But Australia's climate change policy has changed significantly since the Tamblyn Review. We now appear to entering a period of tightening supply when new generation may be needed by the market. A review of the ability of the NEM to accommodate the impact of Australia's emerging climate change policies would seem very timely.

3.4 Wind and solar PV can affect system security

The increased penetration of renewables does not just have potential implications for the NEM in terms of price signals for new investment. It can also have consequences for the security and stability of the electricity system.

The frequency at which the electricity system operates needs to stay balanced. Balance is easier to do with fossil fuel and hydro power stations than with generation such as wind and solar PV. This is because wind and solar do not operate at the same frequency as the electricity system. Wind turbines, for example, generally rotate according to the speed of the wind, rather than the frequency of the system. On this basis, wind and solar are described as providing asynchronous generation. In addition, constantly changing wind output can affect system frequency if not adequately managed. There are solutions, but they have not been considered necessary to date.

Current regulations and markets have been designed to manage large amounts of synchronous generation. Some generators are paid to provide Frequency Control and Ancillary Services (FCAS) that maintain the balance of supply and demand in the grid (see Box 3 for more detail).

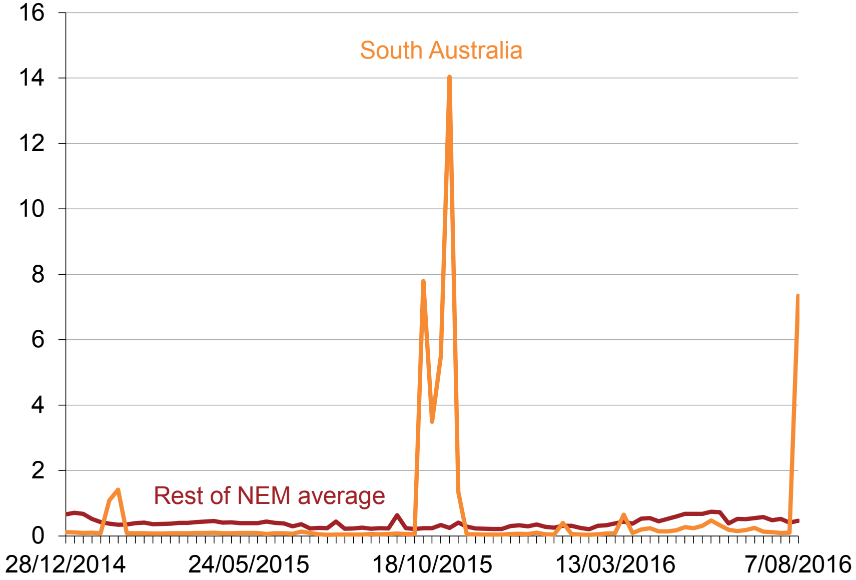
There are signs that already limited local supply of FCAS in South Australia has tightened in the past year. In November 2015, only three power stations – Northern, Torrens Island A and B and Pelican Point – were registered to provide the services. Since then, as discussed, Northern has closed and half of Pelican Point has been mothballed. Importing electricity through Heywood helps to maintain frequency in the South Australian grid, but Heywood provides the state's only external link to that support.

In the past year South Australia has experienced two periods of extreme prices in the market for FCAS. Figure 14 shows that during these periods the cost to the market of these services was significantly higher than usual. Notably, neither of these occurred during the July period when NEM prices spiked.

[47] Australian Energy Market Commission (2009)

Figure 14: South Australia has experienced two periods of high FCAS costs in the past year

Total payments to FCAS providers for the week beginning, $ million



Sources: Australian Energy Market Operator data; Grattan analysis

With the current supply mix, the Heywood interconnector helps to provide system security to South Australia.[48] But if both lines of the interconnector were to suffer an outage, the possibility of a regional blackout in South Australia increases with more wind generation.[49]

[48] Australian Energy Market Commission (2016a)
[49] Australian Energy Market Operator (2016a)

Box 3: Frequency Control and Ancillary Services (FCAS)

Frequency is a measure of the balance between supply and demand in the power system. The balance needs to be maintained every second of every day.

Australia's power system frequency is maintained at 50 hertz. This means that, even at short intervals, supply and demand are balanced. If there is a sudden loss of supply – an outage at a generator – new generation needs to come on board quickly or demand needs to be reduced. Failure to do so may cause black outs.

This is where FCAS come in. Rapidly responding generators or industrial customers with sufficiently large and flexible electricity consumption bid to provide these balancing services within six seconds, 60 seconds or five minutes. Unlike the supply of energy in the NEM, providers of FCAS get paid for both the service they provide and their availability to provide the service. Simply put, they get paid even if the service is not required.

Existing fossil-fuel and hydro generators are synchronous; the generators operate at the same frequency as the electricity system. This provides inertia in the system – it makes changes in the frequency of the overall system slower, which allows for longer time periods in which FCAS can be provided.

Wind and solar are asynchronous. They require sophisticated power electronics and new technical regulations if they are to contribute to system stability and inertia.[50]

[50] Ibid.

This kind of threat has existed on four occasions since the late 1990s.[51] But with fewer fossil fuel generators available to provide system stability, the consequences now are far greater.

In 2010, there was over a 90 per cent chance that the frequency standard of the grid would be maintained in the unlikely event that both lines of the Heywood interconnector were to suffer an outage. In 2015, this fell to a little over 10 per cent.[52] If the frequency standard were not met it would mean blackouts in South Australia. This is a worst case scenario, but it indicates how much changes in the supply mix have affected supply security in South Australia.

In cooperation with AEMO, the AEMC is reviewing system security. [53] The goal is to assess the sort of risks described above and to recommend changes to market rules or regulations to address those risks.

3.5 Greater interconnection is another option

The NEM operates on one of the world's longest interconnected power systems, stretching from Port Douglas in Queensland to Port Lincoln in South Australia and across the Bass Strait to Tasmania – a distance of about 4500 kilometres.[54] Historically, each state generated most of its own power, with interstate transmission mostly providing opportunities to balance surpluses and scarcities. Recent events suggest that transmission is already expected to provide both reliability and security, a role for which the current connections are not prepared.

The South Australian Government has committed $500,000 to a study that will look at an interconnector between South Australia and New South Wales.[55] The Government seems to be most concerned to keep prices low, yet increased connection with other states can also help to address concerns over flexibility and security.

Investment in a transmission interconnector needs to be financially justified. A market interconnector such as Basslink earns revenue from participating in the wholesale markets in two states. A regulated interconnector covers its costs through consumer network charges set by the AER.

A market interconnector faces the same uncertainties as new generation does. Part of this uncertainty arises in how interconnectors may be used in the future. Will they need to be paid more to meet a small number of extreme conditions rather than to routinely deliver electricity? A similar challenge faces the regulator who, in approving a regulated interconnector, will need to be convinced that the investment "maximises benefits to all those who produce, consume and transport electricity in the market".[56]

Current overcapacity across parts of the NEM could mean that a new interconnector provides South Australia with access to cheap and available electricity from other states. This may not persist.

[51] Ibid.
[52] Australian Energy Market Operator (2016b)
[53] Australian Energy Market Commission (2016b)
[54] Australian Energy Regulator (2015)
[55] Weatherill (2016)
[56] Australian Energy Regulator (2010)

The closure of fossil fuel plants that have been experienced in South Australia could well be repeated in other states. Cheaper electricity would no longer be as available, leaving shareholders or consumers with a high cost and unnecessary interconnector.

Interconnectors face the same policy uncertainty as the rest of the electricity market. Providing policy stability and predictability to address climate change should come first. Once climate change policy is settled, policy makers should turn their minds to reviewing whether the structure of the NEM needs to be improved, supplemented or revised to create efficient incentives for the necessary investment.

3.6 Energy prices will rise

The changing supply mix of Australia's electricity market will have consequences for the prices paid by consumers. Prices on the wholesale spot market will have to rise to cover the long-run costs of new (and existing) generation. Greater volatility of wholesale prices is likely to increase the cost of hedging, thereby increasing customers' bills. And climate change policy will lead to increases in the cost of generation.

A major problem for the 2012-2014 fixed carbon price was that it pushed up electricity prices by about 10 per cent.[57] The Coalition made it part of their election winning strategy in 2013. The fact that its own policy alternative, the ERF, is funded by taxpayers through a budget allocation rather than through electricity price increases was part of its strategy. Since that election result, assessments of climate change policy have placed increased focus on whether policies keep electricity price increases down.[58] This focus appears to acknowledge that politicians are unlikely at present to pursue policies that have a significant and explicit impact on electricity prices.

The even harder reality is that the environmental cost of greenhouse gas emissions is not reflected in the cost of electricity generation that produces such emissions. Failure to fully price this cost acts as a subsidy to these forms of generation. However climate change policy manages to put a price on emissions, the transition will cost money. The cost comes in replacing existing plants such as coal – which generate at about $50 per megawatt hour – earlier than they would otherwise have shut down and replacing them with any combination of gas, wind or solar plants, which generate at around $80-$100 per megawatt hour. The transition is necessary and right, but political leaders must explain it as they make the case for addressing climate change.

[57] For example, see estimates of the effect of the carbon price in Australian Energy Market Commission (2013).

[58] For example, see: Climate Change Authority (2016); Jacobs (2016); and Wood, *et al.* (2016).

4 Recommendations

The events of July do not expose an immediate crisis. Yet they have brought to the top of the agenda the potential consequences of a disconnection between climate change policy and energy markets. The disconnection arises from imposing a set of new century energy supply technologies on a market designed to work with a very different set of technologies. If it is not addressed, there is a real risk that the objectives of reliable, affordable and sustainable energy will not be achieved.

The COAG Energy Council, the body of federal and state energy ministers, acknowledges the challenge.[59] Meeting it requires a credible and predictable national climate change policy and a wholesale market design that together deliver reliable, competitively priced electricity. The dual issues need to be addressed in that order.

4.1 Develop credible, predictable climate change policy

The absence of a stable, credible and predictable climate change policy has threatened the environment and investment in the energy sector for most of this century. The requirements are clear.

First, there is a central lesson from the past eight years of toxic debate on climate policy. Bipartisan commitment to a new policy is crucial.

Second, climate change policy should work with and not outside the electricity market. The RET has succeeded in increasing levels of renewable energy in the NEM, but forcing in new intermittent capacity creates real challenges over efficient dispatch of existing generation and providing clear price signals for investment and divestment.

Third, policies designed to complement the main climate change policy need to do the same in regard to the electricity market. A credible and predictable carbon price should remove any justification for specific policies, such as the RET, to support renewable energy deployment.

Finally, climate change is a global problem. Australia has introduced and will introduce national policies to meet our international commitments to tackle climate change. Unilateral action by states or territories is likely to distort the implementation of national policies and increase costs with no net environmental benefit.

The Federal Government has committed to a 2017 review of its climate change policies. Potential actions emerging from that review include the approach recommended in our recent report, *Climate Phoenix: a sustainable Australian climate policy.*[60] It recommended that the Safeguard Mechanism be transformed into two schemes: an intensity baseline scheme for the electricity sector and an absolute baseline scheme for other large emitters. The baselines of both schemes would be reduced in line with Australia's emissions reduction commitments.

[59] COAG Energy Council (2016)

[60] Wood, *et al.* (2016)

Agreement between political parties and between the Federal Government and the states and territories will be difficult. The events of July in South Australia should provide a strong catalyst for agreement. A settled policy environment is now urgent if Australia is to have an energy market that works.

4.2 Recognise the energy transition and its cost

As part of the Paris Agreement, countries agreed to limit the increase in global temperature to 'well below' two degrees.[61] The Climate Change Authority and others believe that Australia should achieve net zero emissions by 2050 if it is to contribute fairly to this global effort.[62]

This means that Australia will need to dramatically reduce emissions from its electricity sector – which accounts for a third of all of Australia's emissions – in a relatively short period of time.

The Federal Minister for Environment and Energy, Josh Frydenberg, has noted that coal is falling as a proportion of Australia's electricity mix and is being replaced by gas and renewables.[63] Replacing fossil-fuel generation with low-emissions generation is going to cost more. The cost represents the collective historical failure to recognise and account for the environmental damage of greenhouse gas emissions, and it must be borne.

[61] United Nations Framework Convention on Climate Change (2015)
[62] Climate Change Authority (2015); Climate Institute (2015); ClimateWorks (2015)
[63] Karp (2016)

These two key messages – that a major transition is going to happen and there will be a cost – need to be accepted and explained. Setting alternative expectations will leave the public frustrated and disappointed. Increased electricity costs when consumers are not expecting them could lead to a backlash that once again slows Australia's response to climate change.

4.3 Review the NEM

Since its creation in 1998, the NEM has helped to provide affordable, reliable and secure electricity. It faces new challenges that were not envisaged when it was established. When an increasing proportion of generation is intermittent and has low-marginal cost, it raises questions about whether the energy-only NEM can continue to efficiently deliver reliable electricity supply.

Many commentators agree that wholesale electricity markets are facing serious challenges,[64] but agree less on solutions.[65] There are good reasons why capacity markets are considered to be poor solutions. There are also reasons to believe the current market can do the job, but it may need to be supported by payment structures that do not fully exist today. For example, retailers might need to secure contractual arrangements with flexible generators to protect against the results of more intermittent supply.

Australia should not rush to the answer. The events in South Australia in July show that the existing market can still deliver the reliability and security that we need for the time being. But

[64] For example, see: Keay (2016); Nelson (2016); and Vorrath (2016).
[65] King Abdullah Petroleum Studies and Research Center (2016)

complacency is not an option. Rare events can and do happen, and regional blackouts are not the way to create urgency.

Once reasonable clarity over a stable climate change policy framework exists, the Federal Government should review the energy-only NEM, and assess whether alternative or additional mechanisms might be necessary to avoid future threats to reliability and/or security.

4.4 Expedite the system security review

It is not before time that AEMO and AEMC are reviewing the impact on system security of an increasing amount of intermittent, asynchronous generation in the NEM. This review will consider whether current mechanisms are enough to maintain power system security and what, if any, new services and/or regulatory frameworks will be required.

Yet the review is not scheduled to report on progress until the end of 2016. While it will identify issues and recommend solutions, acting on these recommendations will not be a short-term task. It would be highly desirable to move more quickly to address more immediate threats such as the risk of blackouts in South Australia if it is 'islanded' from the NEM.[66]

The COAG Energy Council has agreed "to provide for additional AEMC Commissioners and provide for greater use of the expedited rule change process, as part of wider measures to strengthen the AEMC's governance structure and future capacity".[67] In a market where the pace of technological change is significant, regulatory and market settings risk getting left behind. The COAG Energy Council needs to further consider ways in which the processes to change the market settings can become more responsive. Its attention needs to be focused on these issues early enough to avoid simply being reactive to events such as those that occurred in South Australia in July.

The system security review is expected to consider the hard work of developing market and regulatory frameworks to deliver new system security services that utilise a range of technologies, many of which are only just emerging. Understanding and responding to these issues is likely to become both more complex and more important as the electricity sector moves towards a very low carbon future. This hard work should begin now.

[66] Australian Energy Market Operator (2016a)

[67] COAG Energy Council (2016)

5 References

ABC News (2016) *AGL hikes SA electricity prices 10pc, blames power station closures*, accessed 20 September 2016, from http://www.abc.net.au/news/2016-06-15/agl-customers-in-sa-electricity-prices-rise-by-10-per-cent/7513222

Alinta Energy (2015) *Flinders Operations Announcement*, accessed 20 September 2016, from https://www.alintaenergy.com.au/about-us/news/flinders-operations-announcement

Amelang, S. and Appunn, K. (2016) *Germany's new power market design*, Clean Energy Wire, accessed 14 September 2016, from https://www.cleanenergywire.org/factsheets/germanys-new-power-market-design

Appunn, K. (2015) *Setting the power price: the merit order effect*, Clean Energy Wire, accessed 14 September 2016, from https://www.cleanenergywire.org/factsheets/setting-power-price-merit-order-effect

Australian Energy Market Commission (2009) *Review of Energy Market Frameworks in light of Climate Change Policies: Final Report*, accessed 20 September 2016, from http://www.aemc.gov.au/Markets-Reviews-Advice/Review-of-Energy-Market-Frameworks-in-light-of-Cli

Australian Energy Market Commission (2013) *2013 Residential Electricity Price Trends*, accessed 15 September 2016, from http://www.aemc.gov.au/Markets-Reviews-Advice/Retail-Electricity-Price-Trends-2013

Australian Energy Market Commission (2014) *2014 Residential Electricity Price Trends*, accessed 15 September 2016, from http://www.aemc.gov.au/Markets-Reviews-Advice/2014-Residential-Electricity-Price-Trends

Australian Energy Market Commission (2016a) *System Security Market Frameworks Review*, accessed 14 September 2016, from http://www.aemc.gov.au/getattachment/acecf3fb-51d4-4bce-8fcf-6fd22e81fab3/Information-Sheet.aspx

Australian Energy Market Commission (2016b) *System Security Market Frameworks Review – Terms of Reference*, accessed 14 September 2016, from http://www.aemc.gov.au/getattachment/b1f8c1e1-dcbe-4585-aa45-9152104fdcf2/Terms-of-reference.aspx

Australian Energy Market Operator (2010) *An introduction to Australia's National Electricity Market*, accessed 14 September 2016, from http://www.abc.net.au/mediawatch/transcripts/1234_aemo2.pdf

Australian Energy Market Operator (2016a) *2016 NEM Electricity Statement of Opportunities*, accessed 14 September 2016, from https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/NEM-Electricity-Statement-of-Opportunities

Australian Energy Market Operator (2016b) *Future Power System Security Program: Progress Report*, accessed 23 September 2016, from https://aemo.com.au/Media-Centre/~/-/media/823E457AEA5E43BE83DDD56767126BF2.ashx

Australian Energy Market Operator (2016c) *South Australia: Wholesale electricity market July 2016*, accessed 14 September 2016, from http://aemo.com.au/Media-Centre/-/media/DA7B66D940EE4FABBC8973F9CBDF9EEA.ashx

Australian Energy Regulator (2010) *Regulatory investment test for transmission*, accessed 14 September 2016, from https://www.aer.gov.au/system/files/Final%20RIT-T%20-%2029%20June%202010.pdf

Australian Energy Regulator (2015) *State of the energy market 2015*, accessed 19 September 2016, from https://www.aer.gov.au/publications/state-of-the-energy-market-reports/state-of-the-energy-market-2015

Australian Energy Regulator (2016) *Winter energy prices 2016*, accessed 14 September 2016, from http://www.aer.gov.au/system/files/AER%20Winter%20energy%20prices%202016.pdf

Booth, M. and Uren, D. (2016) 'Call to end wind farms until power solution found', *The Australian,* 25 July 2016, accessed 13 September 2016, from http://www.theaustralian.com.au/news/call-to-end-wind-farms-until-power-solution-found/news-story/acb7ab766e1d1d12140c0edc02a623f6

Browne, O., Poletti, S. and Young, D. (2015) 'How does market power affect the impact of large scale wind investment in'energy only'wholesale electricity markets?', *Energy Policy*, 87(C), p 17-27

Clean Energy Council (2015) *Clean Energy Australia Report 2015*, accessed 23 September 2016, from https://www.cleanenergycouncil.org.au/policy-advocacy/reports/clean-energy-australia-report.html

Clean Energy Regulator (multiple years) *Postcode data for small-scale installations*, accessed 14 September 2016, from http://www.cleanenergyregulator.gov.au/RET/Forms-and-resources/Postcode-data-for-small-scale-installations#SGU--Solar-Deemed

Climate Change Authority (2015) *Special Review draft report: Australia's future emissions reduction targets*, accessed 21 March 2016, from http://www.climatechangeauthority.gov.au/special-review/first-draft-report

Climate Change Authority (2016) *Towards a climate policy toolkit: Special Review of Australia's climate goals and policies*, accessed 14 September 2016, from http://climatechangeauthority.gov.au/reviews/special-review/towards-climate-policy-toolkit-special-review-australias-climate-goals-and

Climate Institute (2015) *Government climate targets fail key tests*, accessed 21 March 2016, from http://www.climateinstitute.org.au/articles/media-releases/government-climate-targets-fail-key-tests.html

ClimateWorks (2015) *Australia can achieve the new emissions reduction target and more*, accessed 21 March 2016, from http://climateworks.com.au/story/media-release/australia-can-achieve-new-emissions-reduction-target-and-more

CME (2016) *South Australia's wholesale electricity market: what really happened in July 2016?*, accessed 14 September 2016, from http://cmeaustralia.com.au/public-reports/160815-final-south-australia-7-july-getup-report/

CO2CRC (2015) *Australian Power Generation Technology Report*, accessed 23 September 2016, from http://www.co2crc.com.au/wp-content/uploads/2016/04/LCOE_Report_final_web.pdf

COAG Energy Council (2016) *Communique of the 5th meeting of the COAG Energy Council*, accessed 14 September 2016, from http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/Energy%20Council%20Communique%20-%2019%20August%202016%20-%20FINAL.pdf

Commonwealth of Australia (2014) *Renewable Energy Target Scheme: Report of the Expert Panel*, accessed 14 September 2016, from http://webarchive.nla.gov.au/gov/20150621235616/http://retreview.dpmc.gov.au/ret-review-report-0

Commonwealth of Australia (2015) *Australia's 2030 Emissions Reduction Target*, accessed 22 March 2016, from http://www.environment.gov.au/climate-change/publications/australias-2030-emission-reduction-target

Department of Environment (2015) *Tracking to 2020: an interim update of Australia's greenhouse gas emissions projections*, accessed 22 March 2016, from http://www.environment.gov.au/climate-change/publications/tracking-to-2020

Donoghue, K. (2016) *South Australia's (re)balancing act*, Australian Energy Council, accessed 15 September 2016, from https://www.energycouncil.com.au/analysis/south-australia-s-re-balancing-act/

Evans, N. (2013) *Security of electricity supply: is a Capacity Market the answer?*, Letters & Notes on Regulation, Regulatory Policy Institute, accessed 14 September 2016, from http://www.rpieurope.org/Letters_and_Notes.shtml

Forrest, S. and MacGill, I. (2013) 'Assessing the impact of wind generation on wholesale prices and generator dispatch in the Australian National Electricity Market', *Energy Policy*, 59, p 120-132

German Federal Ministry for Economic Affairs and Energy (2016)

Electricity Market 2.0: An electricity market for Germany's energy transition, accessed 13 September 2016, from http://www.bmwi.de/EN/Topics/Energy/Electricity-Market-of-the-Future/electricity-market-2-0.html

Jacobs (2016) *Modelling of Alternate Policy Scenarios*, accessed 20 September 2016, from http://www.ena.asn.au/sites/default/files/australias_climate_policy_options_modelling_of_alternate_policy_scenarios_22082016.pdf

Karp, P. (2016) 'Josh Frydenberg plays down Climate Change Authority call for tougher emissions limits', *The Guardian,* 1 September 2016, accessed 14 September 2016, from https://www.theguardian.com/australia-news/2016/sep/01/josh-frydenberg-rejects-climate-change-authority-calls-for-tougher-emissions-limits

Keay, M. (2016) *Electricity markets are broken–can they be fixed?*, OIES Paper EL 17, Oxford Institute for Energy Studies, accessed 14 September 2016, from https://www.oxfordenergy.org/wpcms/wp-content/uploads/2016/02/Electricity-markets-are-broken-can-they-be-fixed-EL-17.pdf

Ketterer, J. C. (2014) 'The impact of wind power generation on the electricity price in Germany', *Energy Economics*, 44, p 270-280

King Abdullah Petroleum Studies and Research Center (2016) *Designing Electricity Markets to Integrate Renewable Energy*, accessed 14 September 2016, from https://www.kapsarc.org/wp-content/uploads/2016/06/KS-1630-WB029A-Designing-Electricity-Markets-to-Integrate-Renewable-Energy.pdf

Koutsantonis, T. (2016) *State Government intervenes in energy market to protect South Australian businesses*, accessed 14 September 2016, from http://www.premier.sa.gov.au/index.php/tom-koutsantonis-news-releases/859-state-government-intervenes-in-energy-market-to-protect-south-australian-businesses

McConnell, D. and Sandiford, M. (2016) *Winds of change: An analysis of recent changes in the South Australian electricity market*, Melbourne Energy Institute, accessed 14 September 2016, from https://d3n8a8pro7vhmx.cloudfront.net/auscon/pages/1246/attachments/original/1470896648/SA_PRICES_FINAL.pdf?1470896648

Moran, A. (2016) 'Renewables an expensive rejection of cheap fuel and competitive advantage', *Australian Financial Review,* accessed 13 September 2016, from http://www.afr.com/opinion/columnists/renewables-an-expensive-rejection-of-cheap-fuel-and-competitive-advantage-20160728-gqfqxv#ixzz4IsJVirX8

Nelson, T. (2016) *The case for climate and electricity policy integration*, ANZ BlueNotes, accessed 22 September 2016, from https://www.bluenotes.anz.com/posts/2016/08/the-case-for-climate-and-electricity-policy-integration/

Nelson, T. and Orton, F. (2016) 'Climate and electricity policy integration: Is the South Australian electricity market the canary in the coalmine?', *The Electricity Journal*, 29(4), p 1-7

Nelson, T., Reid, C. and McNeill, J. (2015) 'Energy-only markets and renewable energy targets: Complementary policy or policy collision?', *Economic Analysis and Policy*, 46, p 25-42

Orme, B. (2016) *Understanding the government's capacity market*, CarbonBrief, accessed 14 September 2016, from https://www.carbonbrief.org/guest-post-understanding-governments-capacity-market

Owen, M. (2016) 'Rush to wind forcing power prices up, say SA Liberals', *The Australian,* 15 July 2016, accessed 13 September 2016, from http://www.theaustralian.com.au/national-affairs/state-politics/rush-to-wind-forcing-power-prices-up-say-sa-liberals/news-story/074719a5fb6373770b1ce54bbeb42186

Parkinson, G. (2014) *Graph of the Day: Has Australia hit peak wind?*, RenewEconomy, accessed 14 September 2016, from http://reneweconomy.com.au/2014/graph-of-the-day-has-australia-hit-peak-wind-48778

Parkinson, G. (2016) *How wind and solar removed major price spikes in South Australia*, RenewEconomy, accessed 14 September 2016, from http://reneweconomy.com.au/2016/wind-solar-removed-major-price-spikes-south-australia-48504

Penberthy, D. (2016) 'The legacy of Mike Rann's Earth Hour vision risks turning off lights for SA', *Adelaide Advertiser,* 21 July 2016, accessed 13 September 2016, from http://www.adelaidenow.com.au/news/opinion/david-penberthy-mikes-earth-hour-vision-risks-turning-off-lights-for-sa/news-story/a38f474b5dc2af599d9ab6ab64e9c55d

Productivity Commission (2013) *Electricity Network Regulatory Frameworks - Inquiry report, Appendix C Hedging in the electricity market* accessed 14 September 2016, from http://www.pc.gov.au/inquiries/completed/electricity/report/28-electricity-appendixc.pdf

Rann, M. (2011) *South Australia meets 20% renewable energy target*, accessed 14 September 2016, from http://www.renewablessa.sa.gov.au/files/110622-ministerial---renewable-energy-.pdf

RenewablesSA 'Renewable Energy Resource Maps', accessed 14 September 2016, from http://www.renewablessa.sa.gov.au/investor-information/resources

Riesz, J., Gilmore, J. and MacGill, I. (2016) 'Assessing the viability of Energy-Only Markets with 100% Renewables', *Economics of Energy & Environmental Policy*, 5(1),

Sloan, J. (2016) 'Energy price reveals folly of renewables', *The Australian,* 19 July 2016, from http://www.theaustralian.com.au/opinion/columnists/judith-sloan/energy-price-reveals-folly-of-renewables/news-story/8a18dd4b193039ec6b6138e682192e55

Spence, A. (2016) 'Major Australian wind farm joins the grid', *The Lead South Australia,* 7 July 2016, accessed 20 September 2016, from http://www.theleadsouthaustralia.com.au/industries/mining-resources/major-australian-wind-farm-joins-the-grid/

Stock, A. and Stock, P. (2016) *The perfect storm: Analysing the role of gas in South Australia's power prices*, Climate Council, accessed 14 September 2016, from https://www.climatecouncil.org.au/perfect-storm-report

UK Department of Energy & Climate Change (2012) *Electricity Market Reform: Capacity Market - Design and Implementation Update, Annex C*, accessed 14 September 2016, from https://www.gov.uk/government/publications/electricity-market-reform-policy-overview

United Nations Framework Convention on Climate Change (2015) *Adoption of the Paris Agreement,* Conference of the Parties, Twenty-first session, accessed 21 March 2016, from https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf

Vorrath, S. (2016) *Graph of the Day: Why the NEM is broken*, RenewEconomy, accessed 22 September 2016, from http://reneweconomy.com.au/2016/graph-of-the-day-why-the-nem-is-broken-12107

Weatherill, J. (2016) *Energy market changes to increase competition and drive down costs*, accessed 14 September 2016, from http://www.premier.sa.gov.au/index.php/jay-weatherill-news-releases/1112-energy-market-changes-to-increase-competition-and-drive-down-costs

Western Australia Department of Finance (2014) *Electricity Market Review: Discussion Paper*, accessed 20 September 2016, from http://www.finance.wa.gov.au/cms/uploadedFiles/Public_Utilities_Office/Electricity_Market_Review/electricity-market-review-discussion-paper.pdf

Wood, T., Blowers, D. and Chisholm, C. (2015) *Sundown, sunrise: how Australia can finally get solar power right*, Grattan Institute, accessed 22 March 2016, from http://grattan.edu.au/report/sundown-sunrise-how-australia-can-finally-get-solar-power-right/

Wood, T., Blowers, D. and Moran, G. (2016) *Climate phoenix: a sustainable Australian climate policy*, Grattan Institute, accessed 14 September 2016, from http://grattan.edu.au/report/climate-phoenix-a-sustainable-australian-climate-policy/

Wood, T., Carter, L. and Harrison, C. (2013) *Shock to the system: dealing with falling electricity demand*, Grattan Institute, accessed 23 September 2016, from https://grattan.edu.au/report/shock-to-the-system-dealing-with-falling-electricity-demand/