Media backgrounder:
8 facts about energy this summer

17 January 2018

There is a lot of media interest in how the electricity system that connects Australia's eastern states will cope this summer. Many industry bodies, government agencies and academic institutions have published detailed reports on this topic, and plenty of data exists, but not all of this can be readily decoded.

This backgrounder explains recent developments in Australia's National Electricity Market in a more accessible style for the media and the general public. All sources are linked for finding more detail.

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1) Coal power stations have become a major cause of unreliability

In the space of one week in December last year, coal power stations in Australia failed without warning, or 'tripped', four times:

- Millmerran coal power station (QLD), 420 MW unit, failed on 12 December 2017
- Mt Piper power station (NSW), 700 MW, failed on 13 December 2017
- Loy Yang A power station (VIC), 560 MW unit, failed on 14 December 2017
- Eraring coal power station (NSW), 700 MW unit, failed on 18 December 2017.

Many other sudden and unexpected failures have occurred, including ongoing problems at Loy Yang A in Victoria, which has now had six failures in three weeks.

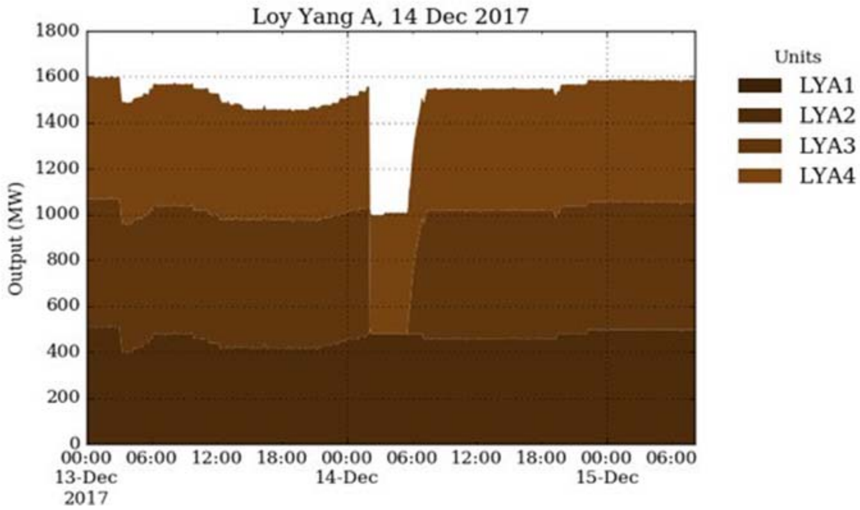
This sudden loss of hundreds of megawatts (MW) from coal-burning power stations represents a far bigger risk to energy security than any other energy source:

- The Australian Energy Market Operator (AEMO) has identified the "unforeseen material reduction in generation capacity" as one of the most likely causes of failing to meet reliability standards (ie. have a blackout).
- Leading energy economist Bruce Mountain said: "The biggest single source of insecurity to the power system is a trip of a major coal thermal generator unit simply because they are so large – [it's] not the wind or the sun, or people switching on their air-conditioners."
- Dylan McConnell from the Melbourne University Climate and Energy College said: "It is these instantaneous losses of large amounts of capacity that would be causing [the Australian Energy Market Operator] most concern about power system security as we move through summer."

Thermal generators like coal are particularly vulnerable to faults and breakdowns in extreme heat (for further detail, see Fact 5). Heatwaves often coincide with peak electricity demand, so coal is failing precisely when it is needed most.

The Australia Institute report *Can't Stand the Heat* notes that Australia's aging coal and gas fleet is not designed to operate in extreme weather conditions. During the February 2017 heatwave, 3600 MW failed during peak demand periods in South Australia, New South Wales and Queensland, equivalent to 14 percent of Australia's coal and gas generation in those states.

Figure 1 shows the sudden loss of 560 MW of output from Victoria's Loy Yang A power station on 14 December 2017:



While wind and solar have variable output, this output can now be predicted days in advance, which gives AEMO time to prepare, and is typically a smaller and less sudden loss of capacity. These coal failures are unpredictable, representing a much larger risk of blackouts.

2) The Tesla big battery is proving its worth

South Australia's new lithium-ion battery, currently the world's largest, is already demonstrating its value to the National Electricity Market (NEM). (The NEM is Australia's east-coast grid linking Queensland, NSW, Victoria, South Australia and Tasmania.)

An important part of a renewable-energy-powered grid is the ability to store energy while it is sunny and windy so it can be used when it is dark and still. Rapid advances in storage technology, especially batteries, are making this possible.

The benefits of the Tesla big battery is not just providing dispatchable (ie. on demand) supply. It is also providing lightning-fast frequency control to the grid.

When a major coal unit trips, the frequency in the grid can fall rapidly. If it falls too far, the grid can become unstable and fail.

The battery isn't providing the full frequency response. Rather it is reacting quickly and holding things together briefly while other generators respond – a very valuable role (and one for which it isn't currently being paid).

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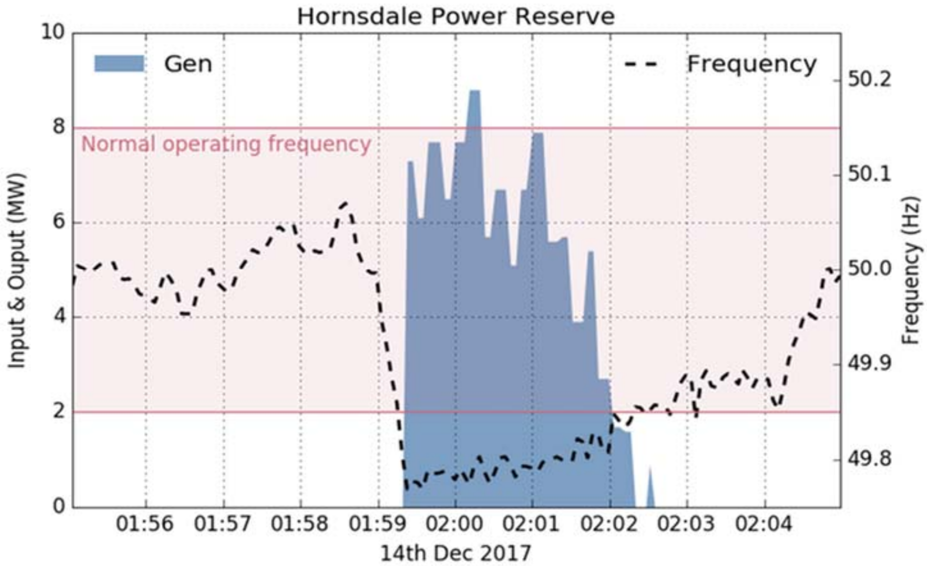
The chart below shows how the Tesla battery (officially known as the Hornsdale Power Reserve) responded as the frequency in the NEM fell after a unit at Loy Yang A failed. As the frequency returns to the normal range, the battery reduces its output.



The above chart is taken from this article by Melbourne University's Dylan McConnell, which explains the battery's summer performance in detail.

More large-scale batteries are on their way, including a battery linked to a Victorian wind farm and glasshouse at Nectar Farms and possibly an even bigger battery in Queensland.

Energy market reform is needed to encourage more large-scale battery storage. Specifically, current rules that average pricing out over 30 minutes rather than 5 minutes act as a drag on investment in fast-response batteries. For more information on the need for quicker introduction of a '5-minute settlement rule', see here.

3) Rooftop solar is reducing strain on the grid

The growth in rooftop solar over the last ten years has been phenomenal. Victoria now has more than 1100 MW of solar panel systems smaller than 100 kW (data available here). This is all likely to be 'behind the meter', meaning it is not counted towards total supply in the National Electricity Market.

In a case of "many hands make light work", large numbers of relatively small solar panel systems (mostly on residential homes) are adding up to play an important role in reducing the strain on our energy grid.

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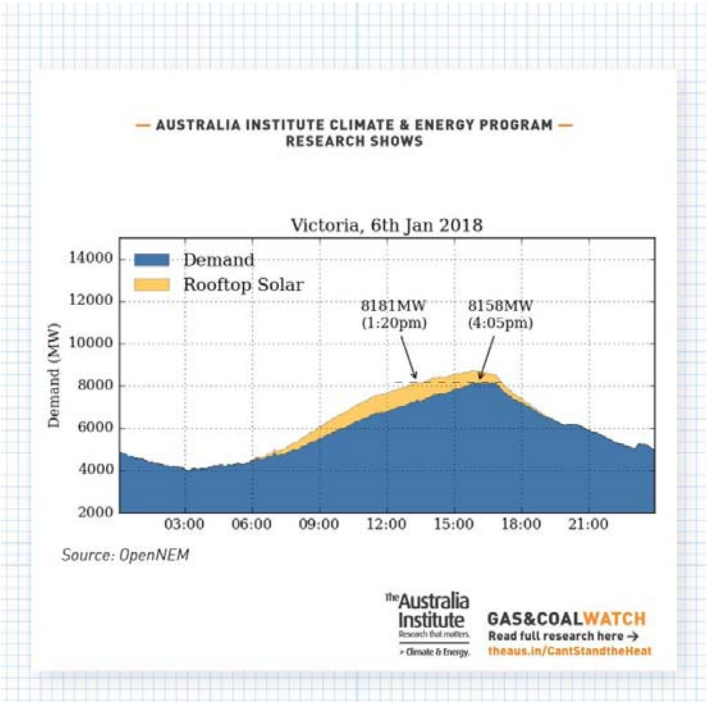
The graph below (from The Australia Institute's *Gas and Coal Watch*) shows how, on a very hot day this January, Victoria's rooftop solar:

- Reduced the highest point of peak demand from the grid (at 4pm) by almost 600 MW
- Delayed the moment of peak demand from the grid by almost three hours, meaning the grid was under strain for less time.



The Victorian Essential Services Commission is in the process of introducing a peak feed-in tariff for rooftop solar (in addition to a recent increase in the standard feed-in tariff). This acknowledges the role solar plays in supporting the grid at critical times, providing an incentive for more households to repower their homes with clean energy.

Rooftop solar capacity also plays an important role in reducing the costs of electricity. To meet moments of peak demand, typically on hot summer afternoons, the grid normally requires peaking gas plants to fire up. These generators can turn on relatively quickly but are expensive to operate, and the costs flow through to consumers. Most of Victoria's gas generators, for example, only run a few times each year when demand gets very high.

With more rooftop solar shaving off the high points of peak demand, there is much less need for gas peaking plants to turn on, or they will run for much less time. The upshot is fewer price spikes in the wholesale market, which helps lower average prices for consumers.

4) Demand is just as important as supply

Too often commentators fall into considering only the supply side of electricity. But it really is an electricity *market*, and markets need to consider both supply *and demand*. Often, reducing demand is a much better solution than increasing supply.

Rooftop solar is one way to reduce demand and strain on the grid. Another is energy efficiency. While less visible to the public, this hidden saviour is helping families and businesses slash their running costs, cut energy waste and maintain reliable supply.

Energy efficiency simply means using less energy for the same result. Over the last 20 years improved efficiency standards for appliances and new buildings have saved around 5,000 MW of coal-fired generation capacity. That's roughly the equivalent of Loy Yang A and B plus Hazelwood that's no longer needed to power our appliances.

But while that's good progress, we've hardly scratched the surface of what's possible, with Victorian homes built before 2005 averaging only 2 stars compared with 6 stars required for new homes. Recent research concluded that efficiency improvements in buildings plus higher standards for new buildings could deliver more than one quarter of Australia's emission reduction commitments under the Paris Agreement.

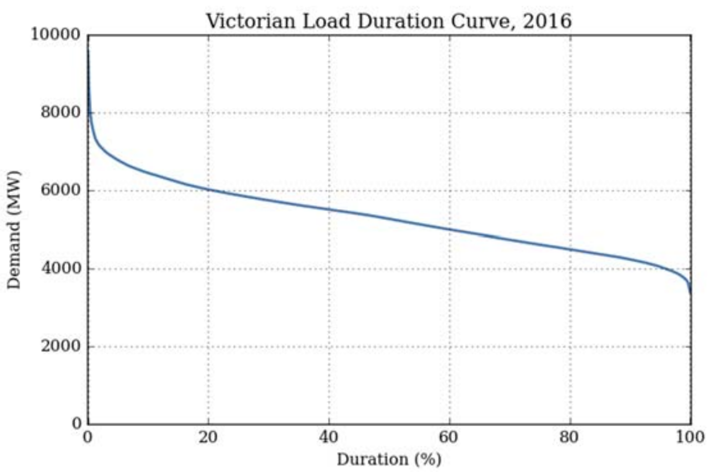
The majority of household energy use goes towards keeping our homes warm in winter and cool in summer, and heating hot water. So cutting waste through simple measures like insulation, draught-sealing and low-flow shower-heads can reduce annual energy costs by 40 percent – delivering savings of up to $1,000 per year for an average pre-2005 home.

This doesn't just benefit individual users. Residential and business users account for the vast majority of electricity consumption, so energy efficiency in the home and at work also benefits the system as a whole.

Energy efficiency can play an especially important role in reducing demand at peak times, reducing the need for expensive peaking generation capacity. In a heatwave, for example, an energy-efficient home will be able to maintain a comfortable temperature with less electricity consumed for air-conditioning.

As noted in Fact 3 above, there are 'peaking generators' (typically gas power stations) that only turn on for very short times to meet peak demand on hot days. These cost money to build, operate and maintain, for just a few hours of actually generating electricity.

The 'load duration curve' below (via Dylan McConnell from Melbourne University Climate Energy College) shows that Victoria's demand very rarely goes above 7000 MW, the low percentage of duration on the far left of the graph. Conversely, demand is almost always above 4000 MW, as shown by the right side of the graph:



In 2016, approximately 1700 MW of generation capacity was used for just 43 hours across the entire year.

Another measure ramping up this summer is 'demand management' or 'demand-side response'. This essentially involves payments to consumers to reduce their energy use for a short period (ie. paying to reduce demand). The Australian Renewable Energy Agency has an excellent post explaining the concept here.

This is often a much cheaper option than paying a generator to add more supply. AEMO's Summer Readiness report (pages 14-15) indicates there is 884 MW available from demand response programs, including 143 MW of demand under a new trial with the Australian Renewable Energy Agency. Demand response programs can involve any energy users – whether a large number of individual households or a small number of large industrial users.

5) The biggest threat to energy security is climate change

People often raise concerns about energy security in summer. During long spells of hot weather, people and businesses run their air-conditioners, increasing electricity demand (explained in more detail above) and strain on the grid.

However another important concern is that our electricity grid infrastructure, especially aging coal power plants, are vulnerable to faults and breakdowns in the heat.

The NSW Energy Security Taskforce drew similar conclusions, flagging that "large coal thermal plants generally will not perform as well in extreme hot weather and can also have output limited by environmental constraints, for example, cooling pond temperature limits."

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Their infographic below is a helpful guide to the many ways fossil fuel and energy infrastructure can fail in the heat:

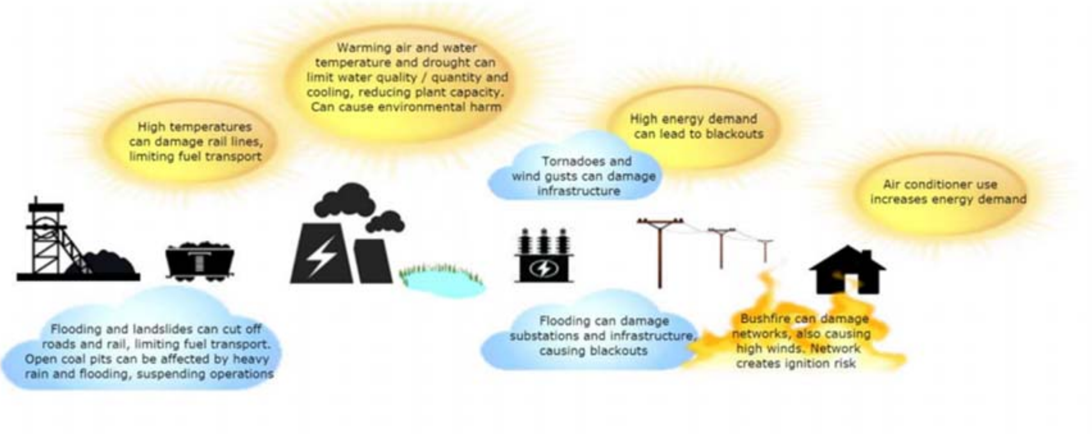
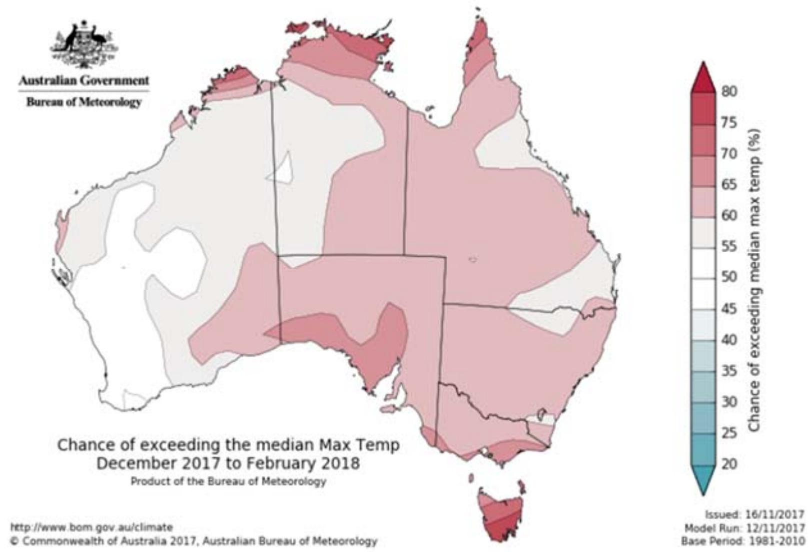


Figure 2.7: The potential impacts of extreme weather events on thermal generation supply chain

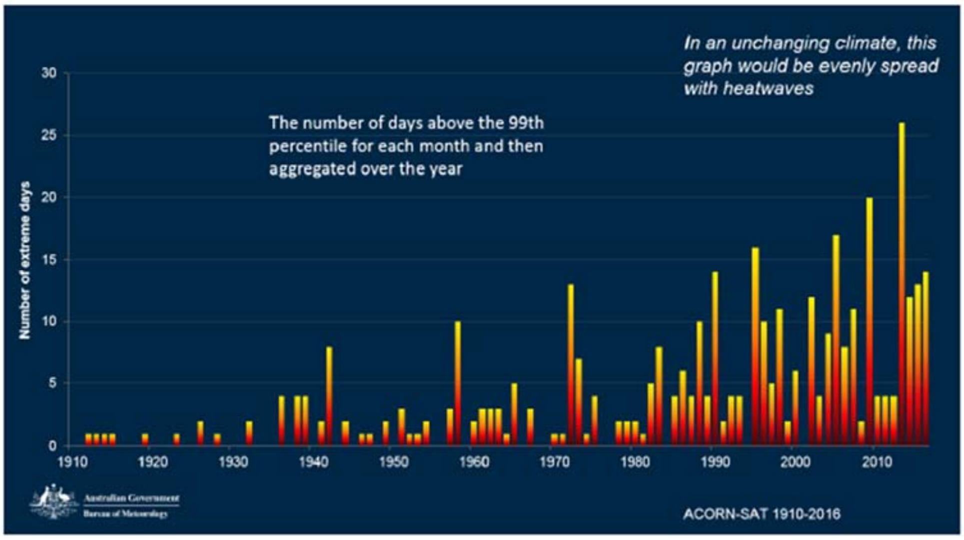
What often goes unsaid is that extreme summer weather events like heatwaves can now be [directly attributed to human-caused climate change].

Two graphs highlighted in [AEMO's Summer Readiness report] indicate how climate events feed into their energy planning. The first shows a high likelihood of temperatures going over median maximums:

Figure 1 Temperature outlook for December 2017 to February 2018 – chance of exceeding median maximum temperature



The second graph demonstrates the role of climate change in increasing the number of extreme heat days – the times when the energy grid is under the most strain and when coal and gas power stations are most likely to fail:



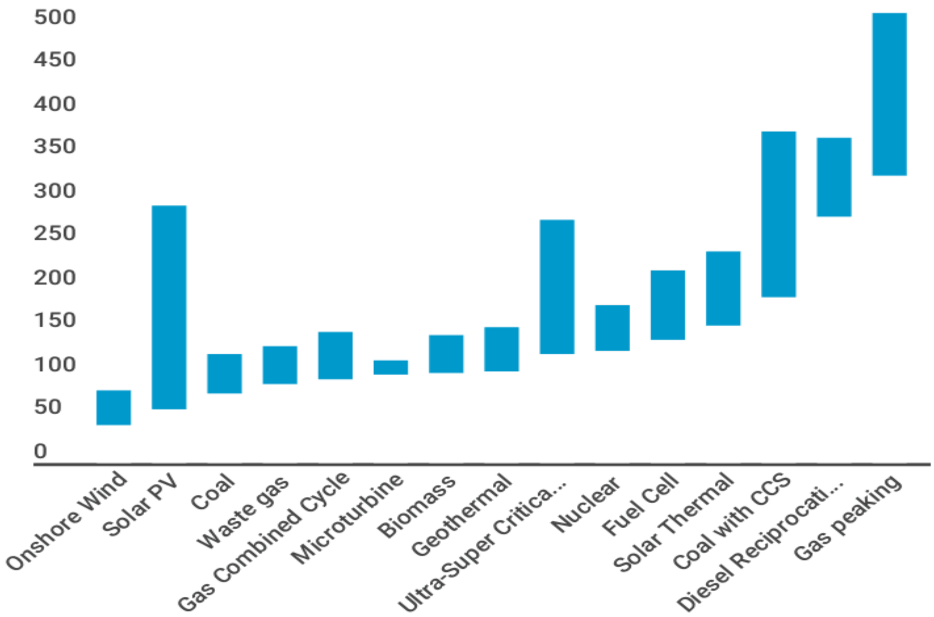
Other climate-driven weather events can affect the electricity system. In September 2016, an extreme storm knocked over 22 transmission towers in South Australia, causing a 'system black' event. Low rainfall or prolonged droughts have also reduced the ability to use hydroelectricity generators.

6) Solar and wind are the cheapest form of new supply

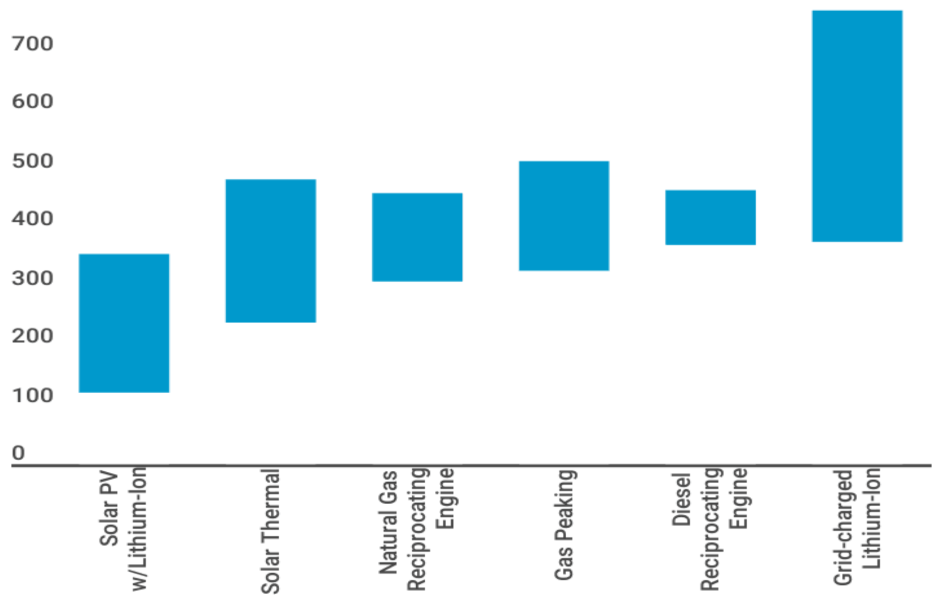
Analysis by Bloomberg New Energy Finance indicates that wind and solar are now the cheapest options for new electricity supply. They forecast that within 15 years, it will be cheaper to *build new solar* than it will be to *operate existing* coal power stations.

Other energy market analysts at Reputex found that renewables are the cheapest new supply, based on the Levelised Cost Of Electricity (LCOE). LCOE represents the cost per megawatt-hour for building and operating a power station in order to breakeven over its assumed lifetime.

Below is their chart showing wind and solar as the cheapest option. (The vertical axis represents cost per megawatt-hour in dollars.)


500
450
400
350
300
250
200
150
100
50
0
Onshore Wind
Solar PV
Coal
Waste gas
Gas Combined Cycle
Microturbine
Biomass
Geothermal
Ultra-Super Critica...
Nuclear
Fuel Cell
Solar Thermal
Coal with CCS
Diesel Reciprocati...
Gas peaking

A second chart shows solar plus battery storage as the cheapest form of flexible/peaking capacity:



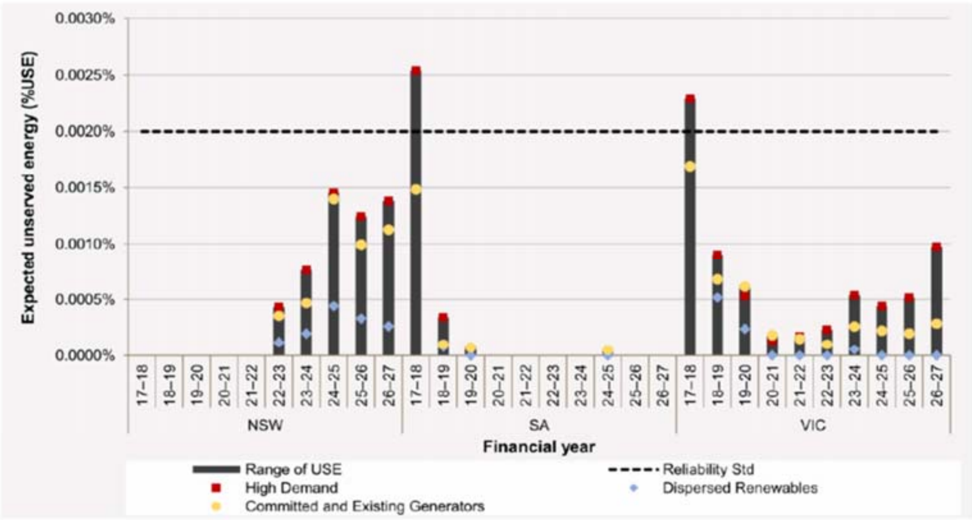
More renewable energy projects are in the pipeline. Analysis by [Green Energy Markets] indicates that, nationally, there are over 12,000 MW of wind farms and 15,000 MW of solar farms planned (with approximately half of each type already holding planning approvals) – a list that has "grown spectacularly" in the last 12 months.

7) Risk to the grid drops after this summer

As noted above, there are a lot of renewable energy projects in the pipeline. Any supply shortfall this year is temporary, not a representation of our future electricity system.

AEMO has indicated that this summer will be the biggest test for the grid partly because Hazelwood power station has closed but new renewable energy capacity is not yet online.

The chart on the next page, from AEMO's 2017 Electricity Statement of Opportunities, shows that the possibility of 'unserved energy' (ie. supply shortfalls) drops significantly in Victoria and South Australia after 2017/18:



It is also worth noting that the reliability standard of less than 0.002% of unserved energy equates to 10 minutes and 30 seconds of shortfalls over an entire year.

A large part of the delay in a number of renewable energy projects can be attributed to the destabilisation of the industry under Prime Minister Tony Abbott, whose numerous reviews of the Federal Renewable Energy Target sapped project proponents of confidence. Had those projects gone ahead several years ago, there would be more supply in place this summer.

One of the short-term stop-gap measures in place in Victoria is 110 MW of temporary diesel generators installed in the Latrobe Valley. While diesel is not an ideal measure from an environmental perspective, there is an estimated 61 percent chance that the generators won't even be needed. If they are needed, it is likely to be in the range of 4-8 hours total. This is a far better environmental outcome than the high levels of constant, daily pollution from Hazelwood power station.

A media backgrounder that Environment Victoria produced in March 2016, in the lead up to Hazelwood's closure, is here.

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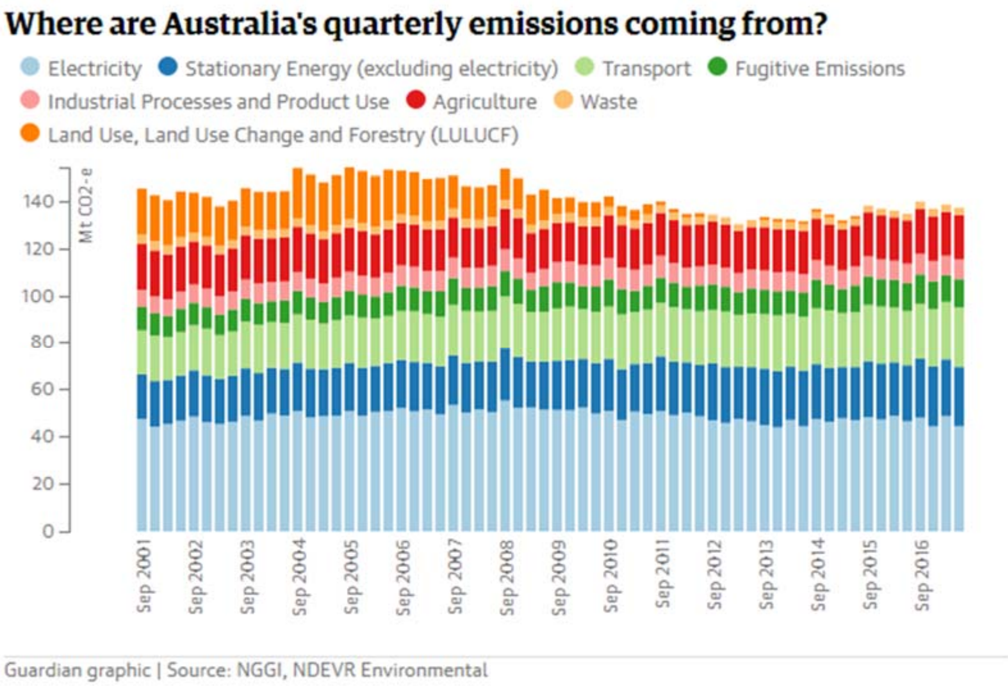
8) Electricity remains the number one source of climate pollution in Australia

Electricity is the largest single source of climate pollution in Australia. The chart below from the Guardian, shows the contribution our electricity consumption makes to total greenhouse gas emissions.



Recent federal government data (released in late December under the cover of Christmas for the second year in a row) indicates that greenhouse gas emissions from electricity went down by just over 2 percent from last year. A significant amount of this reduction can be attributed to the closure of Hazelwood, which was until March 2017 the most polluting power station in Australia. A useful summary analysis of the data is available here.

If Australia is to take meaningful action on climate change and contribute to international efforts under the Paris Agreement, we need to accelerate the shift away from dirty coal power to clean renewable energy. Reducing emissions from other sectors (such as transport and agriculture) is comparatively difficult, whereas zero-emission and low-cost alternatives to polluting electricity supply already exist.

(Authorised by Nicholas Aberle, Acting CEO, Environment Victoria, Lvl 2, 60 Leicester Street, Carlton VIC 3053.)