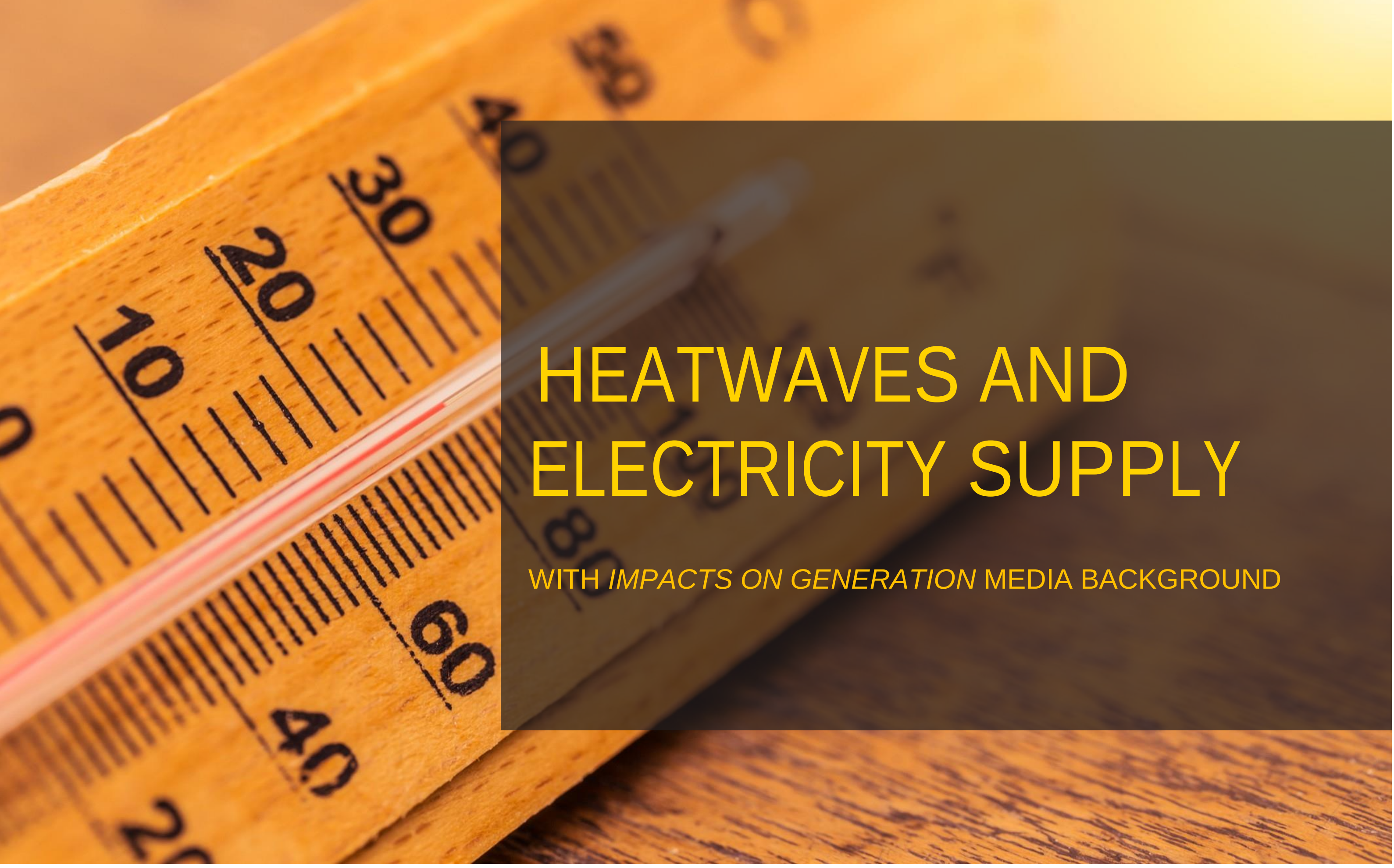


HEATWAVES AND ELECTRICITY SUPPLY

WITH *IMPACTS ON GENERATION* MEDIA BACKGROUND

Summer is the time of heatwaves in many parts of Australia.

Hot weather places significant demand on the electricity system, increasingly so over the last decade with the increased use of air conditioners in homes and businesses.

Extended hot weather in summer can place significant strain on the electricity system, increasingly so over recent decades with the increased use of air conditioners in homes and businesses.

Heatwaves are three or more consecutive days of unusually high temperatures. They place the grid in many parts of mainland Australia under great stress, sometimes resulting in blackouts. These can be caused by a number of factors: for example local faults, bushfires or generator faults.

PEAK DEMAND

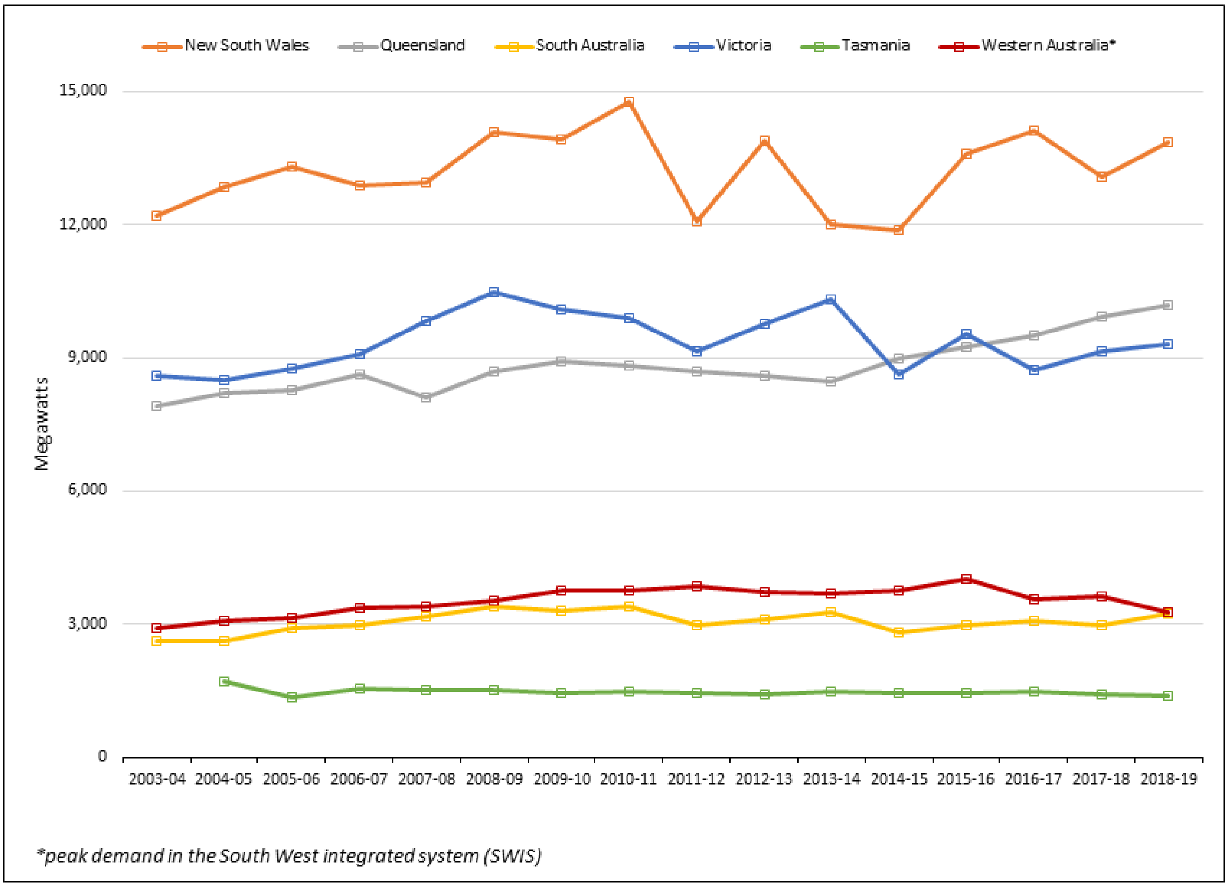
Peak demand is the maximum amount of electricity demanded by a state, region, or even a street. In order to make sure electricity is available for peak events, the grid is built to meet this capacity – even though it won't always be needed. In all Australian states, except Tasmania, peak demand occurs in summer during heatwaves. Peak demand is measured in megawatts (MW). The scorecard for peak operational demand events and the season in which they occurred are shown below.

Peak	QLD	NSW	VIC	SA	TAS	WA
MW	10,044	14,744	10,576	3,399	1,790	4,304
Period	Summer 2018/19	Summer 2010/11	Summer 2008/09	Summer 2010/11	Winter 2008	Summer 2015/16

Source: AEMO; Western Power. WA data covers the South West Interconnected System, with population centres in the state's south west region. Summer demand refers to the period 1 Nov-31 Mar and winter demand refers to the period 1 May-31 Jul each year. Data is current at 30 June 2019.

While the increased reliance on air conditioning has caused a rise in peak demand over the past couple of decades, in recent years this has been somewhat tempered by the greater role household solar and batteries are playing and a reduction in demand from large industrial facilities, some of which have closed. The exception is Queensland, where large uptake of rooftop solar PV has been offset by growing demand. The chart below shows the trend for peak demand in summer and winter over the past two decades.

Figure 1. Peak demand by state, summer 2003 – winter 2018



Source: Electricity Gas Australia 2005 – 2019, AEMO

Heatwaves have the biggest impact on the electricity grid in January and February, especially when multiple states have concurrent heatwaves. South Australia and Victoria, for example, often have heatwaves at the same time and the two power systems have strong interconnections.

Power systems across the eastern seaboard have interconnections and normally high demand in one state can be met by extra generation from another.

Heatwaves and electricity demand

The occurrence of heatwaves is predictable and the following range of identifiable factors can vary the level of demand:

Duration of the heatwave: electricity demand tends to increase in the third and fourth days of consecutive hot days, as air conditioners increase output to manage the accumulating heat load in buildings.

School holidays and weekends: demand tends to be higher from mid-January as schools and businesses resume, and weekdays have higher demand than weekends.

Solar PV: increased deployment of rooftop solar PV helps reduce system demand during most summer heatwave peaks (providing there is no cloud cover) but shifts the maximum peak event to later in the day as the sunlight dwindles. In future this could be offset by higher uptake of storage in conjunction with rooftop solar.

WHAT HAPPENS IN A HEATWAVE?

We know when heatwaves are coming and plan accordingly. Ongoing maintenance takes place to keep the grid and generators in good working order before summer. Electricity networks have specific operational plans developed in advance of the hottest days to keep customers safe and comfortable while maintaining the reliable performance of the network during periods of increased demand. They will also have emergency response crews ready to respond if equipment fails or if there is an emergency to minimise the time customers are without power.

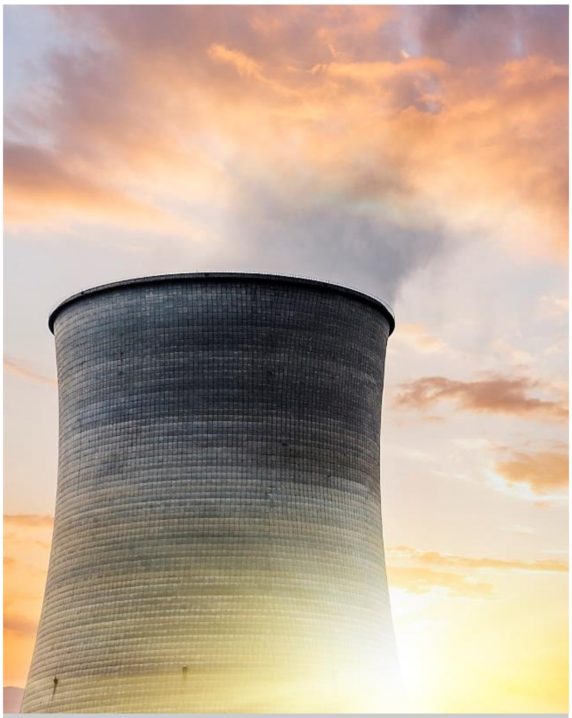
While pressure is placed on the grid by high demand, high temperature-associated heavy loads can also impair the operation of key infrastructure like generators and transmission lines. Bushfires can lead to outages on major transmission lines. These impairments impact on the operation of the system.

Networks also use smart technology and demand response to manage demand on the hottest days. We are also seeing new services and technology working with the grid to allow customers to make the most of their solar and batteries and to engage and incentivise customers to help shift their electricity usage voluntarily.

In preparation for an extreme heatwave, some large industrial customers will undertake voluntary load shedding. That is, they agree to switch off part or all of their operations. This helps reduce demand on those days. Some industrial customers have greater flexibility than others in being able to voluntarily reduce their electricity demand on these days.

During hot days, it is not unusual to see high spot prices in that state's wholesale electricity market. This is how the market is designed to work. Higher prices provide signals to generators to enter the market to help meet supply. Peak generators, such as hydro or gas, are built specifically for these types of events, and can sometimes run for only a few days a year. These higher wholesale prices do not translate into higher retail electricity prices during a heatwave, because retail prices are fixed across a year and retailers manage the price risk for their customers.

As rooftop solar PV operates behind the residential meter, we can only estimate its total generation. Its impact shows as reduced demand, when in fact it is a different, distributed source of generation.



The impact of announced power stations closing

In May 2016, the 544MW Northern Power Station closed in South Australia. It was the last remaining coal-fired generator in that state. In March 2017, the 1,600MW Hazelwood power station closed in Victoria.

AEMO assessed that it would need to secure 125 MW of resources under its Reliability and Emergency Reserve Trader (RERT) measures to meet the NEM’s reliability standard in Victoria for the 2019/20 summer.

LOSS OF SUPPLY

There are three basic types of power interruptions that can occur during a heatwave:

1. **Localised outages**: these can be for any number of factors – i.e. a tree limb on a line, a truck hitting a pole, equipment failure (not usually heat related). Some may be due to heat and high demand. These are generally communicated by local network operators to customers via websites, twitter and other social media. They can involve a handful or a few thousand households depending on the cause, and supply is restored once repairs take place.

2. **Power system disturbance**: where a major event has disturbed the security of the power system, customers may be interrupted over a wide area. There are many possible causes, but most frequently it is caused by a sudden interruption to critical transmission lines. For example, in January 2007, bushfire smoke short-circuited lines bringing power from NSW to Victoria, and many customers across Victoria and South Australia were interrupted until the power system could be re-stabilised, which took a few hours.

3. **Involuntary load shedding**: in the event that there is not enough supply to meet demand, the Australian Energy Market Operator (AEMO) directs sections of the grid to be shut off until increased supply can be restored or demand reduces, generally in the evening. These are known as rolling blackouts, as different parts of the grid take turns being without power. These are infrequent and efforts are taken to minimise their frequency and duration.

The shortage of electricity supply can be the result of several factors. It could be a fault or heat-related stress in a generator (or generators) which reduces supply at critical times. A transmission line may have its capacity reduced to avoid equipment damage resulting from high temperatures (the lines can sag under heavy load and high temperatures) or shut off because of the risk of bushfires. Any of these events, under certain conditions, can increase the risk of outages but most will affect only localised parts of the grid at any time.

Rooftop solar PV or batteries by themselves will not protect your house from experiencing an outage unless they are configured to do this. At present few systems have been set up for this, so even if you have a solar PV system installed, you can still be affected and should be prepared.

AEMO has identified more than 1500MW of emergency reserves that may be available via the RERT process.

The RERT is an emergency mechanism by which AEMO can top-up the supply demand balance. These reserves are mostly types of demand-side response, where customers have voluntarily offered to reduce their consumption for a few hours in return for a fee. AEMO attempts to use these reserves only as a last resort, to avoid having to order blackouts once normal market supplies are fully committed. Costs are then recovered from customers.

Impact of increased renewables in a heatwave

Rooftop solar PV contributes to the supply of electricity on hot sunny days. Wind generators may also contribute to supply during heat waves, depending on the amount of wind blowing.

Renewable generation, particularly from rooftop solar, is changing the shape of daily energy demand. An occurrence called a 'duck curve' is shown in figure 2; this curve is caused by the shifting energy demands of the population due to the rapid uptake of rooftop solar.

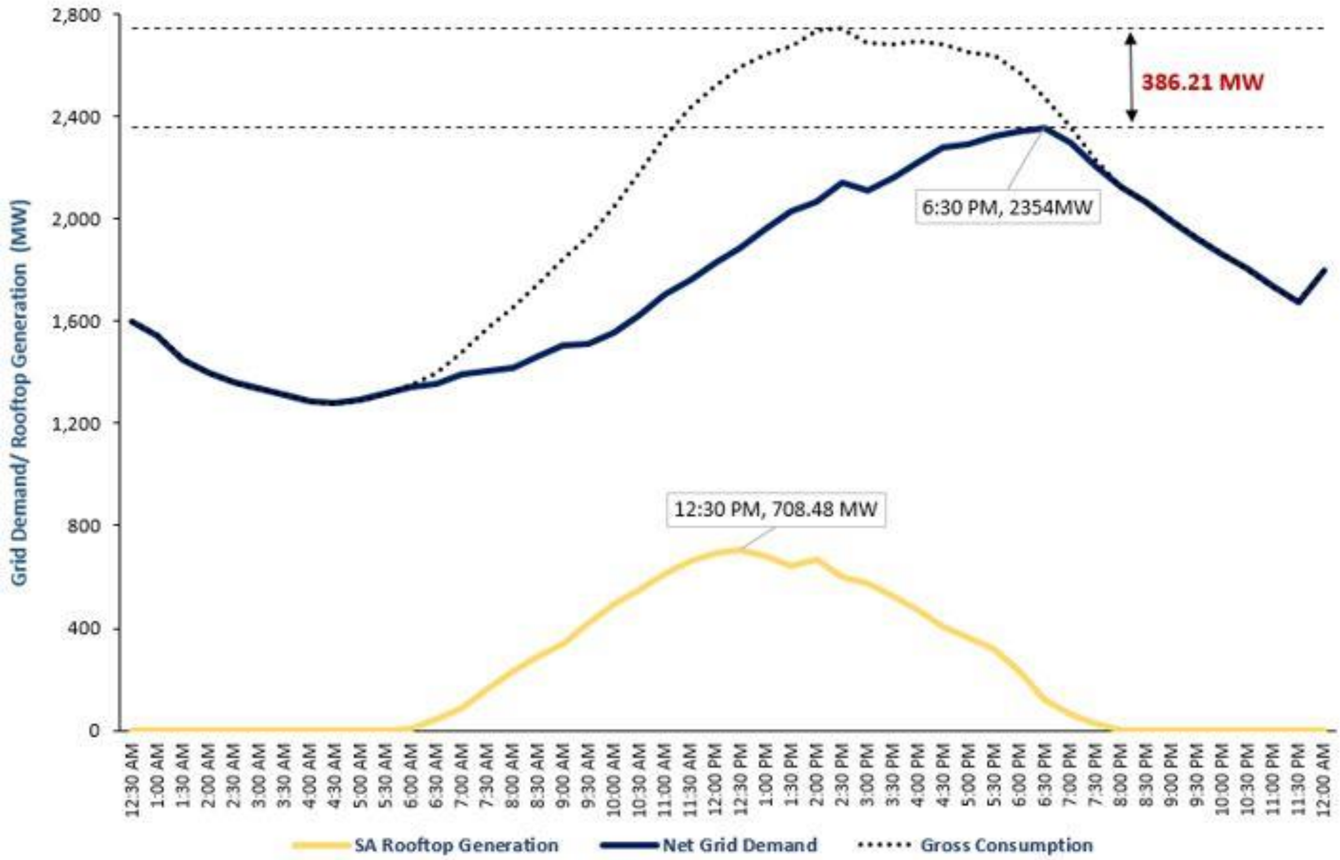
Historically peak hot-day demand was typically experienced in the early afternoon, however it has now shifted to later in the day. During the day when the sun is shining and the wind is blowing, there is less reliance on the grid due to the increased use of renewable energy. While daytime demand is considerably lower, there is now a sharper spike in grid demand as the sun goes down.

As renewable energy further grows and coal plants retire, demand in the middle of the day is expected to continue to shrink further, moving to later in the evening once the sun sets.

This demand peak, and subsequent quick drop, requires careful planning to ensure reliability risks are managed. The shifting demand requires firm generation to start up and shut down more often, and in a very short space of time to meet the population's energy needs.

Figure 2. Rooftop solar changing NEM

South Australia Rooftop Generation and Net Grid Demand (27 December 2018 at 42.2C max temperature)



Source: Australian Energy Council analysis of Neo Express data

South Australia has the highest penetration of intermittent renewable generation in the world. Last summer the state (which has the NEM's highest rooftop PV penetration as a percentage of peak demand) experienced daily peaks at 8.00pm (AEST).

More than 45 per cent of South Australia's generation comes from wind energy. This means generation only occurs if the wind is blowing. While there is technically enough capacity to meet demand in South Australia, even if there is no wind blowing during a heatwave, the supply-demand balance is tighter during these conditions.

Increased use of renewable energy requires careful planning to ensure that these risks are managed, so we can continue to decarbonise supply while maintaining reliability of supply.

MORE INFORMATION

The Australian Energy Council
www.energycouncil.com.au

Energy Networks Australia
www.energynetworks.com.au

The Australian Energy Market Operator (AEMO)
www.aemo.com.au

What can households do?

Every household in Australia is in a different part of the electricity network – so only one network supplies electricity to your community. Find out which network business services your suburb. Follow them on social media and bookmark their website to receive timely information in the event of a local fault. This will help you know how long the power will be out so you can plan.

Stay informed during heatwaves. AEMO oversees management of the electricity system and will advise how the system is performing. You can follow AEMO on social media (Twitter; Facebook) and monitor news reports to receive updates on system demand.

Life support customers should register their details with their local energy networks and their electricity retailer who issues their bill. If you rely on a continuous power supply for life support equipment, you are urged to have a back-up plan in case there are any unplanned power outages.

In some situations, governments or regulators may ask households to minimise energy usage to help reduce peak demand and avoid the risk of rolling outages. Simple measures such as increasing the cooling temperature on your air conditioner by a couple of degrees can help everyone and save on your power bill.

MEDIA BACKGROUND:

THE IMPACT OF HEATWAVES ON DIFFERENT FORMS OF GENERATION

Peak temperatures reduce the performance of most types of generation as well as the carrying capacity of networks. Periods of higher temperatures will increase electricity demand, particularly through the increased use of air conditioners, and supporting this peak demand will require more dispatchable generation.

In a modern electricity grid, reliability is a priority. The different features of these different types of generation pose different challenges for overall system reliability. In terms of higher temperatures and their impact on different large-scale generation technologies, the 2018 Generator Report Card notes that:

- **Thermal plant (coal, gas, diesel):** all see their maximum capability limited due to reduced cooling efficiency at increasing temperatures. This is a more significant issue for air-cooled plants like Kogan Creek and Millmerran than it is for water-cooled power stations. Thermal generators that use steam turbines – all coal, some gas, and in future solar thermal – need to exhaust waste heat to turn the steam back to water. Australian generators use cooling towers or water bodies for this. The hotter the air or water respectively, the harder the process is, and in some cases these generators may have to reduce production to keep the cooling process within safe limits.

- **Solar PV:** experiences an efficiency loss at higher temperatures (generation performance drops off at a rate of about 0.4 per cent with every degree Celsius), although this appears to have been mostly mitigated by over-sizing inverters and additional panels relative to other electrical components, such as transformers at the site.

- **Wind farms:** have displayed some degradation in performance at higher temperatures because:
  - Some wind farms (particularly European designed) still have default high temperature cut-outs in place or may not have had additional cooling systems installed.
  - Localised transmission congestion has occurred, often when temperatures are high.
  - In some regions there is a strong correlation between high temperatures and low wind speeds resulting in lower output.

- **Battery storage:** particularly large-scale lithium-ion requires its own cooling systems and at higher temperatures the power loads these systems will need to draw from the battery will increase.

- **Hydro:** Hydro generation is least affected (at least directly) by heatwaves. Its remoteness however means in getting its electricity out to customers, it may be exposed to the high-temperature network constraints. And in related seasonal conditions, it is exposed to drought.

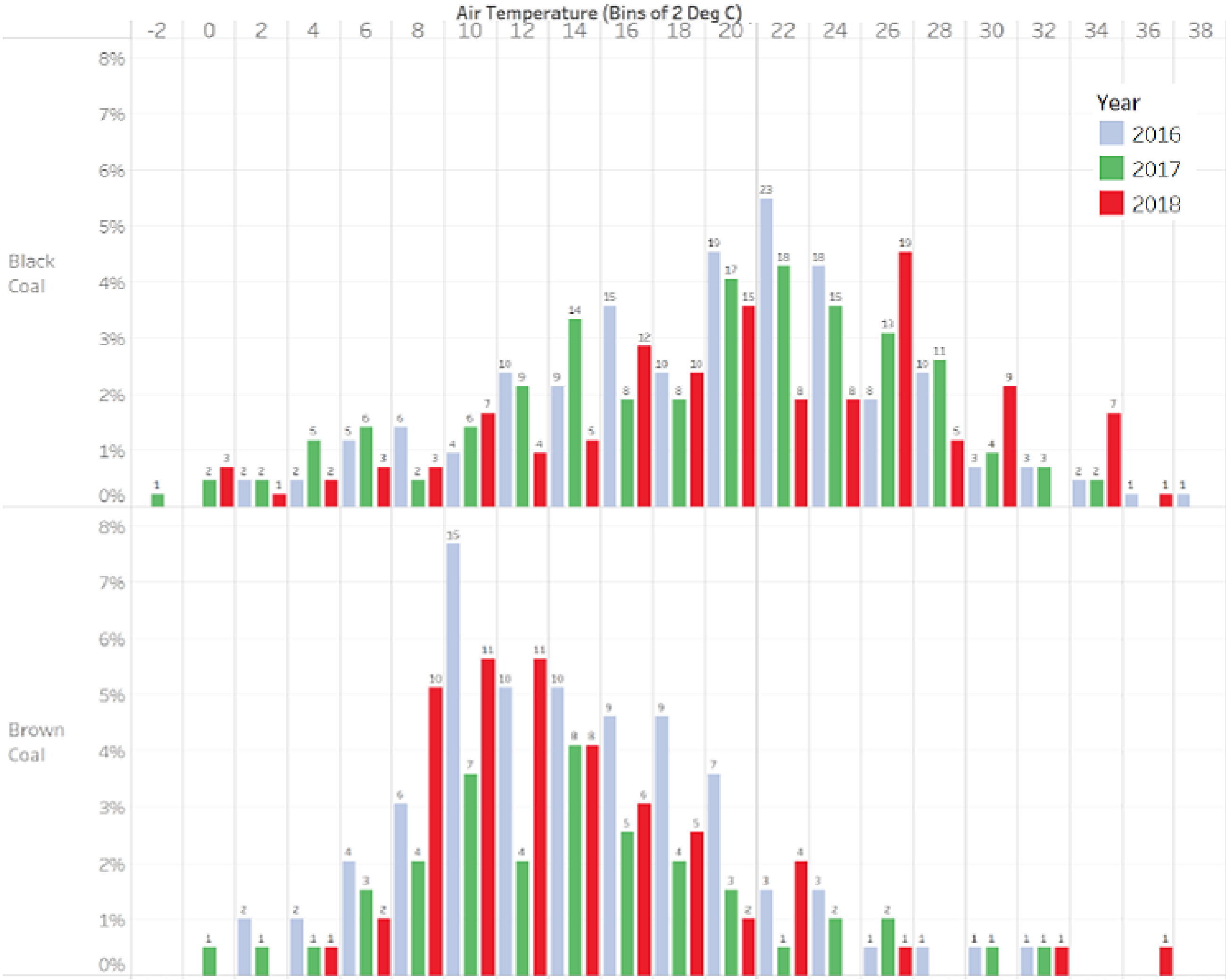
COAL GENERATION AND UNIT TRIPS

There is usually increased focus and commentary on the performance of coal units on hotter days, however there is no evidence that thermal plants are becoming less efficient. Units are unavailable at different times of the year, and while there are well understood effects of high temperatures on plant outputs, it does not appear that plant failures as indicated by unit trips are disproportionately occurring during periods of higher temperatures.

The Generator Report Card looks at 2016-2018 to determine if there is an indication of additional unit trips at higher temperatures (figure 3). It states that the data “does not generally support the hypothesis that generation trips occur more during hotter weather”, although the authors note that there is still a need to continue to monitor these types of metrics.

The consequences of a plant trip are higher during times of hotter weather, given the higher demand level, and therefore there is a greater focus on unit performance during times of heat stress. In the case of coal and other traditional plant, this is compounded by the reductions in the amount of dispatchable plant available in the NEM.

Figure 3. Percentage of plant trips (black/brown coal) at Various Air Temperature Groups



Source: 2018 Generators Report Card

Note: The difference in the shapes between black and brown coal shown in figure 3 is mainly a reflection of the warmer average temperatures in Queensland/New South Wales compared to Victoria/South Australia.

MEDIA CONTACTS

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