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Coal Out: Fossil fuel power station breakdowns in Queensland

Over 2018 and 2019 there were more breakdowns at Queensland's gas and coal power stations than in any other National Electricity Market (NEM) state. Queensland's newer supercritical coal power stations had disproportionally high rates of breakdown with Australia's newest coal power station at Kogan Creek, the most unreliable single generating unit in the NEM.

Discussion paper

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September 2020

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ISSN: 1836-9014

Summary

The Australia Institute's Gas and Coal Watch program monitors breakdowns at coal and gas power stations in the National Energy Market (NEM). This report focuses on the performance of coal and gas power stations in Queensland from 13 December 2017 (when The Australia Institute began monitoring) to the end of 2019.

Breakdowns at gas and coal power stations are problematic because they usually involve sudden and unexpected losses of hundreds of megawatts of capacity. When these breakdowns occur at times of high demand, particularly during heatwave conditions, they can significantly increase the risk of blackouts.

There were 93 breakdowns at Queensland's gas and coal power stations over a two-year period from 13 December 2017 to 31 December 2019. Coal and gas power stations in Queensland have broken down more often than in any other state, contributing 41% of breakdowns despite contributing only 34% of fossil fuel capacity in the NEM.

Coal and gas power stations in Queensland had almost twice as many breakdowns per unit of capacity than NSW, despite being a newer fleet with four modern, supercritical power stations. The NSW coal fleet consists entirely of older subcritical power stations.

Queensland's four so called 'High Efficiency Low Emissions or HELE' supercritical power stations broke down 25% more often per gigawatt (GW) than older subcritical power stations in the NEM. The newest power station on the NEM, the 14 year old Kogan Creek Power Station, uses supercritical technology. Despite this it is the second worst performing power station (by breakdowns per GW capacity) in the NEM.

Kogan Creek is a single 'unit' power station, thought that unit is the largest on the NEM. Unfortunately, it is the worst performing individual generating unit (by number of breakdowns) and due to its size, is responsible for the largest breakdowns. When this happens it pushes the grid frequency below safe operating limits and risks triggering a voltage collapse in the Queensland power system.

The proposed new coal fired power station at Collinsville appears to be of similar technology to the Kogan Creek Power Station, and as such is likely to have similar problems with reliability and result in similar emissions levels. On cost, it is now cheaper to build new renewable energy generation with six hours of storage, than new coal power stations.

Given renewables can deliver when Queenslanders need them most, during sunny extreme heat days when electricity demand is peaking, and they are more affordable and have zero emissions, they could be considered a viable alternative to any Collinsville coal power plant proposal.

Contents

Introduction

The Australia Institute founded Gas & Coal Watch in December 2017 to monitor the National Energy Market's (NEM) fossil fuel power plants for breakdowns.

Gas & Coal Watch is based on a database of unit trips which have been identified and verified in collaboration with OpenNEM (https://opennem.org.au/).

A new ‘‘breakdown’’ is logged in Gas & Coal Watch when an unscheduled outage is identified by OpenNEM at a coal or gas unit in the National Electricity Market. Most coal and gas power plants consist of multiple units.

Unscheduled outages are either full unit trips where generation from a unit falls to zero or partial unit trips where generation from a unit drops significantly. Unscheduled outages are checked manually to confirm that the drop in generation is significant in absolute terms (currently a threshold of 100 Megawatts or above per unit is used, as well as false starts of any size) and relative terms (a judgement call based on the unit's dispatch target).

The Australian Energy Market Operator (AEMO) also records unplanned outages. While its exact criteria are not known, they appear to be less conservative than those used by The Australia Institute.[1]

If multiple units at a plant experience an unscheduled outage, a separate breakdown is recorded for each unit in most cases. Rarely, there are partial unit trips across all units at a plant. These are recorded as a single breakdown for that plant.

This special report summarises the breakdowns at Queensland's coal and gas power stations over the period 13 December 2017 to 31 December 2019 and compares them to the rest of the NEM.

[1] AEMO (2019) *Network Outages*, https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-events-and-reports/network-outages

Breakdowns at Queensland power stations

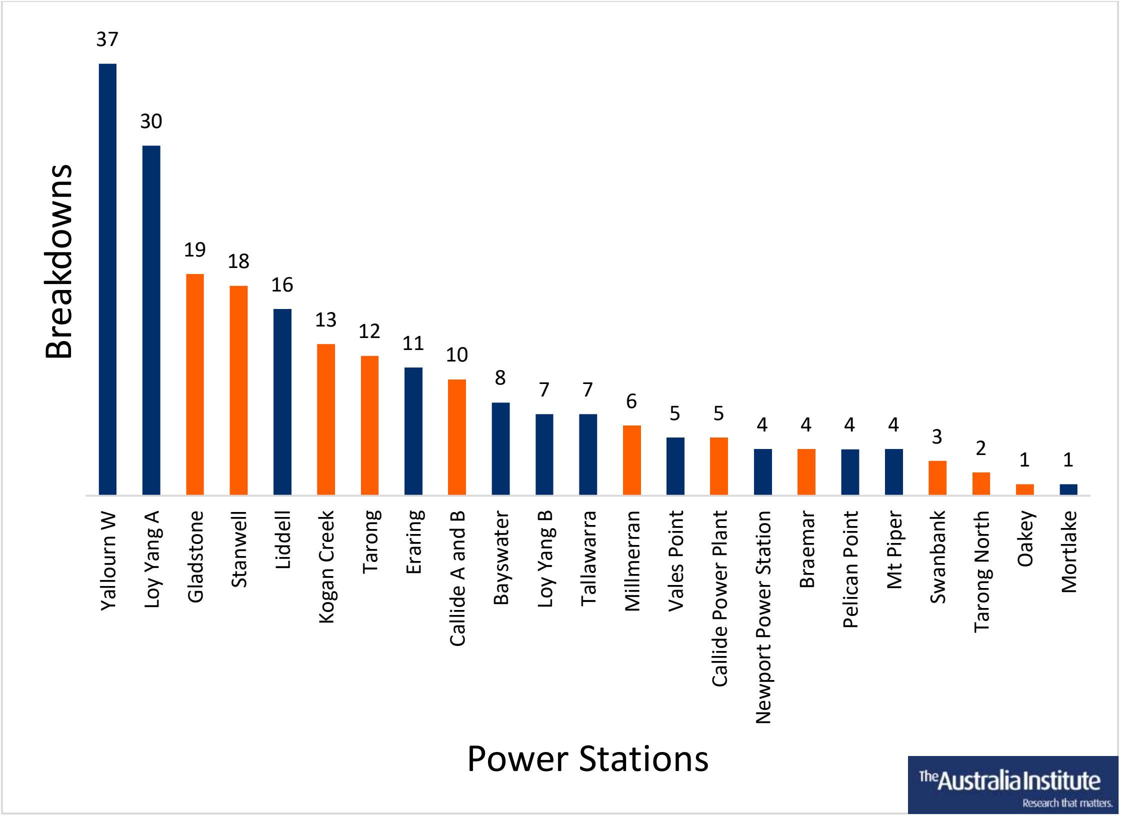
Since Gas & Coal Watch began monitoring in mid-December 2017 to the end of 2019, there were 227 breakdowns at gas and coal power stations in the National Electricity Market (NEM).

There were 93 breakdowns at Queensland gas and coal power stations:

- 19 at Gladstone (Subcritical black coal)
- 18 at Stanwell (Subcritical black coal)
- 13 at Kogan Creek (Supercritical black coal)
- 12 at Tarong (Subcritical black coal)
- 10 at Callide A and B (Subcritical black coal)
- 6 at Millmerran (Supercritical black coal)
- 5 at Callide Power Plant (Supercritical black coal)
- 4 at Braemar (Gas)
- 3 at Swanbank (Gas)
- 2 at Tarong North (Supercritical black coal)
- 1 at Oakey (Gas)

Figure 1 below shows the number of breakdowns at all fossil fuel power stations in the NEM that have experienced breakdowns over this period. Queensland power stations are shown in orange.

Figure 1: Breakdowns by power plant, 13 December 2017–31 December 2019 (Queensland plants in orange)



Source: OpenNEM

As shown in Table 1 below, Queensland fossil fuel power stations had 41% of breakdowns in the NEM, the most breakdowns of any state, despite making up only 34% of fossil fuel capacity in the NEM.

Table 1: Breakdowns of coal and gas power stations by state

State	Capacity (GW) – fossil fuels only	Share of NEM	Breakdowns	Share of breakdowns
NSW	12.4	25%	51	22%
Queensland	11.9	24%	93	41%
Victoria	7.1	14%	79	35%
SA	3.1	6%	4	2%
Tasmania	0.4	1%	0	0%
Total	35.0	69%	227	
Total NEM capacity	50.5			

Source: OpenNEM

Note: Capacity figures have changed somewhat over the years that Gas & Coal Watch has been operating. These figures represent a middle ground for capacity during the period.

BREAKDOWNS PER GW

The Australia Institute's Gas & Coal Watch program also measures breakdowns of power stations relative to their capacity. This measure is important because it puts the number of breakdowns in context of the contribution of that power station to the grid.

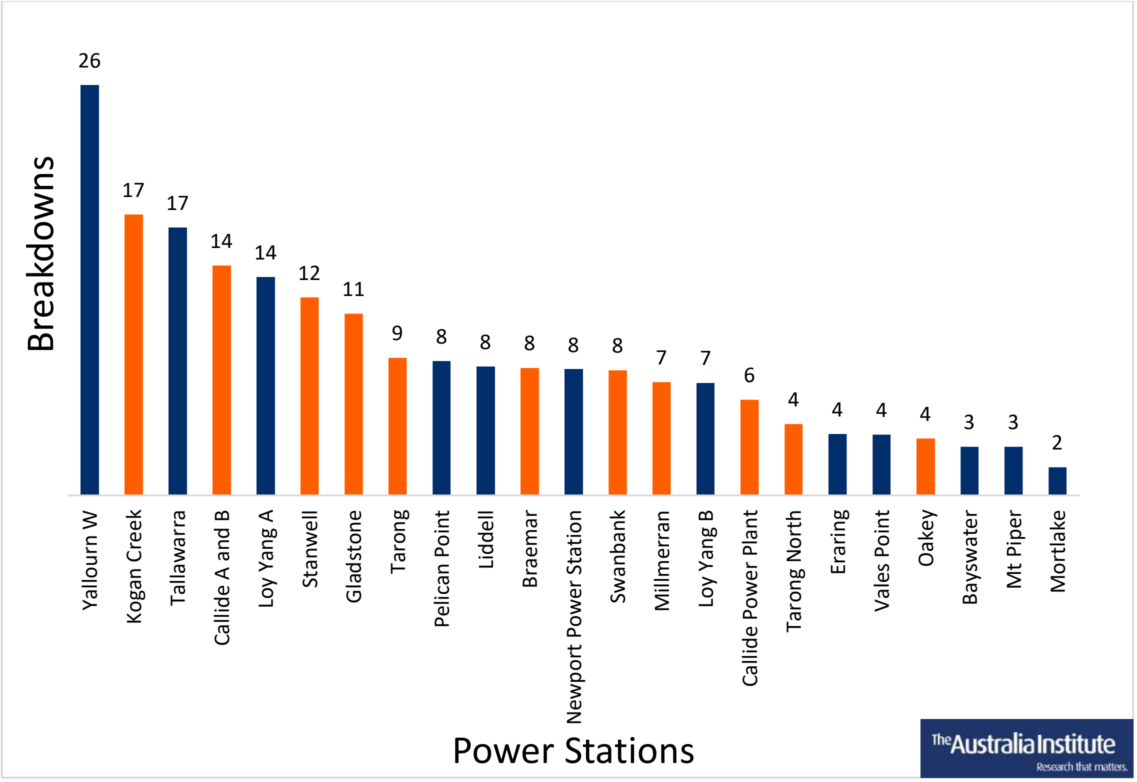
A power station's *capacity* is the amount of energy each power station can produce when operating at its full output. This is measured in gigawatts (GW). Table 2 and Figure 2 below show the number of breakdowns per GW of capacity for all of Queensland's coal and gas power stations. Queensland's newest coal power station, Kogan Creek Power Station (commissioned in 2007), has the most breakdowns relative to its capacity of any power station in Queensland over this period.

Table 2: Breakdowns per GW of capacity at Queensland power stations, 13 December 2017–31 December 2019

Power station	Type	Breakdowns per GW
Kogan Creek	Supercritical coal	17
Callide A and B	Subcritical coal	14
Stanwell	Subcritical coal	12
Gladstone	Subcritical coal	11
Tarong	Subcritical coal	9
Braemar	Open cycle gas turbine	8
Swanbank	Subcritical coal	8
Millmerran	Supercritical coal	7
Callide Power Station	Supercritical coal	6
Tarong North	Supercritical coal	4
Oakey	Open cycle gas turbine	4

Source: OpenNEM

Figure 2: Breakdowns per gigawatt, 13 December 2017–31 December 2019 (Queensland plants in orange)



Source: OpenNEM

As shown in Table 3 below, despite having a newer fleet of coal power stations than NSW,[2] including four supercritical power stations, Queensland power stations had almost double the amount of breakdowns per unit of capacity as NSW with its entirely subcritical fleet of coal power stations.

[2] Australian Senate, Senate Standing Committee on Environment and Communications (2016) *Retirement of coal fired power stations*, Table 2.1, https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Coal_fired_power_stations/Interim%20Report/c02

Table 3: Breakdowns of fossil fuel power stations per unit of capacity by state

State	Capacity (GW) – fossil fuels only	Breakdowns	Breakdowns/GW of fossil fuel capacity
NSW	12.4	51	4.1
Queensland	11.9	93	7.8
Victoria	7.1	79	11.1
SA	3.1	4	1.3
Tasmania	0.4	0	0.0
Total	*35*	*227*	*6.5*
Total NEM capacity	*50.5*		

Source: OpenNEM

BREAKDOWNS BY INDIVIDUAL UNIT

Coal power stations are usually made up of a number of individual generating units that can operate independently of each other. For instance, Stanwell Power Station near Rockhampton in Central Queensland consists of four 365 MW units and Gladstone Power Station has six 280 MW units.[3] Kogan Creek Power Station in the Darling Downs is unusual for a coal power station in that it consists of a single 750 MW unit.

Table 4 below shows the number of breakdowns for the ten worst performing individual generating units (by number of breakdowns) across the entire NEM. Queensland's Kogan Creek Power Station's single unit is the worst performing unit (by number of breakdowns) in the NEM. Three of Queensland's coal units are in the top ten worst performing units in the NEM. Only one NSW coal unit is among the worst performing units in the NEM, which incidentally, along with other Liddell Units, is scheduled for retirement in 2023.

Table 4: Worst performing units in the NEM by breakdowns

Unit name	Place	Type	State	Breakdowns
Kogan Creek	Worst	Supercritical	Queensland	13
Yallourn W Unit 3	2nd	Brown coal	Victoria	12
Yallourn W Unit 2	3rd	Brown coal	Victoria	11
Loy Yang A Unit 2	4th	Brown coal	Victoria	10
Loy Yang A Unit 1	5th	Brown coal	Victoria	9
Stanwell Unit 4	6th	Subcritical black	Queensland	8
Liddell Unit 2	7th	Subcritical black	NSW	7
Yallourn W Unit 1	7th	Brown coal	Victoria	7
Yallourn W Unit 4	7th	Brown coal	Victoria	7
Callide B Unit 1	7th	Subcritical black	Queensland	7

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[3] AEMO (April 2020) *NEM Registration and Exemption List*, https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/information-for-current-participants/participants-registered-for-the-nem

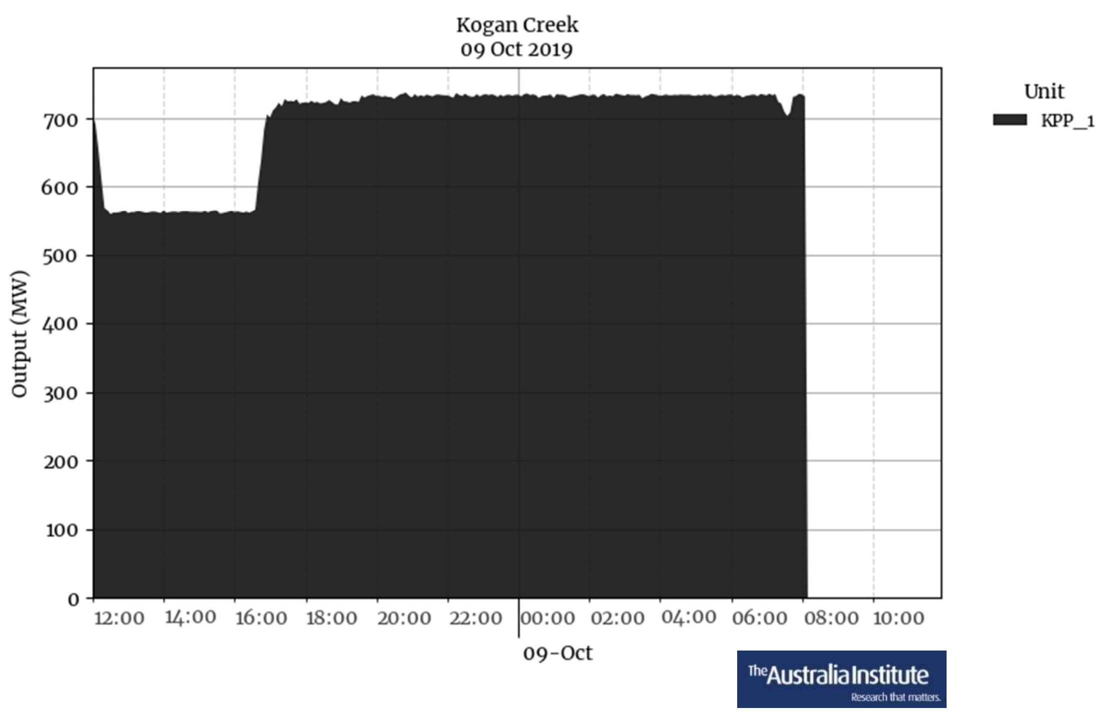
Kogan Creek

As detailed above, Kogan Creek has experienced more breakdowns than any other power station in Queensland over the period of Gas and Coal Watch monitoring. It also has the most breakdowns per unit of capacity in Queensland and is the single most unreliable individual generating unit in the NEM.

This is particularly significant because Kogan Creek is also the largest individual fossil generating unit in the NEM. This means that when it breaks down it has potentially more impact on the overall electricity supply of the NEM than breakdowns of any other generating unit.

Kogan Creek has a history of tripping completely and instantaneously, as was the case on 9 October 2019 as shown in Figure 3 below. The solid black area shows the power station's output of just over 700 MW until it abruptly drops to zero just after 7 am. Table 5 below shows that there were four breakdowns of over 700 MW at Kogan Creek in 2018 and 2019.

Figure 3: Kogan Creek Unit Trip, 9 October 2019



Source: OpenNEM

Table 5: Breakdowns at Kogan Creek Power Station

Date	Generation lost (MW)
23/12/2017	350
11/01/2018	195
18/04/2018	~750
05/06/2018	750
16/06/2018	752
13/08/2018	~286
13/12/2018	334
1/12/2019	500
10/3/2019	290
4/10/2019	18
4/10/2019	121
5/10/2019	307
9/10/2019	710

Source: OpenNEM

As the largest single generator in the NEM, and with its record of losing its full capacity instantaneously, Kogan Creek Power Station also poses a particular threat to grid frequency.

When sudden decreases in supply push grid frequency out of its safe range there are a number of risks, including damage to equipment on both the power generation and demand sides.

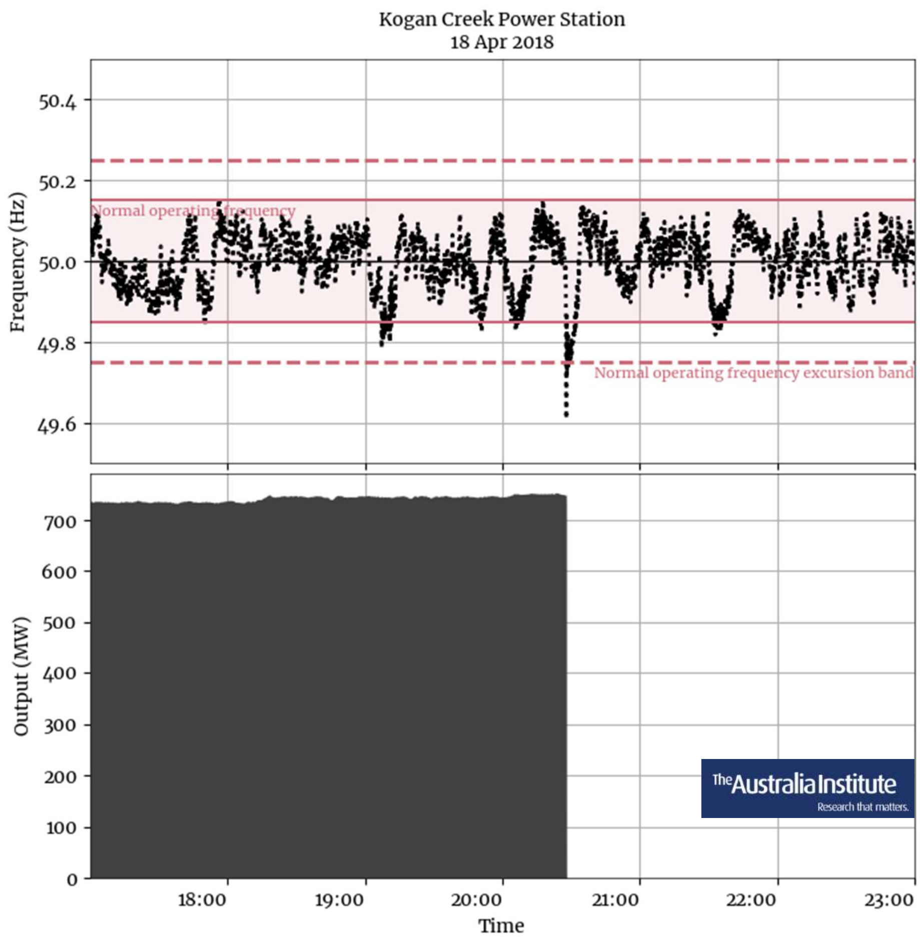
If supply exactly meets demand, the frequency of the power system is 50 Hertz (Hz). Because demand and supply never remain exactly matched, routine frequency fluctuation is between 49.85 and 50.15 Hz (the 'normal operating frequency band').

When a gas or coal plant breaks down, the frequency will often fall below 49.85 Hz, at which point new supply needs to be brought on quickly to restore the frequency. The Frequency Control Ancillary Services market is activated to address the fall in frequency.

The lowest level of frequency that is acceptable when there is a contingency event like a power plant breakdown is 49.75 Hz (the 'normal operating frequency excursion band').

As can be seen in Figure 4 below, the sudden breakdown at Kogan Creek on 18 April 2018 caused a drop in frequency to well below the acceptable lower limit of a secure power system.

Figure 4: Frequency impact of Kogan Creek unit trip of 18 April 2018



Source: OpenNEM

This is not an isolated incident. It has been reported that on 1 May 2020, constraints were put on the export of electricity from Queensland to protect the region in case Kogan Creek tripped, which could have triggered a voltage collapse in the Queensland region.[4]

[4] McArdle (1 May 2020) *Spot prices plunge in QLD, and may well remain underwater for the coming week,* http://www.wattclarity.com.au/articles/2020/05/spot-prices-plunge-in-qld/

Suboptimal Supercritical

Kogan Creek is the newest coal power station in Australia and uses 'supercritical' technology to generate electricity from coal.

Four of Queensland's coal plants burn black coal using 'subcritical' technology. The other four burn black coal using 'supercritical' technology. Coal plants in other states burn black coal (NSW) or brown coal (Victoria), using only subcritical technology.

Older 'subcritical' power stations lose energy from the steam generated to drive the turbines. Supercritical power stations, which date from 1957, reduce this heat loss of energy by turning the water directly into a 'supercritical fluid' that has properties of both gas and liquid. 'Supercritical' coal plants have the specialised equipment needed to keep water at such a temperature and pressure that it turns supercritical.

Supercritical coal power stations have been dubbed 'High Efficiency Low Emissions' (HELE) by the coal industry. However Kogan Creek power station is only slightly less emissions intensive than other older subcritical power stations in Queensland. Stanwell Power Station is a subcritical power station commissioned in 1996, a decade before Kogan Creek. It emits 0.86 tonnes of CO_2 for every megawatt hour (MWh) of electricity it produces. Kogan Creek produces 0.82 tonnes of CO_2/MWh, meaning that it produces only around 5 percent less greenhouse gas emissions per unit of energy than Stanwell Power Station.[5]

The next generation 'ultra-supercritical' plants operate at even higher temperatures and pressures and can further reduce energy loss and make the process more efficient. Since the 1990s, some ultra-supercritical plants have been built overseas. The industry hopes to develop 'advanced ultra-supercritical' plants that would take it a step further and increase efficiency through even higher temperatures and pressures. Plants with the most efficient current coal technology, 'ultra-supercritical', still emits upwards of 0.74 tonnes of CO_2 per MWh of electricity produced.[6]

While supercritical plants are more efficient than subcritical plants (when burning similar fuels), this is in physical terms: they are slightly better at converting input energy into useful output energy. They are not necessarily superior to subcritical plants in practical or economic terms. Supercritical plants can have higher capital costs, require more complicated and expensive components and be less able to 'ramp' up and down – in other words, slower to respond to changes in demand. These limitations can cause problems for

[5] NGER (2020) *Electricity sector emissions and generation data*, http://www.cleanenergyregulator.gov.au/NGER/National%20greenhouse%20and%20energy%20reporting%20data/electricity-sector-emissions-and-generation-data

[6] Ogge and Browne (2019) *Suboptimal supercritical* https://www.tai.org.au/content/suboptimal-supercritical

electricity consumers. For example, boiler tube leaks are a common cause of breakdowns at coal plants.[7] Higher pressures and temperatures, like those seen in supercritical plants, will put greater stress on coal plant boilers. These greater temperatures and pressures could be a reason for the higher rate of coal breakdowns at the newer supercritical power plants in Australia.

Australia has four coal power plants that have been built in the last 20 years, all of which are in Queensland. All of these are supercritical power stations.

Table 6: NEM supercritical coal plants in Queensland

Power Station	Age (Years)
Callide Power Plant	20
Millmerran Power Station	19
Tarong North Power Station	19
Kogan Creek Power Station	14

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Although the older subcritical black coal plants have enormous issues with reliability, these newer supercritical power stations break down more often.

As shown in Table 7 below, Queensland's so called 'HELE' supercritical power stations made up 11% of NEM breakdowns over the period of monitoring, despite making up only 6% of capacity. On average they broke down 9 times per GW of capacity compared to 6.7 times for the older subcritical black coal power stations.

[7] Bamrotwar and Deshpande (2014) *Root Cause Analysis and Economic Implication of Boiler Tube Failures in 210 MW Thermal Power Plant*, https://www.scribd.com/document/306366367/RCA-of-Boiler-Tube-Failure-in-210-MW-plant

Table 7: NEM unit trips 13 December 2017 to 23 December 2019

Group	Capacity (GW)	Share of NEM	Breakdowns	Share of breakdowns	Breakdowns/GW of capacity
Subcritical black	15.4	30%	103	45%	6.7
Supercritical black	2.9	6%	26	11%	9.0
Total black coal	*18.3*	*36%*	*129*	*57%*	*7.0*
Subcritical brown	4.7	9%	74	33%	15.7
Gas	12	24%	24	11%	2.0
Total fossil fuels	*35*	*69%*	*227*	*100%*	*6.5*
Total NEM capacity	*50.5*				The Australia Institute Research that matters.

Source: OpenNEM

Implications of a new supercritical coal power station at Collinsville

In 2019, a 1 GW coal power station was proposed for construction at Collinsville in the Whitsunday region of Queensland by a small local company, Shine Energy. The company originally announced it intended to build an 'ultra-super critical' power station. However it has been reported that the proposal is now for a power station with a similar emissions intensity to the now 14 year old Kogan Creek power station.[8] This suggests that unless a very inefficient ultra-supercritical power station is proposed, the proposal may have changed to just a supercritical power station.

Given the higher rate of breakdowns of supercritical power stations in Australia, it likely that adding another one will reduce the overall reliability of the NEM.

Renewable energy, even with the cost of firming power added is already considerably lower cost than building new coal power stations, and that advantage is expected to increase considerably over the coming decades.[9]

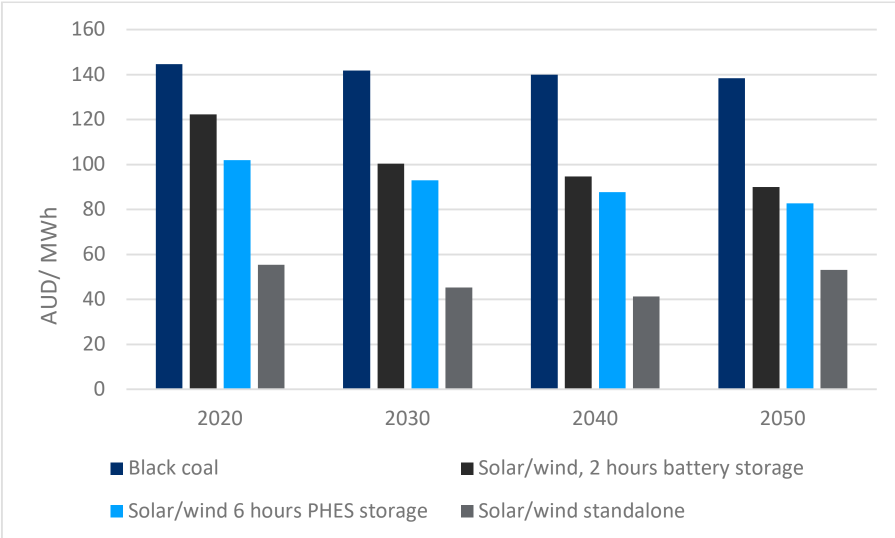
Figure 5 below shows CSIRO and AEMO analysis of the Levelised Cost of Energy (LCOE) for various electricity generation technologies. The LCOE is a way of comparing the relative costs of various technologies over their lifetime. Solar and wind are shown with the cost of firming power from batteries and pumped hydro to enable them to produce dispatchable energy when required. Coal is shown incorporating a small risk premium to account for future climate policies, but without a carbon price.

In the CSIRO and AEMO analysis, new coal power stations are 30 percent more expensive than renewables with six hours of energy storage, and by 2050 they are projected to be 40 percent more expensive. This added cost would likely be covered by taxpayers, higher electricity prices or both.

[8] Smee (April 2020) *Proposed Queensland coal-fired power plant under cloud over emissions and financing,* https://www.theguardian.com/australia-news/2020/apr/23/proposed-queensland-coal-fired-power-plant-collinsville-emissions-financing

[9] AEMO, CSIRO (2018) *GenCost 2018: Updated projections of electricity generation technology costs*, https://publications.csiro.au/rpr/download?pid=csiro:EP189502&dsid=DS1

Figure 5: Levelised Cost of Electricity for coal and renewable technologies



Source: CSIRO/AEMO (2018) *GenCost 2018* and author's calculations.

Note: AUD/MWh stands for Australian dollars per megawatt hour. PHES stands for pumped hydro energy storage.

Given the un-competitiveness of new coal power stations relative to renewable energy, unless there is government intervention, new power generating capacity in Queensland is likely to be renewable energy.

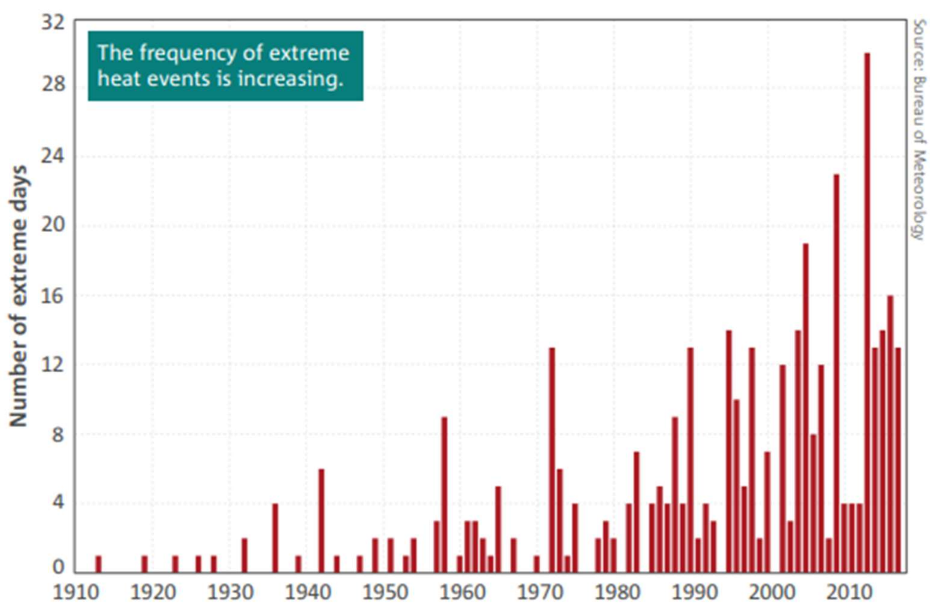
As such, intervening to build a new supercritical coal power station in Collinsville could actually make Queensland's electricity supply less reliable, more expensive and more high-polluting than it would otherwise have been.

The effect of increasing extreme heat due to global warming

The unreliability of gas and coal fired power stations is compounded by global warming, which is increasing the frequency and severity of extreme heat events. This results in high electricity demand peaks due to increased demand for cooling in the extreme conditions.

The last two summers have been the hottest on record in Australia, and last summer was the second hottest on record for Queensland with the average maximum temperature of 2.3 degrees above average.[10] This trend will continue while emissions continue to rise.[11] Of crucial importance are the number of extreme heat days when demand for electricity for cooling creates very high energy demand. Figure 6 below shows the increasing frequency of extreme heat days across Australia.

Figure 6: Number of days each year where the Australian area-averaged daily mean temperature is above the 99th percentile of each month from the years 1910–2017



Source: BOM (2019) *State of the Climate 2018*, http://www.bom.gov.au/state-of-the-climate/State-of-the-Climate-2018.pdf

[10] BOM (2020) *Seasonal climate summary for summer 2019-20*, http://www.bom.gov.au/climate/current/season/aus/archive/202002.summary.shtml

[11] BOM (2019) *State of the Climate 2018*, http://www.bom.gov.au/state-of-the-climate/State-of-the-Climate-2018.pdf

When demand is high on these days, any sudden loss of power presents a much greater risk of blackouts than it would when demand is at lower levels. There are many causes of sudden losses of power. The most common cause is transmission lines failing in the heat or being cut by bushfires. Power stations may not break down in any greater frequency in the extreme heat, but sudden losses of hundreds of megawatts from power station failures in these circumstances can and has contributed to large scale blackouts.[12] Solar and wind generation is typically the result of many small generating units. If individual solar panels or wind turbines break down, it has little effect on the overall reliability of the electricity supply.

Fortunately, as Energy Networks Australia has recognised, increasing the amount of renewable energy, solar in particular, reduces this exposure:

> 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, particularly in liquefying coal seam gas for export.[13]

[12] Parkinson (2019) Brown coal generators failed the grid in Victoria heat-wave, blackouts, https://reneweconomy.com.au/brown-coal-generators-failed-the-grid-in-victoria-heat-wave-blackouts-55696/

[13] Energy Networks Australia (2019) *Heatwaves and electricity supply*, https://www.energynetworks.com.au/resources/fact-sheets/heatwaves-and-energy-supply-explained/

Solar cuts and delays heatwave peak demand

Solar regularly cuts critical heatwave peak demand days by over 1,000 MW and delays peak demand by several hours.

On 16 December 2019, temperatures reached 42 degrees in Rockhampton,[14] and electricity demand for Queensland reached very high levels of over 9,300 MW.[15]

Figure 7 below shows in blue the operational demand (energy demand supplied by the grid) of Queensland on that day. The yellow area represents power supplied ‘behind the meter’ by rooftop solar to Queensland households and businesses. This effectively reduced the demand for electricity that Queensland’s power stations needed to supply on that day, by supplying power directly to households and businesses with rooftop solar.

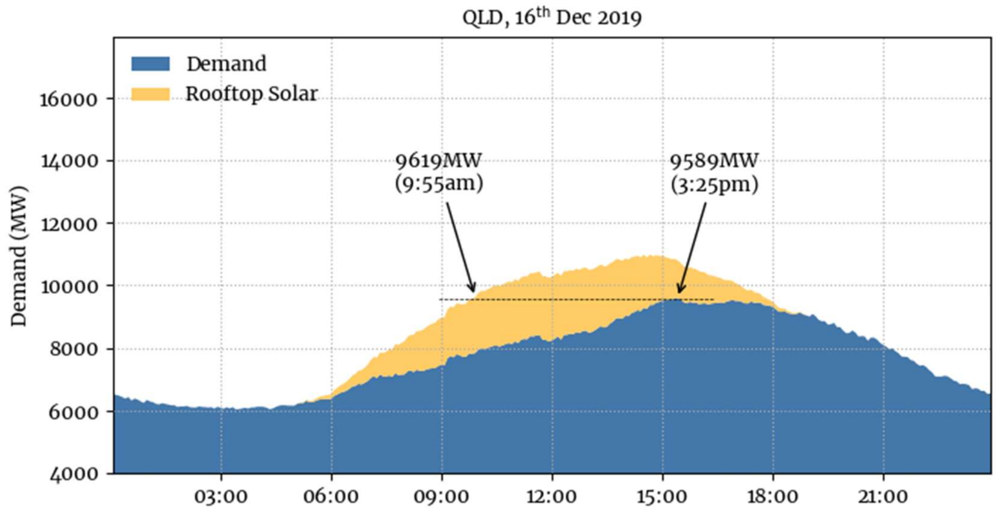
On that day, as shown in Figure 7, rooftop solar in Queensland cut peak demand by 1,390 MW, equivalent to almost double the capacity of Kogan Creek Power Station (750 MW). It also delayed the level of peak demand ultimately reached by five and a half hours.

This regular delay and reduction of peak demand by solar is critical to buffering Queensland and the NEM overall from supply shortages, including those caused by coal and gas power station breakdowns on critical extreme heat days. Because solar reliably delivers power at these critical times, installing more solar would further increase the security of Queensland’s electricity supply.

[14] BOM *Climate Data Online, Rockhampton AERO Stn No 39083*, http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=122&p_display_type=dailyDataFile&p_startYear=2019&p_c=-305531712&p_stn_num=039083

[15] AEMO (2020) *Aggregated price and demand data, Historical data*, https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/data-nem/aggregated-data

Figure 7: Operational and underlying demand, Queensland, 16 December 2019



Source: OpenNEM

Conclusion

The NEM's ageing fleet of fossil fuel power stations continues to experience regular breakdowns. At the same time climate change is increasing the frequency and severity of extreme heat days which result in higher peaks of electricity demand.

Because coal and gas power stations are typically made up of large generating units of hundreds of megawatts, when they break down unexpectedly, they can pose a significant risk of blackouts, particularly on hot, high demand days.

Queensland's coal power stations have been responsible for more breakdowns over the period monitored by Gas and Coal Watch than any other state, despite having the youngest fleet of coal power stations. The newest of all these, Kogan Creek Power Station, is also the most unreliable single generating unit in the NEM. Because it is also the largest unit, it poses a particular risk to the Queensland power supply.

The proposed new coal fired power station at Collinsville appears to be similar technology to the Kogan Creek Power Station, and as such is likely to have similar problems with reliability and result in similar emissions levels. By contrast, Queensland is increasing its uptake of renewable energy and recently overtook South Australia in terms of renewable energy capacity. New renewable energy is already lower cost than building new coal power stations, and left to the market, renewables could provide cheaper electricity for Queensland, even with the additional cost of energy storage.

Solar has the advantage of delivering electricity right when the Sunshine State needs it most – when it's sunny and hot. The research shows that solar can cut underlying peak demand in Queensland by over 1000 MW, and delay peak demand by many hours. This greatly mitigates the risk posed by breakdowns at coal and gas power stations.

Installing more solar will continue to increase the reliability of Queensland's electricity supply. If this is combined with batteries or other forms of storage, even the remaining early evening peak can be greatly reduced. Increasing the share of both large scale solar and rooftop solar PV should be a priority of the Queensland and Australian Governments.