

Meltdown 2018

Breakdowns at gas and coal plants over 2018

In 2018 there were 135 major breakdowns at gas and coal power stations in the National Energy Market. While the oldest coal plants were responsible for a large proportion of the breakdowns, newer supercritical plants were also unreliable. There were three breakdowns at one of the newest gas plants. Victoria's brown coal plants were the least reliable overall.

Discussion paper

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Summary

In 2018, The Australia Institute's Gas & Coal Watch identified 135 major breakdowns at gas and coal power stations in the National Electricity Market (NEM), each one removing hundreds of megawatts of capacity from the system.

Gas and coal plants can break down in the heat, and older coal plants are particularly vulnerable. In addition, extreme heat drives high demand, meaning that the fossil fleet is most likely to break down at times when it is most needed.

The breakdowns at coal and gas plants in 2018 were not only at old coal power plants, but also at the newest gas plants and supercritical coal plants.

There were 74 breakdowns at black coal power plants in New South Wales and Queensland and 44 at Victoria's brown coal plants. There were more black coal breakdowns overall, but more breakdowns at brown coal plants relative to capacity. There were also 17 breakdowns at gas plants.

Figure 1: Overall breakdowns (2018)

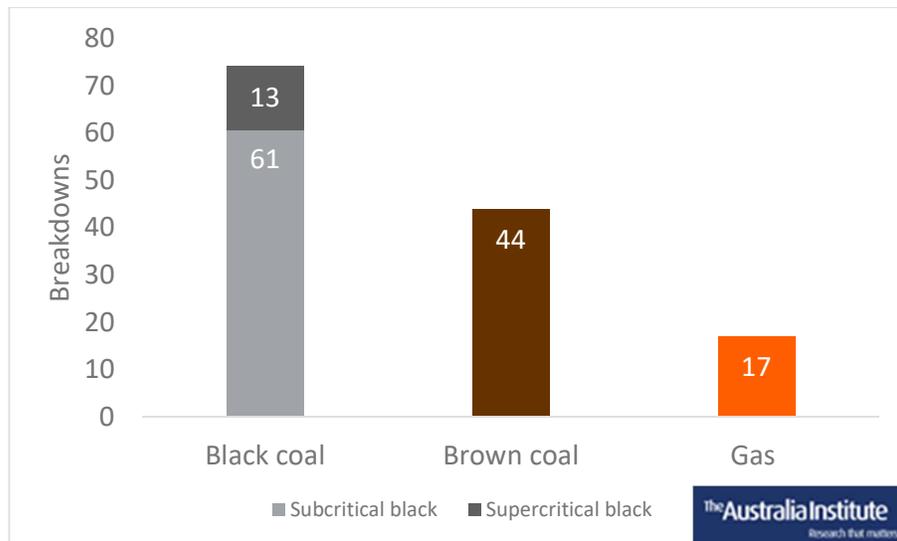


Figure 2: Breakdowns per GW of capacity (2018)

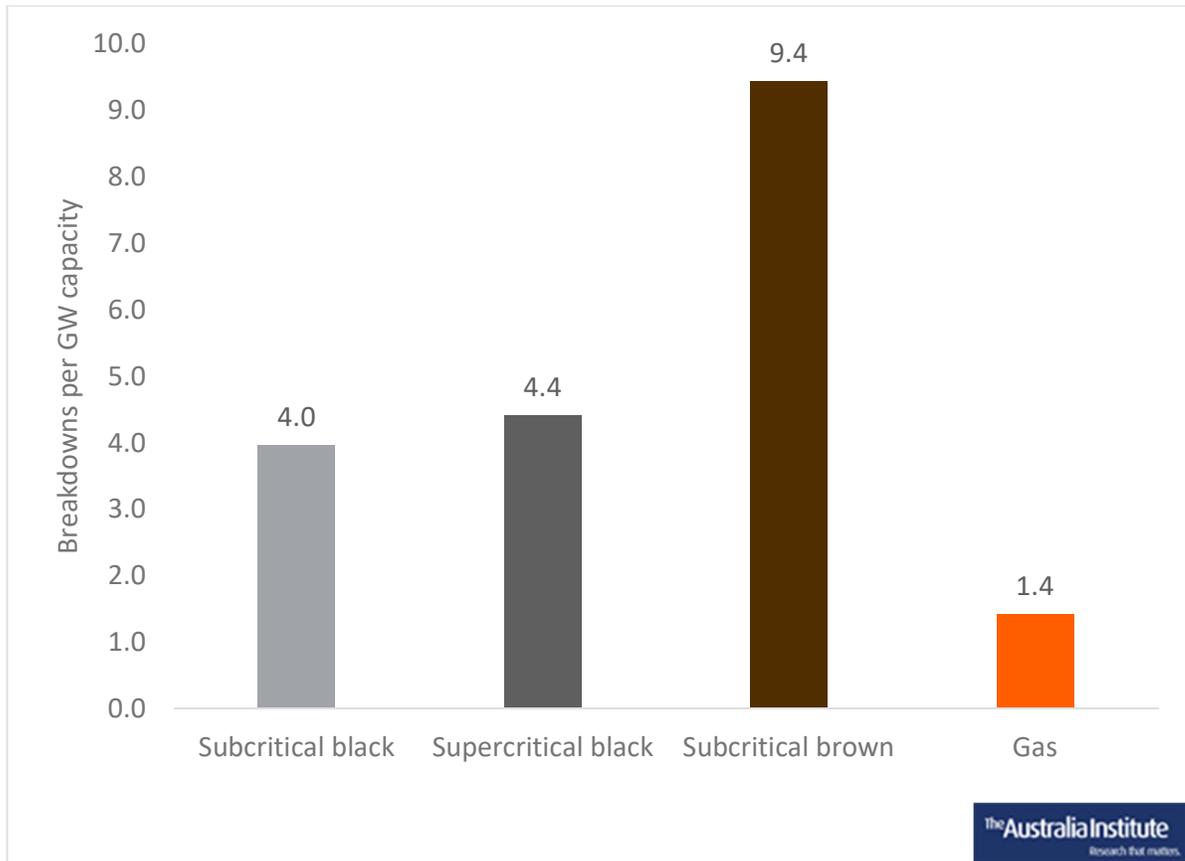


Table 1: Breakdowns by fossil fuel type, share of capacity

Group	Capacity (GW)	Share NEM	B'downs	Share b'downs	B'downs/GW
Black coal	18.3	36%	74	55%	4.0
Brown coal	4.7	9%	44	33%	9.4
Gas	12.0	24%	17	13%	1.4
Total	35.0	69%	135	100%	3.9

Note: The remaining capacity in the NEM is mostly from renewables.

Introduction

The Australia Institute founded Gas & Coal Watch in December 2017 to monitor the National Energy Market's fossil fuel power plants for breakdowns, particularly over the summer when generating units are vulnerable.

This report summarises the results from Gas & Coal Watch's first year of operations. It identifies 135 breakdowns, of which the vast majority were unit trips. In a unit trip, one of a power plant's units is suddenly, typically unexpectedly, taken off the grid. 10 breakdowns were in the form of sharp, sudden decreases in electricity output that did not involve a unit being taken totally offline.

Thermal electricity generation is particularly affected by the heat because its efficiency depends on temperature extremes between input and output. Closed-system generators typically use water for cooling, and during periods of extreme heat power stations can fail if the water from the cooling tower is too warm, if access to water is limited, or if the discharged water being pumped out of the cooling tower is too hot.¹ 65 per cent of generating capacity in the NEM depends on water for cooling coal and gas fired power stations.² Air-cooled plants are less efficient overall, and also lose efficiency in the heat.

As global warming results in more hot days, this vulnerability exacerbates. This is compounded by increased demand for electricity on hot days.

¹ Union of Concerned Scientists (2011) *Energy and Water in a Warming World: Freshwater Use by US power plants*, http://www.ucsusa.org/clean_energy/our-energy-choices/energy-and-water-use/freshwater-use-by-us-power-plants.html#.WfEcCohx3IU

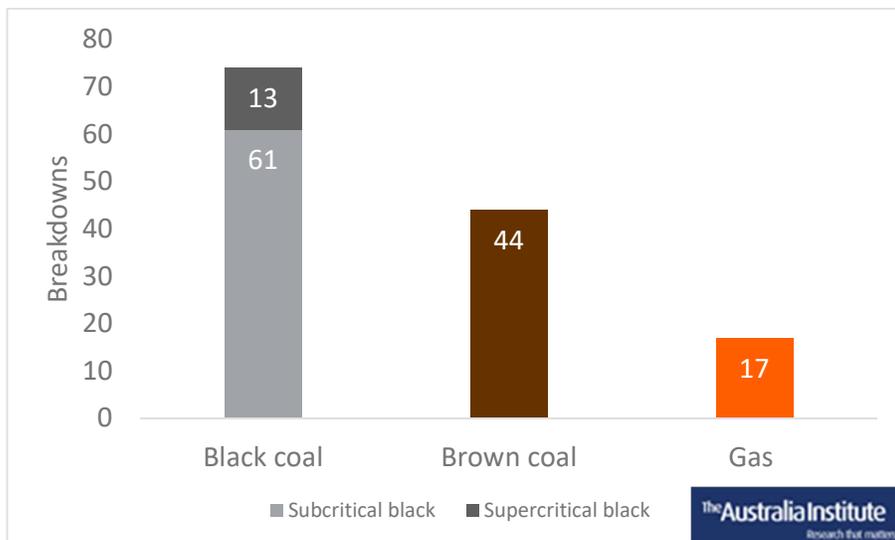
² Smart and Aspinall (2009) *Water and the electricity generation industry*, Australian Water Commission

Overall breakdowns

In the NEM, brown coal plants are found only in Victoria, while black coal plants are found only in Queensland and NSW. NSW, Victoria, Queensland and South Australia all have at least one gas plant that broke down in 2018. Tasmania has gas plants, but they did not break down.

In absolute terms, black coal was the worst performer, with 74 breakdowns to brown coal's 44 and gas' 17.

Figure 3: Overall breakdowns (2018)



Absolute figures can be misleading, because there are more black coal plants than brown coal plants. Black coal is the single largest contributor to electricity in the NEM, responsible for 36% of capacity.

Taking capacity into account, brown coal is the worst performer with 9.4 breakdowns per GW capacity. Gas is the best at 1.4 breakdowns per GW capacity.

Figure 4: Breakdowns per GW of capacity (2018)

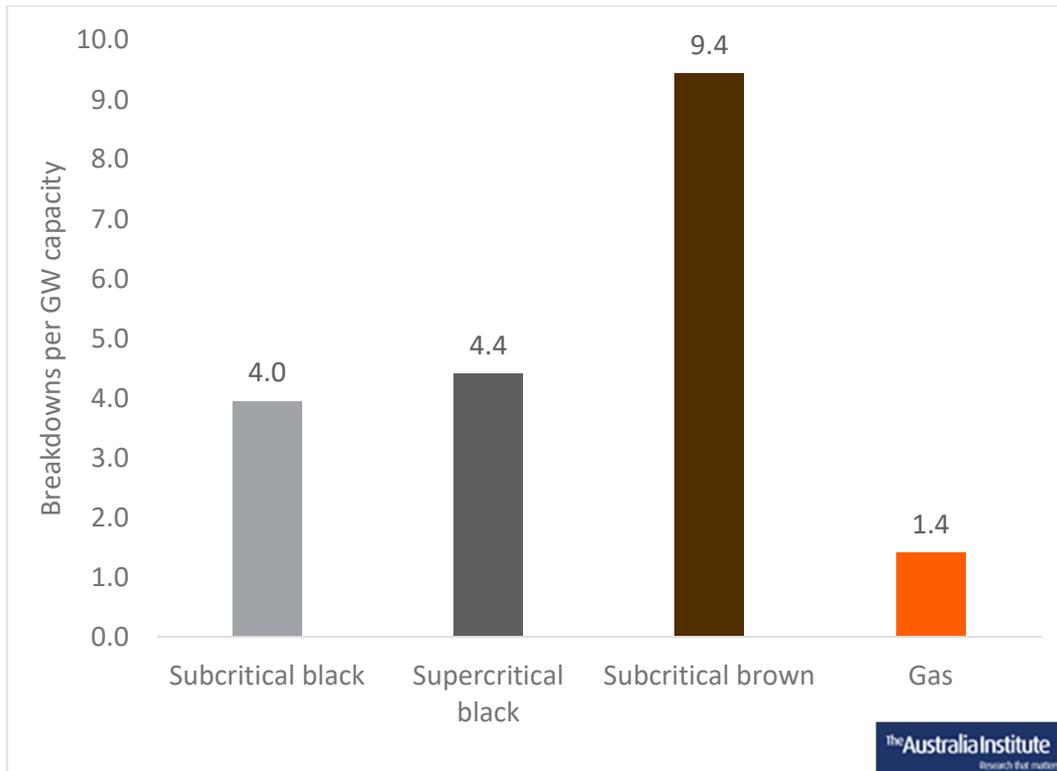


Table 2 shows the full details of breakdowns by fossil fuel group and share of capacity.

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Coal

Australia's 16 coal plants are responsible for 46% of the NEM's capacity, or 23 GW. Gas & Coal Watch further categorises plants by whether they burn brown coal (a lower efficiency, more polluting form of coal) or black coal. Black coal generation is almost four times larger than brown coal generation, with 18.3 GW of capacity to brown coal's 4.7 GW.

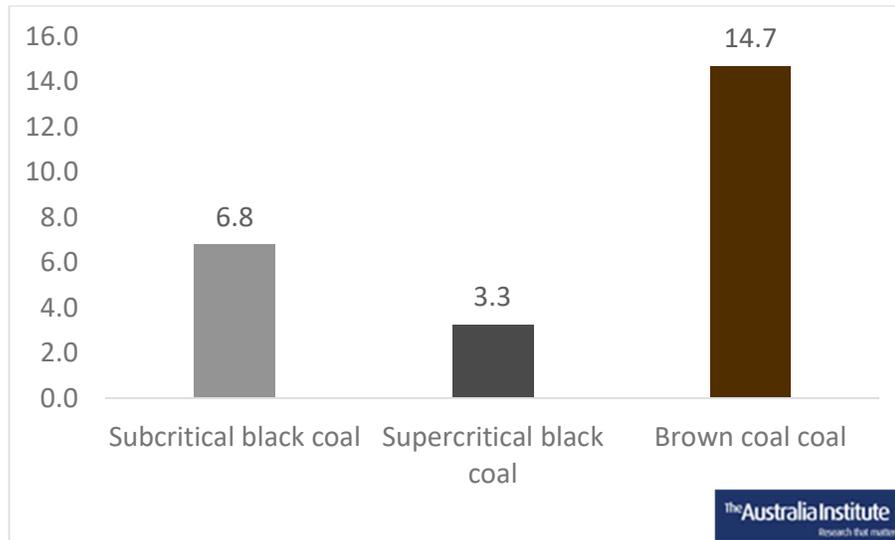
Our analysis also distinguishes between "supercritical" black coal plants and "subcritical" black coal plants. A supercritical plant keeps water at high pressures and temperatures for greater efficiency. Australia's supercritical plants are newer than all subcritical plants in Australia. All of Australia's brown coal plants are subcritical.

Brown coal plants are the worst performers overall, with 14.7 breakdowns per plant, followed by subcritical black coal plants (6.8 breakdowns per plant) and then supercritical black coal plants (3.3 breakdowns per plant).

Table 3: Breakdowns at coal stations by group

Group	Plants	Breakdowns	Share of coal stations	Share of coal breakdowns	Breakdowns per plant
Subcritical black	9	61	56%	52%	6.8
Supercritical black	4	13	25%	11%	3.3
Brown coal	3	44	19%	37%	14.7
Total	16	118			7.4

Figure 5: Breakdowns per coal plant



The number and type of coal plant in each state result in different rates and severities of breakdowns. Victoria’s three coal plants are just 19% of all coal plants in the NEM, but experienced 37% of coal breakdowns (14.7 breakdowns per plant). Queensland experienced more breakdowns per coal plant, at 6.3 per plant in 2018, than NSW did, at 4.8 per plant.

Table 4: Breakdowns at coal stations by state

State	Stations	Breakdowns	Share of coal stations	Share of coal breakdowns	B’downs per plant
NSW	5	24	31%	20%	4.8
Queensland	8	50	50%	42%	6.3
Victoria	3	44	19%	37%	14.7
Total	16	118			7.4



Table 5 shows breakdowns at each coal power station during 2018. Every coal plant experienced at least one breakdown. Loy Yang A and Yallourn W experiencing the most breakdowns of all plants in the NEM, at 22 and 18 breakdowns respectively.

Table 5: Coal power station breakdowns in 2018

Name	State	Group	Breakdowns	Breakdowns per GW
Bayswater	NSW	Subcritical black	3	1.1
Eraring	NSW	Subcritical black	4	1.4
Liddell	NSW	Subcritical black	11	5.5
Mt Piper	NSW	Subcritical black	1	0.8

Vales Point	NSW	Subcritical black	5	3.8
Callide A and B	Queensland	Subcritical black	5	7.1
Callide Power Plant	Queensland	Supercritical black	3	3.6
Gladstone	Queensland	Subcritical black	14	8.3
Kogan Creek	Queensland	Supercritical black	6	8.1
Millmerran	Queensland	Supercritical black	2	2.3
Stanwell	Queensland	Subcritical black	12	8.2
Tarong	Queensland	Subcritical black	6	4.3
Tarong North	Queensland	Supercritical black	2	4.4
Loy Yang A	Victoria	Subcritical brown	22	10.1
Loy Yang B	Victoria	Subcritical brown	4	4.0
Yallourn W	Victoria	Subcritical brown	18	12.4
Total			118	

BLACK COAL

Thirteen black coal plants, all in Queensland or NSW, contribute 18.3 GW to the NEM, 36% of its total generation capacity.³

In 2018, each of these plants experienced at least one breakdown – and collectively, they experienced 74 breakdowns, making this group the single largest source of breakdowns.

Two of the oldest and largest plants, Liddell in New South Wales and Gladstone in Queensland, had frequent breakdowns, with 11 and 14 breakdowns respectively. However, the relatively new (commissioned in 1993) coal plant Stanwell had more breakdowns than Liddell, with 12.

Supercritical black coal

Despite being much newer and somewhat more efficient than the subcritical plants, supercritical plants did not perform better than subcritical plants overall.

Australia has four supercritical coal plants, all in Queensland:

- Kogan Creek
- Callide C (also known as “Callide Power Plant”)
- Tarong North

³ AEMO (2018) *Generation Information Page*, <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information>

- Millmerran

These plants are described as High Efficiency, Low Emissions (HELE) plants because they are typically more efficient than subcritical coal plants. However, they are less efficient and have worse emissions than competing power generation like gas and renewables.

Supercritical plants, the newest black coal power plants in the NEM, broke down more often than subcritical black coal plants. Supercritical black coal plants represent 16% of total black coal generation and experienced 18% of total black coal breakdowns.

The nine worst unit trips, in terms of lost capacity, were all at black coal power plants. The supercritical Kogan Creek plant was responsible for the three largest losses of capacity in the NEM, as its single unit can generate up to 750 MW.

Table 6: Greatest losses of capacity from unit trips (2018)

Station	Unit	Category	State	Date	MW lost
Kogan Creek	KPP_1	Supercritical black	Queensland	16/06/2018	752
Kogan Creek	KPP_1	Supercritical black	Queensland	18/04/2018	750
Kogan Creek	KPP_1	Supercritical black	Queensland	5/06/2018	750
Eraring	ER03	Subcritical black	NSW	13/07/2018	698
Bayswater	BW04	Subcritical black	NSW	8/02/2018	657
Eraring	ER02	Subcritical black	NSW	25/12/2018	657
Vales Point	VP6	Subcritical black	NSW	7/06/2018	631
Bayswater	BW02	Subcritical black	NSW	19/07/2018	626
Mt Piper	MP2	Subcritical black	NSW	24/10/2018	583
Loy Yang A	LYA3	Subcritical brown	Victoria	22/06/2018	562
Loy Yang A	LYA3	Subcritical brown	Victoria	4/11/2018	562



Note: Actual generation can somewhat exceed nameplate capacity, which is why Kogan Creek lost 752 MW on the 16th of June when its nameplate capacity is just 750 MW.

Note: Two unit trips at Loy Yang A are tied for 10th place.

BROWN COAL

Three brown coal plants, all in Victoria, contribute 4.7 GW to the NEM, 9% of its total generation capacity.⁴

⁴ AEMO (2018) *Generation Information Page*, <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information>

During 2018, the three plants experienced 44 breakdowns, making these plants the group with the highest rate of breakdowns.

Older plants were more susceptible to breakdowns, with the older Yallourn W (commissioned in 1975) and Loy Yang A (commissioned in 1984) experiencing 18 and 22 breakdowns respectively in 2018. The younger Loy Yang B (commissioned in 1993) had four breakdowns.

These vulnerabilities will be an increasing liability for the NEM as these antiquated plants continue to age while extreme heat events continue to increase in frequency, intensity and duration as a result of global warming.

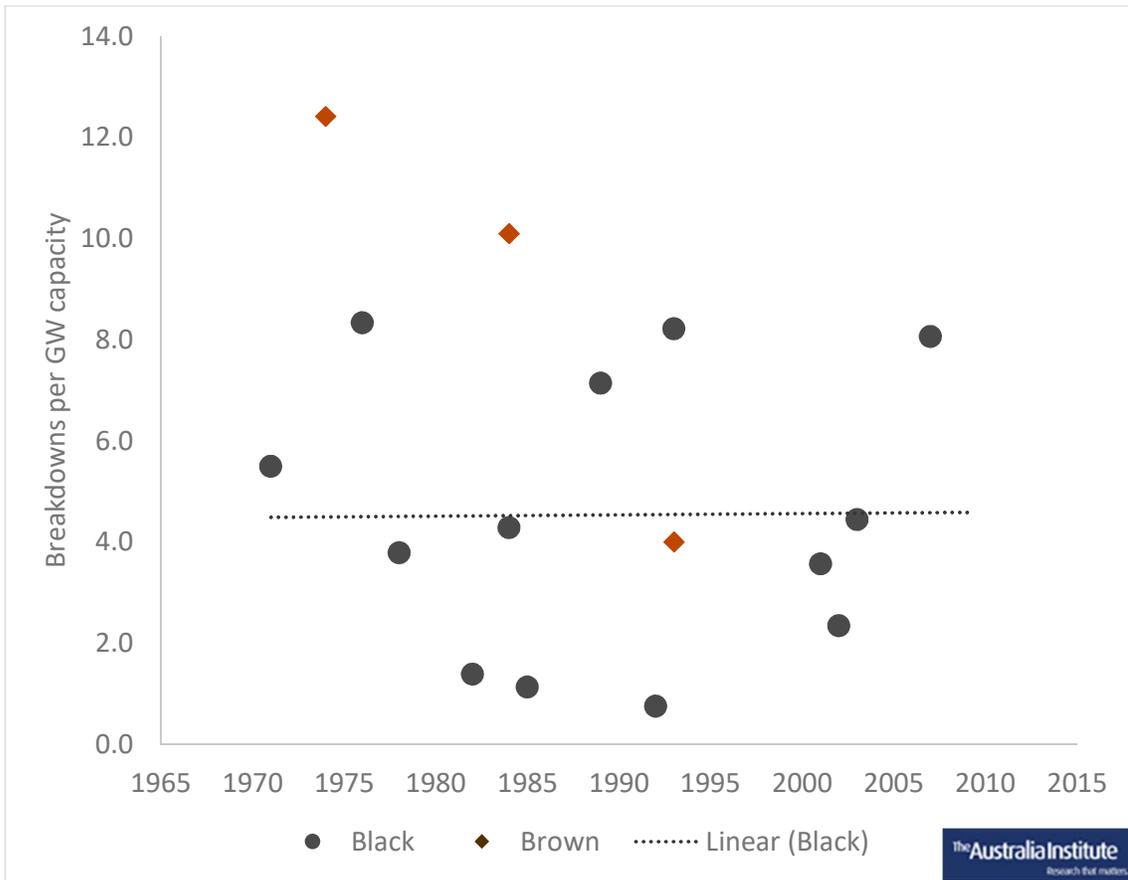
AGE

The National Electricity Market's coal fleet was commissioned between 1971 (Liddell) and 2007 (Kogan Creek). There are large fluctuations in breakdowns, with some of the older stations having fewer breakdowns than the newer plants.

Out of the three brown coal plants, the newest (Loy Yang B) performs best and the oldest (Loy Yang A) performs worst.

Age has no apparent effect on how often black coal plants break down. Newer black coal plants break down as often, or even a little more often, than older black coal plants. The linear trend for black coal in Table 7 displays this phenomenon, rising from 4.57 breakdowns per GW to 4.67. The most recently commissioned coal plant – Kogan Creek – is the third most unreliable black coal plant in the market.

Table 7: Coal plants by age and rate of breakdowns



Note: Some power plants had units commissioned at different times. In that case, the earliest commissioning date is used.

Gas

About 40 gas plants in NSW, Victoria, Queensland, SA and Tasmania contribute 12.0 GW to the NEM, 24% of its total generation capacity.⁵

In 2018, six plants experienced 17 breakdowns, making this group the plants with the lowest rate of breakdowns by plant and by capacity.

There are three main types of gas power plants in Australia: steam cycle, Open Cycle gas Turbines (OCGT) and Combined Cycle Gas Turbines (CCGT). CCGT plants combine gas turbines with steam technology so they can be used for bulk electricity supply as well as dispatchable energy.

Gas breakdowns did not discriminate by technology type or age, with breakdowns at both the newest CCGT power plants (Tallawarra, Swanbank and Pelican Point) and at one of the oldest steam cycle plants (Newport in Victoria).

Described as “state-of-the-art” with “fast-start capability”, the Tallawarra plant was only commissioned in 2009.⁶ As well as failing three times in 2018, it failed in Summer 2016–17 with dramatic consequences outlined in our report *Can’t stand the heat*.⁷

Table 8: Gas power station breakdowns (2018)

Name	State	Group	Breakdowns	Breakdowns per GW capacity
Braemar	Queensland	OCGT	3	6.0
Newport Power Station	Victoria	Gas other	4	7.8
Oakey	Queensland	OCGT	1	3.5
Pelican Point	SA	CCGT	4	8.4
Swanbank	Queensland	CCGT	2	5.2
Tallawarra	NSW	CCGT	3	7.1
Total			17	N/A

Note: This table only shows gas stations that had breakdowns. There are about 40 gas stations in the NEM, depending on classification.



⁵ AEMO (2018) *Generation Information Page*, <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and->

⁶ Energy Australia (n.d.) *Tallawarra Power Station*, <https://www.energyaustralia.com.au/about-us/energy-generation/tallawarra-power-station>

⁷ Ogge (2017) *Can’t stand the heat*, <http://www.tai.org.au/content/coal-and-gas-reliability-liability-heat-report>

Conclusion

Older brown coal power stations are particularly vulnerable to breakdowns, but the newer supercritical power stations (so-called High Efficiency, Low Emissions plants) were more likely to experience breakdowns than other black coal plants. Two of Australia's newer gas plants also experienced an unusually high rate of breakdowns.

If Australia is to have reliable electricity generation, unreliable gas and coal plants should be phased out in favour of renewable energy and storage.