Eastern Grid Blackouts

Twelve years ago, I started collecting data from the AEMO due to my interest in electricity supply on the eastern grid of Australia. Subsequently I have created a website called SpasmodicEnergy. Analysis of the data convinces me we are sleepwalking into a disaster. The belief that we can transition from fossil fuels to renewable energy is a delusion. Renewable energy is not expanding anywhere near quickly enough to replace the baseload fossil electricity generators. We are remarkably close to the crunch point. The primary problem is the storage of electricity in the quantities required. We face a future of blackouts across many states. It is hard to determine when but certainly before 2029. The only salvation I can think of is a rapid major expansion in natural gas generators.

It is well-known that coal stations are closing. Five of these are expected to close before 2030. They are to be replaced by renewable energy, in this article the requirement for wind is calculated since it is the primary source of renewable energy on the grid. It is found that 19.7 GW of wind generation will have to be constructed and be firmed by 910 GW hours of pumped hydro energy storage. That means expanding wind stations by 329% and building another three Snowy Mountains 2.0 (Pumped Hydro Energy Storage) facilities. This estimate depends on how many wind droughts there are in a particular period. 2020 was chosen since it has a long drought of 34 hours when the whole eastern grid dropped to an average of 5.56%. Wind drops particularly in winter but that is not every year 2021 was better and 2019 much worse. The worst-case scenario is needed but 2019 had one of 42 hours and 2018 one of 57 hours. So, predicting them is difficult but 2020 is adequate to make the point.

This can be investigated further on the drought page of my website.

These coal stations are marked to close before the end of the decade.

Name	Closure	Capacity (MW)	Grid % 2020	Output 2020 (TWh)
Liddell	2023	2000	4.1%	8.323
Eraring	2025	2880	7.2%	14.616
Callide B	2028	700	1.9%	3.857
Yallourn W Power Station	2028	1480	4.5%	9.135
Vales Point B	2029	1320	3.6%	7.308
		8380	21.3%	43.239

Table 1 coal station closures

Quite often the impact is measured on the capacity of the stations which is quite misleading. In table 1 the percentage of electricity output during 2020 by each station is shown 21.3% in all.

Wind is the expected replacement and so this article will concentrate on what is needed from wind electrical energy to replace the expected closures.

There is little alarm at the prospect of losing more than 21% of our output. The belief is that it can be replaced by renewable energy. The electricity sources in 2020 as shown were 9.75% for wind, 3.32% for grid solar and 6.43% for rooftop photovoltaic cells.

To replace the baseload coal stations wind must be equivalent to baseload electricity so it must be firmed and be dispatchable. This can be achieved by adequate storage. Assuming there is 350 GW hours available (Snowy Mountains 2.0) and 7.58 GW wind capacity (average for 2020) then when it is modelled wind can satisfy 8% of the demand.

When 21.3% is divided by 8% it is found that when those five coal stations close 2.6 times more wind output will be needed. That is an extra 19.7 GW of wind and 910 GWh of storage. The five stations that will close provide baseload power and replacement renewable energy must do the same.

Wind turbines cost $2 billion per GW so the turbine cost is going to be at least $39.4 billion. More than 9000 km² of suitable land must be found and a large amount of transmission lines to connect them. Snowy Mountains 2.0 which will have a capacity of 350 GW hours has a remarkably cheap price at $10 billion. A new PHES is to be built in Queensland at Kidston. It's capacity will be 16 GW hours and cost $6 billion. So, to firm the variable wind output the cost will be between $26 and $135 billion.

Note: it seems to be little realised that even though energy storage makes the renewable electricity generated more useful because it can be accessed when demanded it also has a downside in that there is a significant loss in the storage and a much-increased generation capacity is needed. Also, the stations that are going to close have a capacity of a bit more than 8 GW and yet 19.7 GW of wind is needed to replace them. On the eastern grid wind, only produces on average 29% of its rated capacity. The average capacity of wind stations in 2020 was 7.58 GW and average output about 2 GW. Loy Yang B has a capacity of 1 GW and has an output on average of 1 GW so that is 1 GW hours per hour. In 2020 only two of such stations could have replaced all wind generation with a stable electricity supply.

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NB these estimates will vary depending on the base data used, 2021 for instance when modelled as above will meet only 9% of the demand.