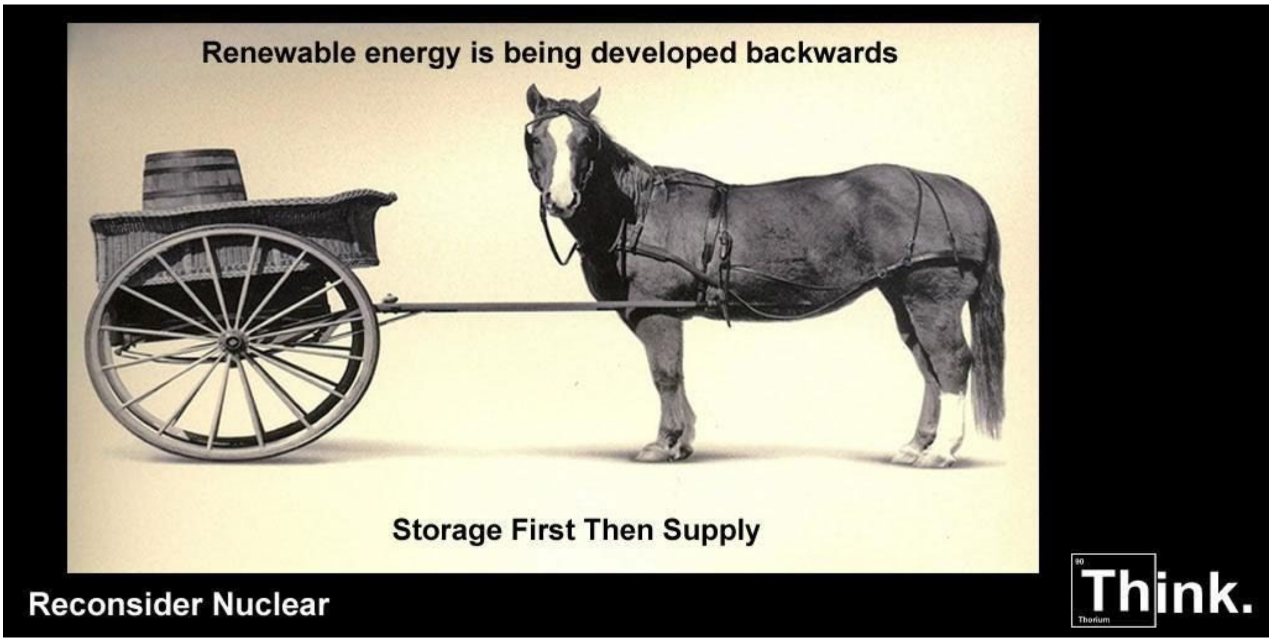
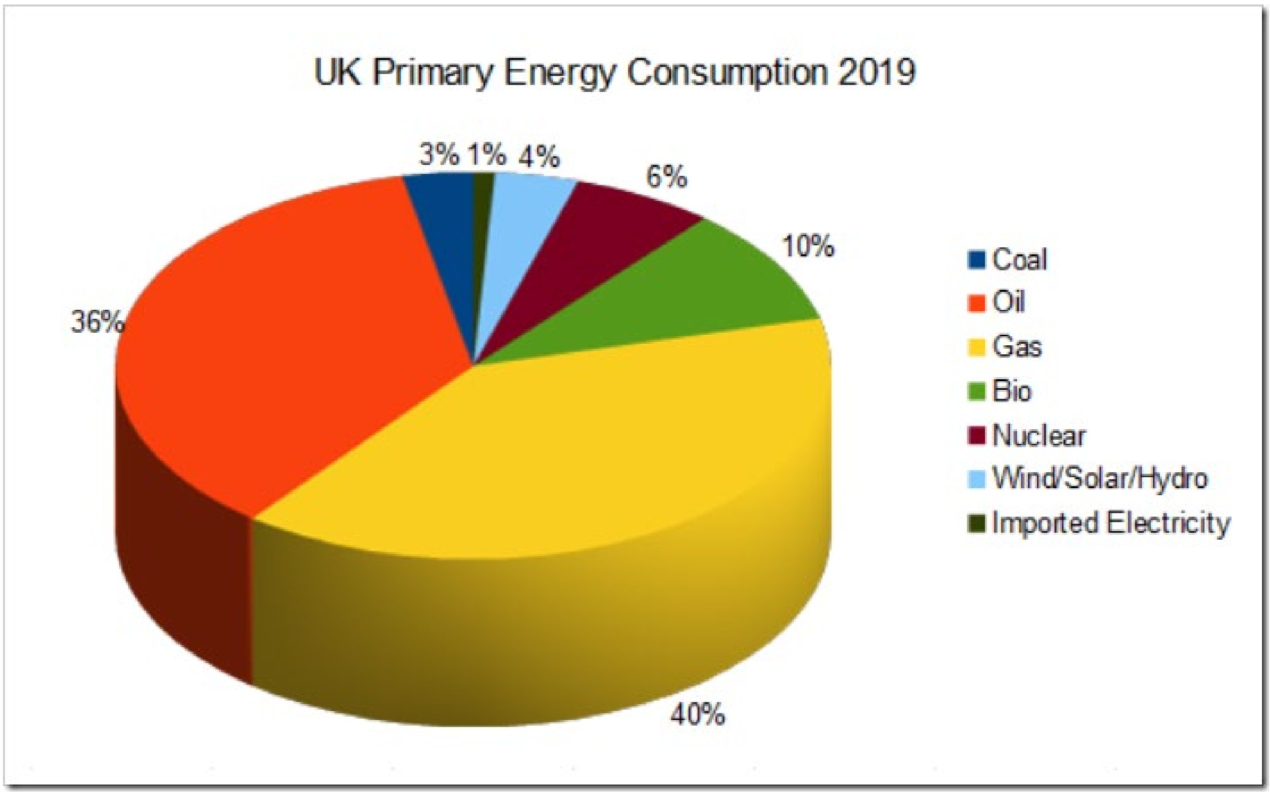
Submission Monday 22
Submission Final in Choke Point Program/NSW Inquiry/

Submission to the NSW Inquiry into Sustainability of Energy Supply

Rafe Champion

22 June 2020





Source: https://notalotofpeopleknowthat.wordpress.com/2020/04/30/uk-energy-trends-2019/

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SUMMARY

Information from the AEMO data base shows the extent and duration of critically low wind episodes (wind droughts) across SE Australia. The system has to be capable of surviving worst case scenarios for wind supply that may only occur once in (say) 100 years.

One of these scenarios occurred in June 2020 when the wind supply fell below 10% of the installed capacity of the wind fleet several times with the longest durations being 33 and 18 hours. This paper shows how those episodes played out in South Australia, New South Wales and Victoria.

Australia cannot aspire to 100% renewable energy until storage technology advances sufficiently to bridge the gaps between the peaks and troughs of solar and wind supply during worst case scenarios.

Australia lacks nuclear power and the capacity to run “extension cords” to neighbours. Both of these facilities act as a substitute for storage.

KEY POINTS

Can wind power replace 20GW of coal power without fail between sunset and sunrise for 365 days of the year?

Readily available information indicates that there are frequent and prolonged “wind droughts”.

It seems that the problem of intermittent wind supply has been under-estimated and the potential for storage by batteries and pumped hydro has been over-estimated.

INTRODUCTION

Since 2010 12 coal-fired power stations have closed, taking almost 6GW of capacity out of the National Energy Market (NEM) that links the electricity grids of the Eastern states and South Australia. That is a significant loss in comparison with the high point of demand at dinnertime that is around 25GW for most of the year and over 30GW in high summer. After Hazelwood power station closed the Australian Energy Market Operator (AEMO), the agency in charge of the system, issued a warning that there is next to no spare capacity in the grid to handle any breakdowns when the demand peaks.

In recent years Australia has led the world in the rate of building RE capacity and all the state governments are pushing for zero emissions. The green energy transition is a major challenge for Australia because we some significant disadvantages compared with most Western nations.

First, Australia is an island. The implications of this isolation from other countries have apparently not been fully appreciated. We have no neighbours to provide power when we are short. All the EU nations and the US states are connected to massive transcontinental grids that provide a full menu from every source of power.

We have no nuclear power. Most developed countries either have their own nuclear power or they have access to it from neighbours. We have some 30% of the known worldwide resources of uranium and we export it for the benefit of others but we do not exploit our own resources to make “clean” nuclear power.

This submission is a preliminary report on the frequency and duration of “wind droughts” when the wind supply across the NEM falls to a point where the grid will fail in the absence of other sources of power. The grid needs power in the way that the human lungs need air. If our lungs are deprived of air by choking or drowning the body soon dies. Similarly, parts of the grid will die if the supply of power is inadequate and if the grid depends on wind there will be “choke points” when the wind supply falls to critically low levels.

Low points in the supply of wind power have not been an issue up to date because we still have more than 20GW of installed coal power capacity but the question has to be asked, **can the sun and wind provide 20GW of power 24 hours a day for 365 days a year?**

It is widely assumed that we do have adequate resources of sun and wind and we just need batteries and pumped hydro storage to fill the troughs between the peaks of intermittent supply. The next section indicates that the problem of wind supply has not been fully appreciated and the following sections signal some problems with battery storage and pumped hydro.

INTERMITTENT WIND SUPPLY

Previous Experience

Extreme periods of low wind (wind droughts) have been reported in the past.

A drought of a very different kind occurred in March and April of 1934. Because Lameroo sits above our underground water supply, windmills (wind pumps) were used to draw water to the surface for stock water and personal use - windmills paved the way for Mallee agriculture. The period from mid-March to the end of April was almost completely windless; therefore no water. Farmers were soon desperate for stock water……. http://www.malleehighway.com.au/html/lameroo.html

AEMO records

Paul Miskelly 2012

The AEMO has a continuous record of the power delivered from all the wind farms attached to the integrated electric power grid covering South Eastern Australia (the NEM). Paul Miskelly used that data for the calendar year 2010 to report that the total wind output across the entire grid fell rapidly to zero or near zero on many occasions in the year.

- **During the first 6 months of the year, there are 58 intervals where the output falls below 2% of the installed capacity. The longest such interval is 229 consecutive 5-minute time steps, or 19 hours approximately. This event occurred in May.**
- During one such event, on May 18, on two occasions, the total output actually dropped to slightly below zero, the first starting at 2.50 am and lasting 40 minutes, the second commencing at 4.35 am and lasting for 70 minutes.
- For the entire year, there are 109 such intervals of varying length, adding up to 155.6 hours, or nearly 6.5 days.

The net result is that a fleet of new-build fast-acting OCGT plant, of comparable capacity to that of the total installed wind capacity, constantly operational in standby mode, is required to balance wind’s mercurial behaviour (Miskelly, 2012).

At the time where were only 23 wind farms with a less than 2GW of installed capacity and it was anticipated that the supply would become more reliable as the number of sites increased.

John Morgan (2015) reported that the situation was much the same in the 12-month period from

Sep 2014 to Sept 2015 when the capacity of the wind fleet was approaching 4GW.

He found 29 days in the year with the fleet delivering less than 10% of capacity. The lowest was 2.7% and there were seven sets of successive low wind days.
https://bravenewclimate.com/2015/11/08/the-capacity-factor-of-wind/

Mike O'Ceirin, an independent analyst, has unpublished information collated from the AEMO records over a seven-year period to the end of 2019 showing an average of 15 episodes per year when the delivery was 6% or less of the installed capacity.

Recent months

In December 2019 there were *eight* episodes when the supply fell below 10% of installed capacity and *one* where it was below 5%. In January the numbers were *twelve and three*, for February *nine and two*, March *six and two*, April *eight* and *three*, June so far *eight and three*.

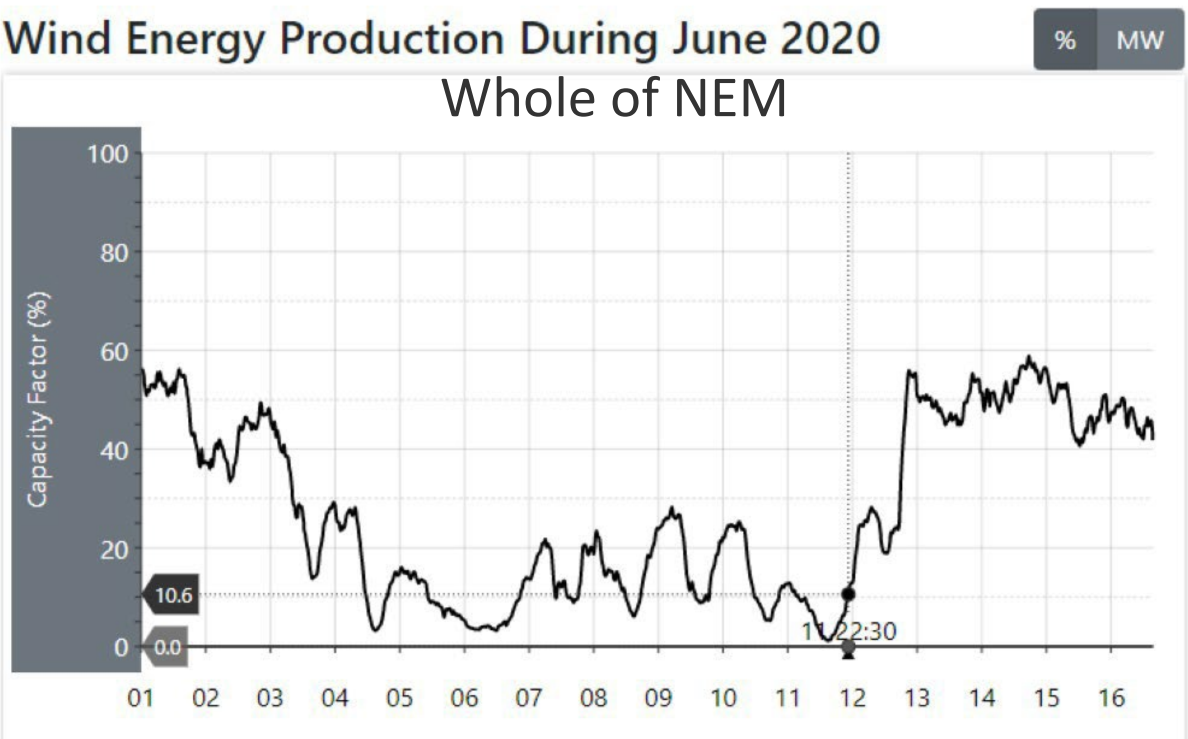
In April the delivery fell below 10% for 5.5 hours on the 1st, 12 hours on the 6th, 10.5 hours on the 7th, 2 hours on the 12th, 22 hours on the 13th, 4 hours early on the 18th and then over 17 hours from 6.30 pm to noon on the 19th, and 5.5 hours on the 27th.

In May the wind fell below 10% for 13 hours on the 4th (lowest point 2.3%) followed by 8.5 hours below 10% on the 14th (lowest point 4.6%), nine hours below 10% on the 15th (3.7%) and seven hours under 10% on the 28th.

Wind droughts in June

In June, up to the time of writing on the 21st there have been eight period with the wind below 10%. Three of these were very long - **33 hours between the 5th and 6th**, **18 hours on the 11th** and **16 hours on the 17th**. The lowest points during those periods for the NEM as a whole were 3.4%, 1.1% and 2.3% while individual states experienced long periods at zero or even negative numbers as the turbines drained power from the grid instead of contributing to it.

This submission had to be submitted by June 22. Later in the month there were several more wind droughts of shorter duration.

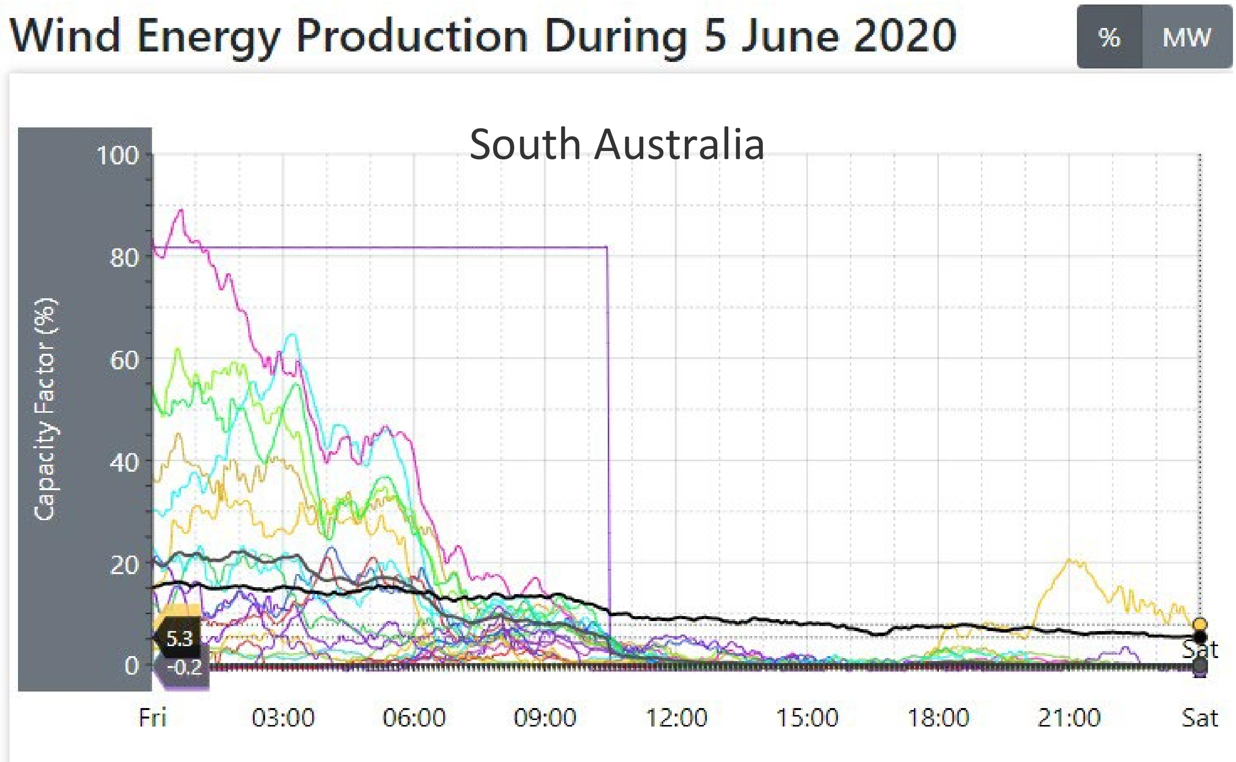


Submission Monday 22

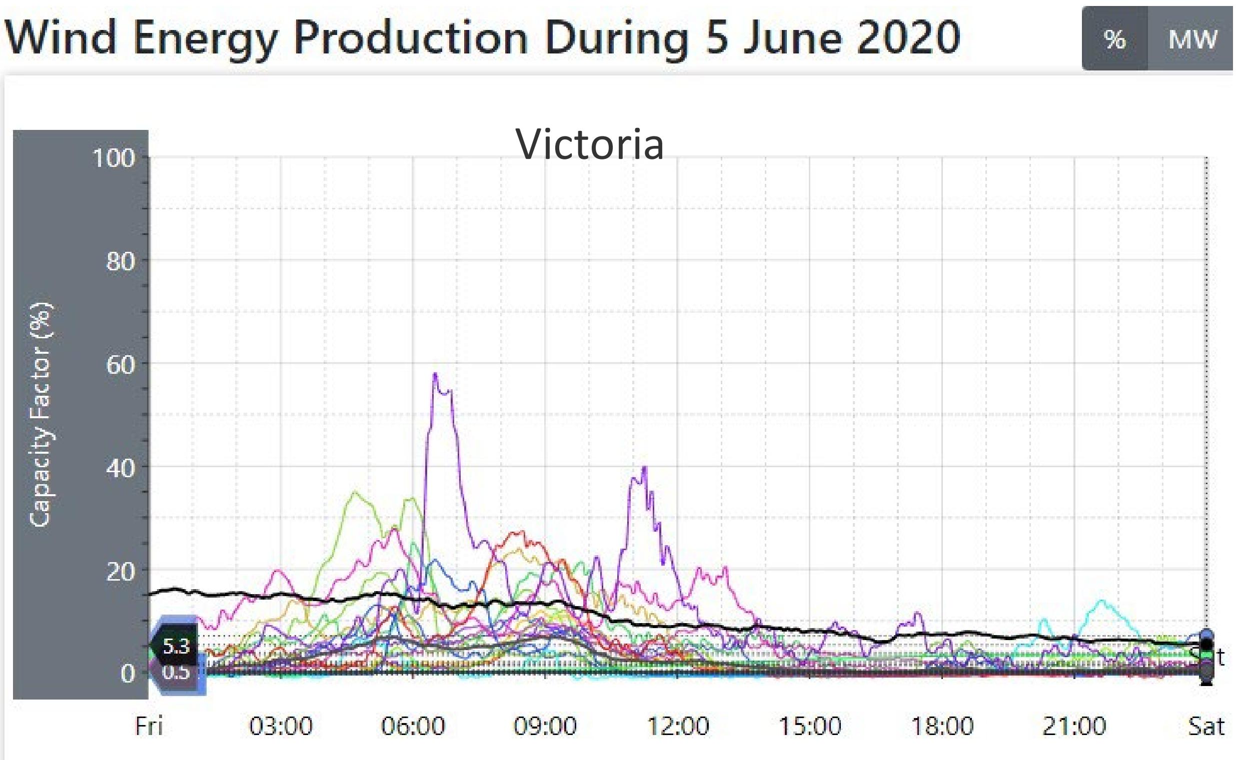
The drought of the 5th to 6th. The wind was below 10% of capacity for a period 33 hours. In South Australia, New South Wales and Victoria the wind stopped completely for many hours during this period and for some of the time the turbines drew power from the grid instead of contributing to it!

In SA the supply was effectively zero from noon on the 5th and remained zero with some negative periods until the next day when it remained near 5% until the evening. **The chart below shows the output for both the NEM as a whole and also for South Australia**. The coloured lines are the individual wind farms in SA.

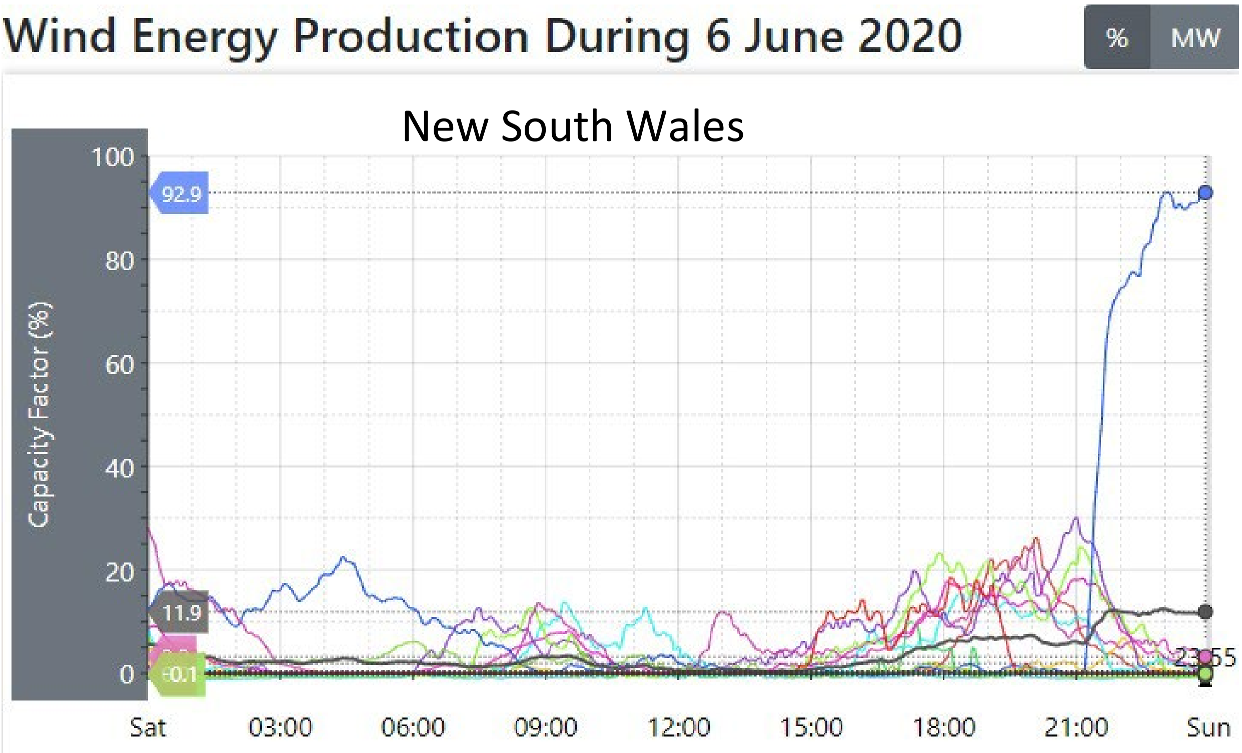
The NEM starting the day near 18% of capacity and ending the day at 5.3%. **The other dark line is the output in SA** that starting above 20%, fell to zero at noon and ended the day at -0.2%. The windfarm that started the day at 80% and then fell suddenly to zero is Hallet Farm 2. It was probably switched off because two other sites nearby started high and went down gradually.



The wind in Victoria started the 5th near zero, rose to approach 5% of capacity in the mid morning, fell to zero at noon and remaining mostly negative until midnight to end the day at 0.5%. The next day the capacity was near zero until the late afternoon. The upper line in the chart running from 18% to 5.3 at the end of the day is the whole NEM.



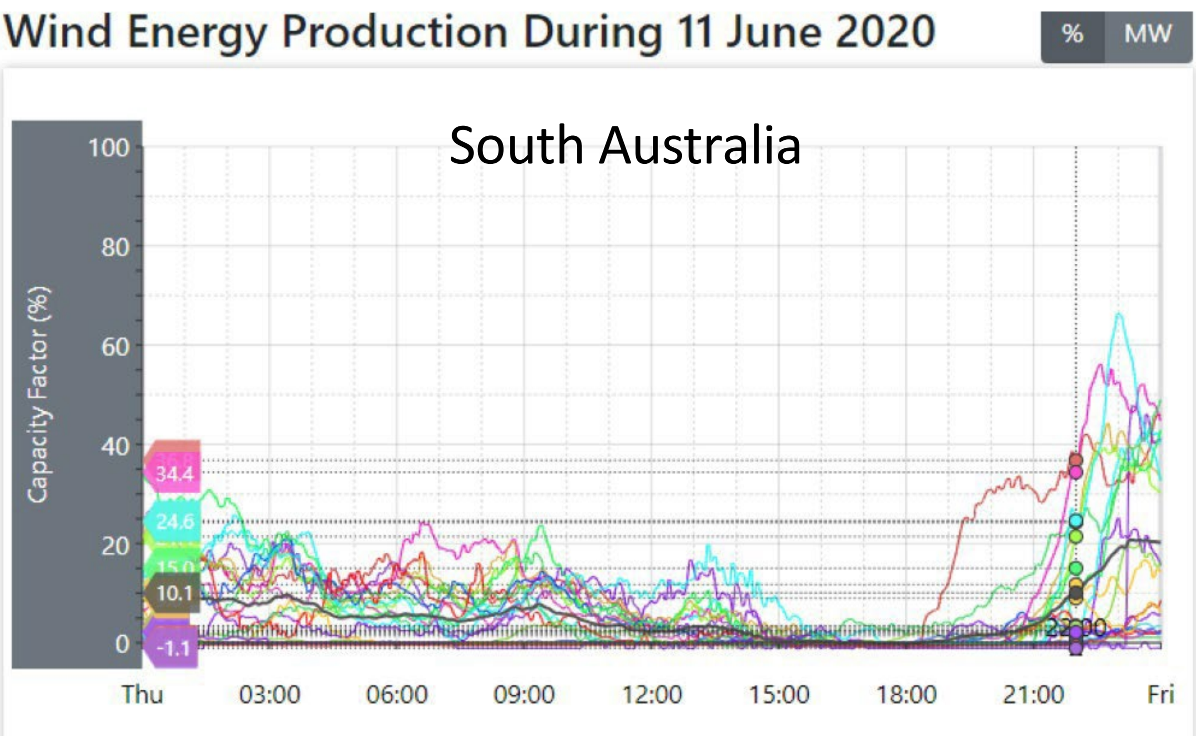
NSW had a spell near zero on the afternoon of June 4 and for most of the 5th the wind supply was near 10%. On the 6th, the third day of the drought, depicted in the chart below, the capacity was under 5% for most of the day with a spell near zero from 10am to 3.30. The Silverton windfarm reached 93% capacity late in the day indicating the geographical variation in wind supply that can occur. It is located on the Barrier ranges near the South Australian border.



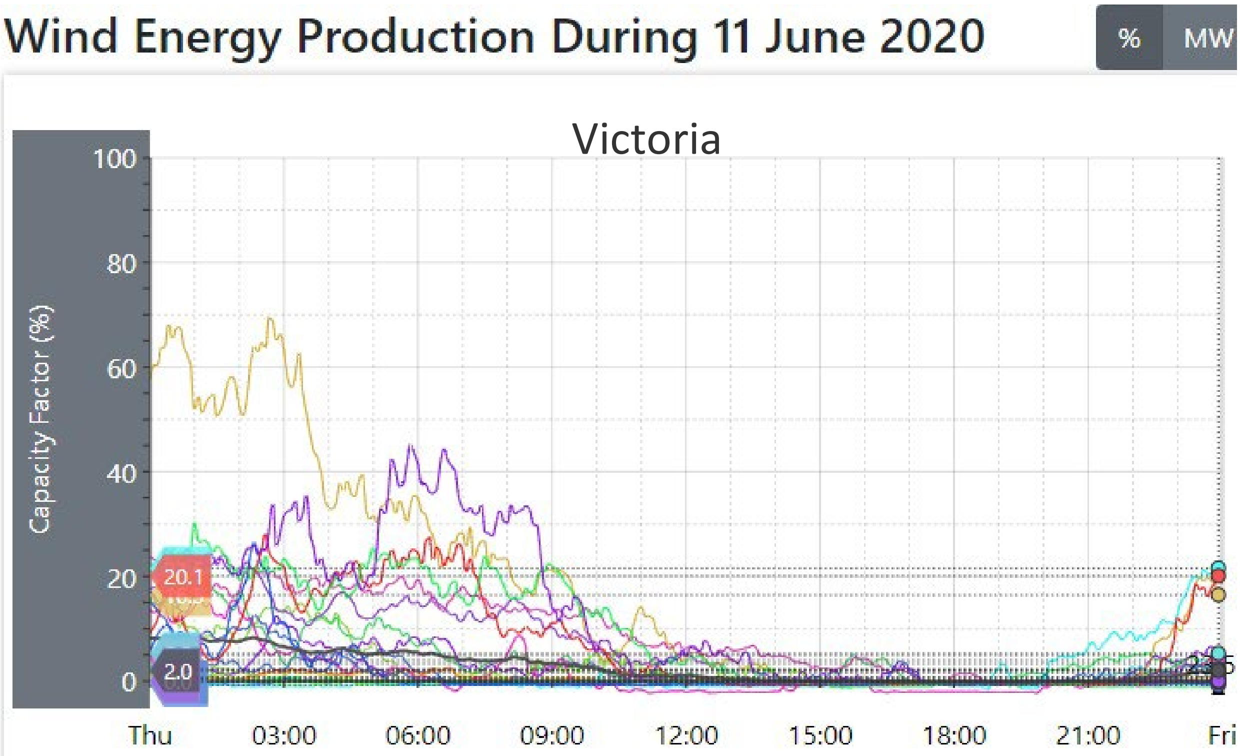
The drought from the 10th – 12th

This low spell began on the 10th and persisted into the 12th in Victoria. On the 11th the wind across the NEM was below 10% of capacity for 18 hours from 4am to 10pm.

In SA on the 10th the wind blew under 5% of capacity from mid-morning until almost midnight. On the 11th, shown below, the wind went down to near zero from the early afternoon until 7pm. The coloured lines are individual wind farms.



In Victoria on the 10th the wind blew sub-5% numbers from noon into the evening and ended the day at 8%. On the 11th it went down to 1% at 10.30am and scored zero to negative numbers until approaching midnight when it rose to end the day at 2% of capacity.

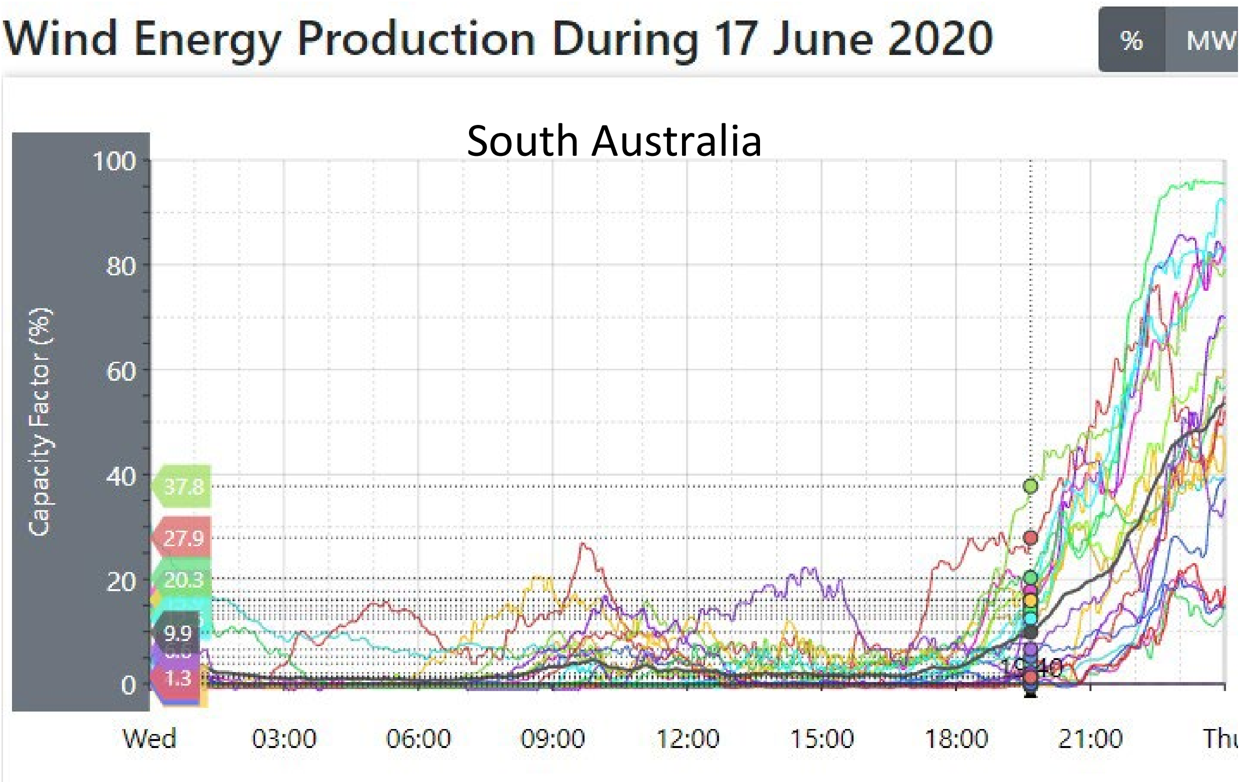


In NSW the wind did not exceed 5% capacity from 1.30pm on the 10th until 6.30pm the next day.

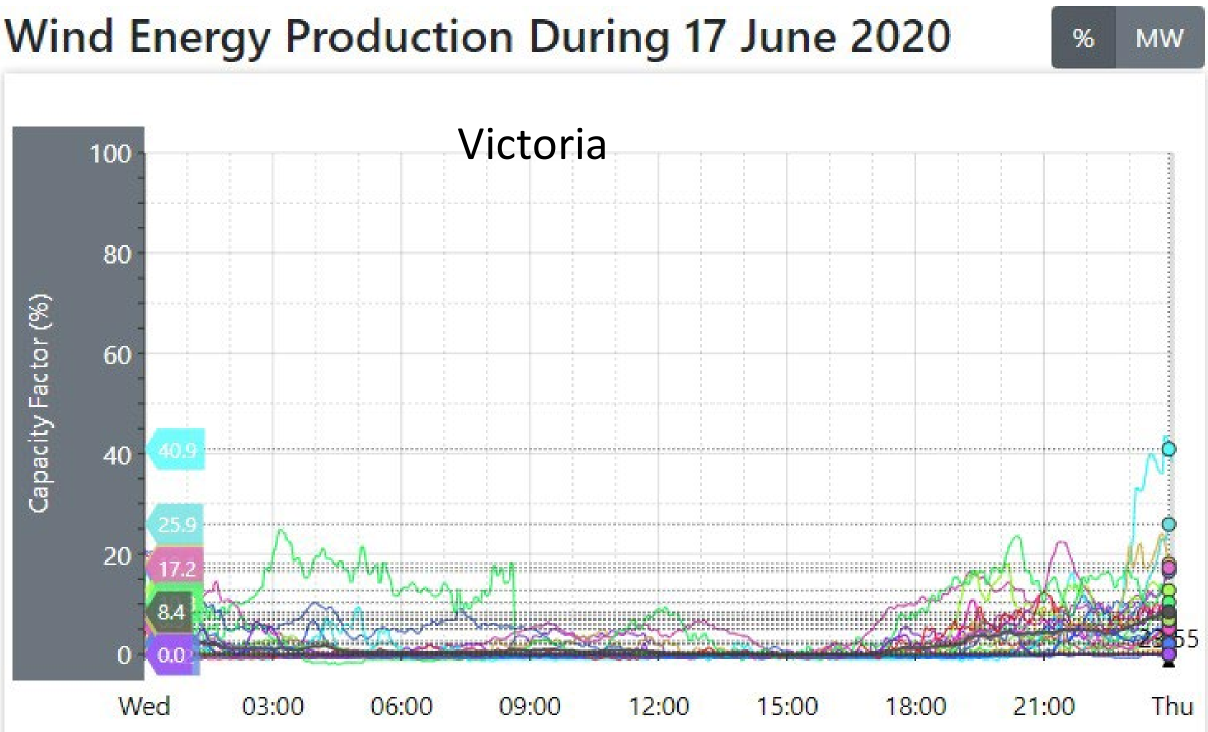
The Wind Drought of June 17th.

June 17th. The wind fell sharply across most of the country for a day between periods of high winds. Across the whole of the NEM the capacity was at or below 10% for 16 hours from 2 am and was at or below 5% for six hours in the middle of the day

In South Australia the wind fell below 5% of capacity late on Tuesday 16 and did not exceed 5% until 6.30pm on Wednesday 17th. For much of the 17th it was at or below 2% of capacity.



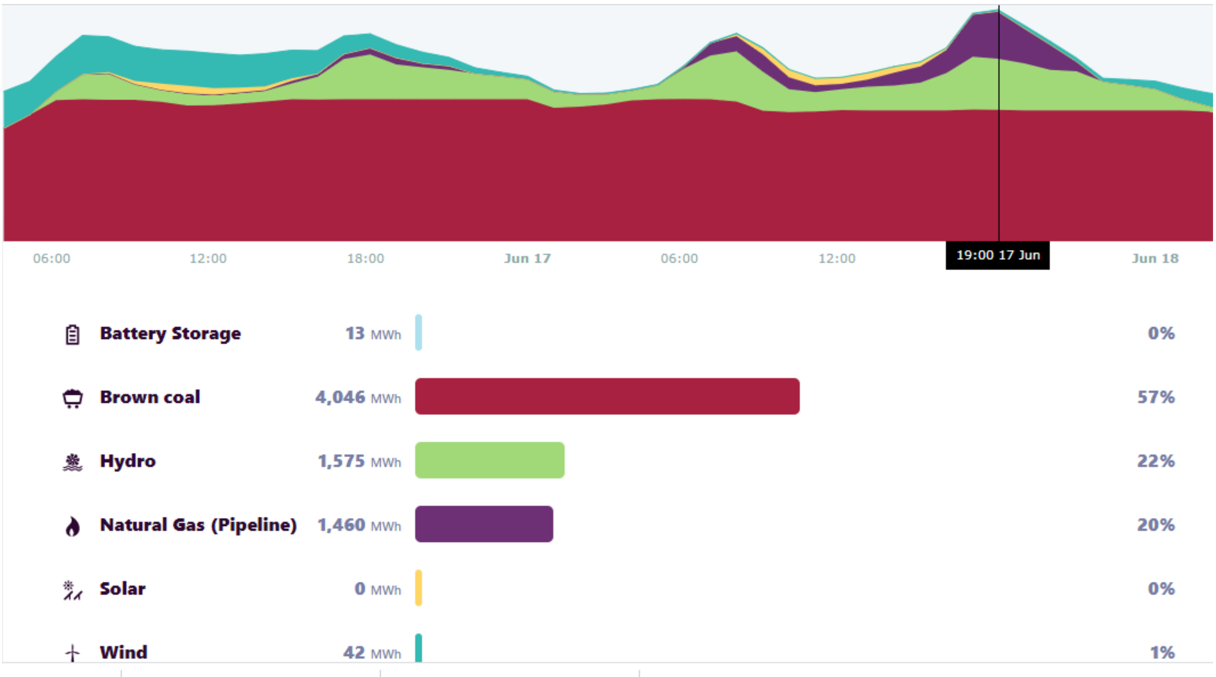
The situation was much the same in Victoria where the fall occurred on Tuesday evening and stayed under 5% until 11pm on the 17th. From 2am to 6pm on the 17th it was near zero.



The fuel mix

The chart below shows fuel mix in the electricity generated in the state of Victoria for 48 hours from 4am on June 16 through the 17th to 4 am on the 18th. This vividly depicts the negligible contribution of wind to the electricity supply during the wind drought on the 17th. the contribution of wind (the blue layer at the top) is barely visible on the 17th until it rose to 1% at 7pm.

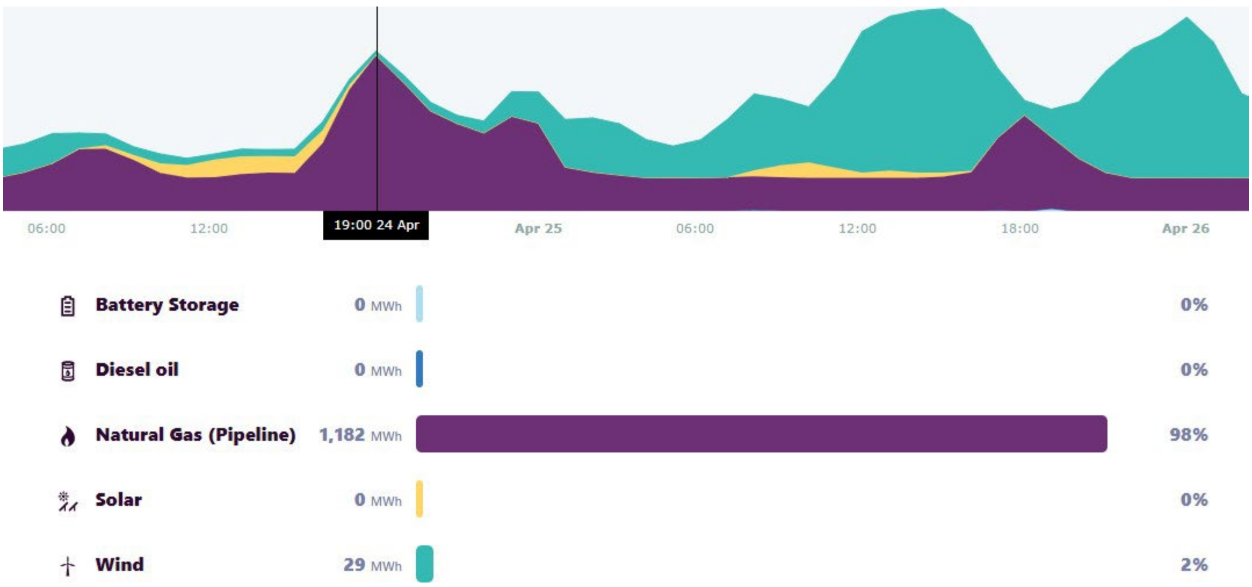
Victorian Fuel Mix



It is important to note that the fuel mix chart is based on the power generated in each state and not the power consumed. In South Australia there is often a large difference between production and consumption due to the large amount of wind in the mix and the variability of the wind supply. This is clear in the chart below where a there is a choke point at the pointer (7pm on the 24 April) when the wind was contributing 2% of the power generated in the state. The gas production would have fallen short of demand and power from Victoria made up the shortfall until the wind picked up the next day.

The increased supply of wind power on the 25 came after the time on the 24th when the grid would have collapsed if it was heavily dependent on wind. See the Discussion to appreciate the need for continuity of supply.

FUEL MIX: SOUTH AUSTRALIA 24 APRIL



THE IMPLICATIONS OF WIND DROUGHTS

All of the long "dry" spells were potentially disastrous for the power supply if wind was required to make a contribution to meet the demand in the grid and this is a point that eluded people who celebrated May 1 when the wind power generated across the NEM topped 5,000MW for the first time. That will happen more often as the system grows but **if the grid** required continuous wind power to keep it alive it would have been seriously compromised several times during April, May **and June**.

Can the low periods be covered by storing power at the high points?

There is a widespread assumption that battery and pumped hydro storage plus enhanced transmission lines and demand management can overcome the problem of intermittent input from the sun and the wind.

BATTERY STORAGE

It needs to be understood that referring to battery **storage** at the grid scale is a misuse of terminology. The capacity of the Tesla batteries currently in use is too small compared with the demand from the grid to count as storage in the way that the word is generally used. Household batteries can be called storage because they permit more or less normal use of electrical appliances for a day or two depending on the size of the battery and the number of appliances in use.

Moore's law does not apply. When people first started to talk about using batteries to support intermittent power there was a general expectation that the storage capacity would expand in the way that data storage increased by "Moore's Law" – doubling every couple of years to reach massive numbers. This has not happened and it will not happen due to the fundamental difference between storing electronic data and energy (Mills, *No New Energy*).

The Chief Scientist Dr Alan Finkel issued a very clear statement about the need for fossil or hydrocarbon fuel to support additional solar and wind power because "…**there will be a limited rate given the availability and cost of batteries…Maybe 20 or 30 years from now we'll have new kinds of batteries, vastly powerful, more extensive batteries and we can do it with batteries**." That was reported in a story in *PV Magazine* https://www.pv-magazine-australia.com/2020/05/28/chief-scientist-says-big-batteries-are-not-ready-to-fast-track-energy-transition/

Bill Gates launched a tirade at the possibility of the RE transition using existing technology. https://www.youtube.com/watch?v=9xe3BWPsBTU

PUMPED HYDRO

Pumped hydro is the other major option proposed for storage and the Snowy2.0 scheme is expected to provide 2GW of continuous power that is equivalent to a major coal-fired power station such as Bayswater.

Snowy2.0 is not a primary generator. It will use some 2.3GW or more of intermittent wind and solar power to pump the water uphill when it is available on sunny and windy days and then release perhaps 2GW of power in a steady stream when the water runs down through the turbines. Thirty or 40% of the power that is harvested is used to pump the water into the upper reservoir.

Independent modelling by Mike O'Ceirin suggests that the scheme could almost match the capacity of Bayswater at very large cost, far in excess of the initial announcements. It will take many years to complete if it survives demands for a more comprehensive business case and criticism from environmentalists who are concerned about the impact on the Kosciuszko National Parkand

When it is completed the Snowy2.0 scheme does not in itself produce more power, it just offers the prospect of stabilizing the flow of power from intermittent providers. To obtain the 2GW flow of power at present would take all the power produced by the current windfleet and the scheme will only **replace** a 2GW power station like Bayswater when another 7GW of wind capacity is operating and connected to it.

Phasing out the 20GW of coal power that we have at present would call for another nine 2GW Snowy2.0 equivalents to follow the first.

DISCUSSION

The facts about the wind supply documented in the AEMO data collection can hardly be disputed. There are frequent and prolonged wind droughts that function as choke points in the supply of RE to the electricity grid. Obviously the most vulnerable times are between sunset and sunrise when there is no solar input.

Storage on the scale required to sustain the grid through these periods is not an option for the foreseeable future. If coal power is closed down and we depend on RE to keep the grid alive before the storage is available, then parts of the grid or even the whole system will die during wind major wind droughts.

This means that RE has been developed backwards, the RE "cart" is in front of the storage "horse."

The logic of the situation

RE promoters point to the growing contribution of wind and solar power that reaches 40% of the electricity supply on some days. This can give the misleading impression that we are almost halfway to 100% RE. There two serious problems with this scenario.

First, electric power only accounts for a third of our total or primary energy consumption. See the pie chart inside the cover page showing the situation in Britain.

Second is the choke point problem caused by wind droughts. The logic of falsification or refutation means that the fact of wind droughts refutes the proposition that the grid can survive on RE. It is not enough to have enough RE some of the time, or most of the time or almost all the time, the grid requires input **all the time**, as our lungs require a continuous supply of oxygen.

The installed capacity and the average capacity (30% for wind) do not apply during a wind drought.

We breath air with an average content of 20% oxygen (less in crowded public transport and submarines) but the average is no consolation during the few minutes that it takes to die from choking or drowning when our lungs are subjected to a severe oxygen drought.

We can be revived from near-drowning and the grid can be revived (with some difficulty) if it goes down for lack of power but how often do we want that to happen? Structures and systems like drains and flood protection levees are built to withstand events with different frequencies – 10 year rains, 50 year rains, 100 year rains, depending on the cost/benefit analysis of protection. Vital things like major bridges, dams and the electricity system are presumably engineered to handle just about the most extreme events that can be envisaged.

That means taking account of wind droughts like the 33-hour period on June 5 and 6 when the wind turbines were running below 10% of capacity and at times some were drawing power from the grid instead of contributing to it. The amount of power that they draw on those occasions does not matter because we still have 20GW of coal power installed and that can run over 90% continuously if necessary. Still the negative numbers are not a good look and they are symbols of a system that is apparently bound to fail.

Island status.

The countries that have made great strides in RE like Denmark and Germany depend heavily on neighbours to take excess power when the sun and wind are active and supply power when the local RE supply is inadequate. RE enthusiasts make much of the power that Denmark exports on good wind days but over the year Denmark imports a substantial amount, possibly as much as half of its electric power.

Australia does not have the luxury of being able to draw on a menu of power sources like the nation states of the EU and the individual states in the US. This is a fundamental problem and there appears to be next to no awareness of the difficulty that this creates for our green energy transition.

South Australia not an island although they aspire to independence! While the balance is shifting towards exports over imports South Australia will always depend on imported power for some of the time until the storage issue is overcome.

CONCLUSION

The statistics on the wind supply show that RE is not sustainable without 100% backup from conventional power until a new generation of storage technology emerges.

REFERENCES

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Mark P Mills Inconvenient Energy Realities https://economics21.org/inconvenient-realities-new-energy-economy and The New Energy Economy: An exercise in magical thinking. https://media4.manhattan-institute.org/sites/default/files/R-0319-MM.pdf

Paul Miskelly (2012), Wind farms in Eastern Australia – recent lessons. *Energy & Environment* 23 (8). https://journals.sagepub.com/doi/abs/10.1260/0958-305X.23.8.1233

John Mogan **https://bravenewclimate.com/2015/11/08/the-capacity-factor-of-wind/**

APPENDIX 1: OTHER PROBLEMS WITH INTERMTTENT ENERGY

Effectiveness of the green transition. *The Planet of the Humans* is a documentary film produced by the radical environmentalist Michael Moore. It vividly demonstrates how hard it is to make the transition to RE without maintaining backup from conventional power and withoutcausing major ecological impacts.

No country has done more than Germany to achieve the *Energiwende* – the green transition. However after spending as much a half a trillion euros, doubling power prices and bringing the grid to the brink of collapse they only lowered emissions over the last decade by drifting towards recession.

Grid stability. It was always expected that problems with grid stability would appear when RE penetrated past ten or 15%. We have passed that point and grid stability will become more problematic as the supply of RE increases, especially the input from rooftop panels.

Price. RE is supposed to be cheap because the sun and wind come free of charge but the same does not apply to the turbines, panel arrays and the new and upgraded transmission infrastructure. The real cost of RE has to include the cost of the 100% of conventional power that will have to be on standby for the foreseeable future.

Decommissioning turbines and disposal of used solar panels. As the first cohorts of turbines and panels reach the end of their working lives the disposal issue will be a major emerging problem in waste management and recycling.

APPENDIX 2: YOU TOO CAN BE A WINDWATCHER

The information on wind resources in this submission should not be controversial because it is readily available to the public on the site of the Australian Energy Marketing Authority (AEMO) and in a processed form on the Aneroid site.

Anyone can access these sites to become a windwatcher in their own right and monitor the wind supply daily or even minute by minute.

Many sites draw on the AEMO data base to monitor the state of play in the electricity system. Every serious wind watcher will have their favourites and I will just refer to the AEMO Data Dashboard and the Aneroid site that draws on it to provide a rolling 24-hour picture. **Also be sure to visit the site of Tony from Oz** to see how a real wind watcher does it. See the link below!

The Data Dashboard https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/data-nem/data-dashboard-nem

On the Dashboard the **Dispatch Summary** indicates the amount of electricity demand and production in each state and the amount of power flowing across state boundaries. It is updated at five-minute intervals.

The **Fuel Mix** is particularly interesting but it lags by a day or more so you don't get to see the contribution of the different sources at the present time until tomorrow or the next day

Rooftop solar does not register in the fuel mix because the rooftops are not connected to AEMO data base like the registered generators and that means a lot of the power generated on rooftops during the day is invisible on the display.

Be warned that in the AEMO fuel mix wind is the blue band at the top and hydro is a green band lower down. The Aneroid display shows the wind in green above the hydro in blue.

Aneroid Energy https://anero.id/energy

The entry page of the Aneroid site is a rolling 24 hour display, showing the sources of supply in various categories – coal, gas, water, wind and sun. It shows the daily demand cycle with twin peaks at breakfast and dinnertime.

From the entry page you can access more detailed information about each source. Windwatchers of course go straight to https://anero.id/energy/wind-energy

This shows the supply of wind with a rolling 24-hour display with the supply expressed in the volume (MW) and the % of the installed capacity. There is a breakdown by state and there are displays for whole months and an archive for past days and months.

Tony from Oz is a veteran wind watcher and he has provided an introduction to the displays on the Aneroid site. https://papundits.wordpress.com/2018/05/13/australian-daily-electrical-power-generation-data-introduction-with-permanent-link-to-daily-and-weekly-posts/

He also provides a daily and weekly summaries of the power situation.

https://papundits.wordpress.com/2019/07/22/australian-daily-electrical-power-generation-data-sunday-21st-july-2019-plus-weekly-and-rolling-totals/