BULLETIN

SUNNY WITH A CHANCE OF WIND

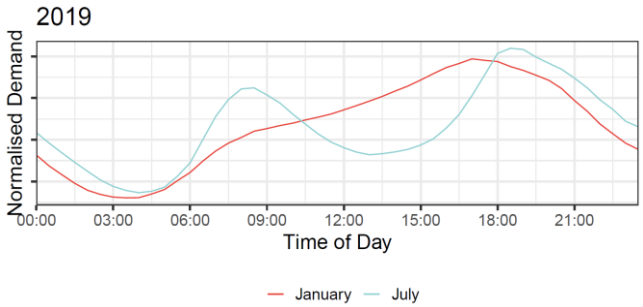
AN ANALYSIS OF SUPPLY DIVERSITY IN THE NEM

As we transition to a 'cleaner' portfolio of generation, the supply diversity of renewables comes under question in relation to the intermittency of supply. We explain that the positive correlation in wind and solar generation in the National Electricity Market means that these forms of generation do not offer adequate supply diversity to provide the reliable electricity supply that consumers need.

Society demands power at the flick of a switch

As a society we demand power at the flick of every switch. We expect this power to be reliable, affordable and increasingly, *sustainable*. The increasing penetration of renewables into the energy market has resulted in further delivering the 'clean' aspect of society's demands but has led to changing the fundamentals of the energy market. The intermittency of supply is raised as the reason we cannot switch to 100% renewable electricity generation. We continue to need a portfolio of generation types in order to meet society's demands for energy. This bulletin explains why.

Figure 1: Normalised average daily NEM demand for January and July 2019



Source: Frontier Economics analysis of AEMO data

The power system needs to operate to supply consumer demand. **Figure 1** shows the normalised average daily National Electricity

Market (NEM) demand for January and July in 2019. We can see from this graph that demand fluctuates during the day and varies across seasons. The explanation lies in seasonal affects and solar PV production.

The difference between the demand for January and July is largely due to the increased cooling load in summer while the heating load in winter is not as large. Both day-time loads are offset by PV generation, but there obviously more PV generation in summer.

Meeting demand

The National Electricity Market (NEM) was designed to reliably and efficiently meet the demand. It has done this by drawing on a variety of generator types that offer different dispatch and cost characteristics. For example, some generators, such as wind and solar, have high fixed costs but almost no operating costs and low levels of dispatchability because they are weather dependent. Other generators, such as coal, have high levels of reliability, and high fixed costs, but low operating costs. The middle of the spectrum is gas which has relatively low capital costs but relatively high variable costs and high reliability.

Batteries can quickly produce energy on demand, but not for very long and at high fixed costs and low energy costs (increasingly negative costs). Hydro impoundment generators have very high fixed costs, very low variable costs and high reliability for the available stored water. Pumped storage hydro has high fixed costs. Additionally, because of the large electricity requirements for pumping, the variable costs are highly dependent on the price of electricity at the time of pumping. These pumped storage hydro plants are highly reliable, but their generation is limited by the available water for generation.

While the average cost of these generators differs, because of their varying technical and economic characteristics, it is necessary to have a blend of generators to optimally deliver affordable and reliable electricity. Hence a mix of generation is necessary to deliver to meet society's demands for electricity.

The NEM is designed to respond to the demand and supply of electricity each 5 minutes of the day. When the supply-demand balance is tight (for example a hot day when people are relying heavily on air conditioners across the Eastern seaboard), we would expect a high price. However, in times when there is an excess of supply over demand (for example, in the middle of a sunny but mild day when solar PV is abundant but daytime demand for heating or cooling is low), then the price can be low (or even negative).

Subsidies have attracted investment in renewable energy

The subsidies provided under the Renewable Energy Target (RET) and other green schemes have led to significant investment in solar and wind generation.

Some people have argued that the geographic dispersion of renewables provides benefits because the supposed climatic diversity between regions will smooth the contribution of renewables to the NEM. The presumption is that there will be, for most times, sufficient wind blowing and sun shining somewhere to provide a high degree of supply reliability.

We undertook some analysis to test this hypothesis.

Wind generation tends to occur at the same time across regions, as does solar

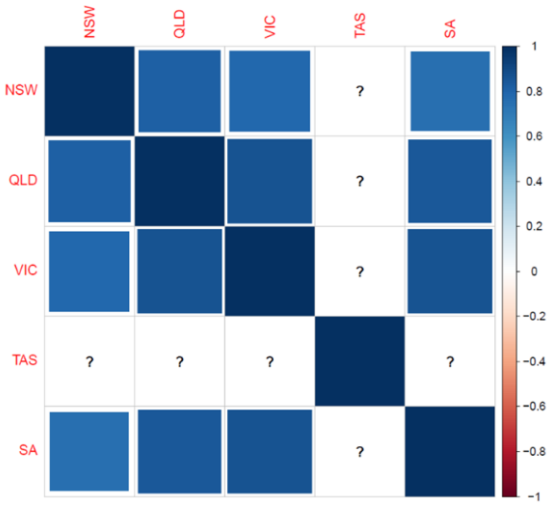
To test this hypothesis we used Australian Energy Market Operator (AEMO) generation and

load data for every half hour since 2014[1]. The key findings of this analysis were:

- there is very strong correlation in solar across all regions in the NEM
- there is reasonably high correlation in wind, particularly in South Australia, Victoria, NSW and Queensland.

Our findings are set out below.

Figure 2: Correlation for solar generation in the NEM



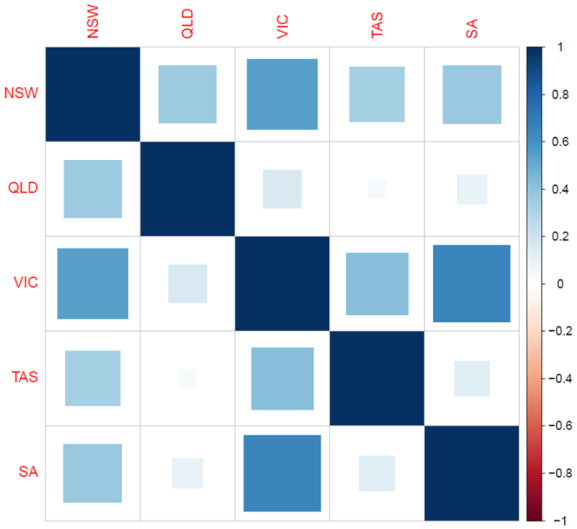
Source: Frontier Economics analysis of AEMO data

Figure 2 provides the evidence for the large correlation between NEM regions for solar generation in a heat map.

The data shows Queensland and Victoria have the highest correlation with a correlation coefficient of 0.87, followed by Victoria and South Australia and South Australia and Queensland with correlation coefficients of 0.86 and 0.85 respectively.

This evidence supports our natural intuition that when it's sunny in one region, it also tends to be a sunny day across the NEM.

Figure 3: Correlation for wind generation in the NEM



Source: Frontier Economics analysis of AEMO data

The heat map in **Figure 3** shows the evidence of a positive relationship for wind generation between the regions in the NEM. While the correlation is not as strong as for wind generation, there is reasonably strong correlation between South Australia and Victoria (correlation coefficient of 0.65) and NSW and Victoria (correlation coefficient of 0.55).

Implications

The results of this correlation analysis have a range of implications for NEM generation. For solar, output tends to occur in all regions at the same time. This makes intuitive sense, and generally, these results suggest that weather conditions tend to be similar across the different States on any day.

[1] AMEO NEMWEB, 2020, accessed 26th February 2020, nemweb.com.au

In regard to wind, correlation is highest between NSW, Victoria and South Australia. This reflects the geographic proximity of these regions. It is important to note that these three regions are by far the largest generators in the NEM together producing more than 89% of total NEM wind generation in 2019[2].

Correlation between wind and solar within regions

While the impact of correlated wind or solar production can lead to price volatility in the NEM, if wind and solar are anti correlated then a diversified renewable portfolio could contribute to more stable and generally lower prices. So we extended our analysis to test the correlation of wind and solar in each region in the NEM. The results are displayed in Table 1.

Table 1: Correlation coefficient for wind and solar correlation in respective NEM regions

	NSW	QLD	VIC	TAS	SA
CORRELATION COEFFICIENT	0.14	0.33	0.12	NA	0.02

Source: Frontier Economics analysis of AEMO data

As evident above, wind and solar are also positively correlated within each state in the NEM. Notably, wind and solar in QLD has a correlation coefficient of 0.33. Note the correlation is low, but positive. For price stability in the NEM, it would have been more useful if they were negatively correlated – meaning that they tended to generate electricity at different times rather than at the same time.

Renewables do not offer adequate supply diversity

From this analysis, it is evident that we need a fit-for-purpose power system to adequately supply customers with energy at the times they demand it. No one generation type can perfectly exclusively serve the market, rather a portfolio of supply options, including fully dispatchable supply options, is required.

Despite claims to the contrary, solar and wind in different states do not tend to diversify the contribution of renewables to the NEM. This is because wind production tends to occur simultaneously across NSW, Victoria and South Australia, and solar production is highly correlated across all regions.

Contact Us

Frontier Economics has been providing independent advice to businesses, regulators and governments for 20 years. From offices in Australia and Singapore, our team has a diverse range of skills and experiences to support the needs of our clients. This includes specialist econometricians and modellers. Please contact:

MARY SCHNELLE

+61 407 909 807
mary.schnelle@frontier-economics.com.au

ANNA BRAKEY

+61 407 909 806
anna.brakey@frontier-economics.com.au

[2] Frontier Economics analysis of AEMO NEMWEB data