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What's Happening with Wholesale Electricity Prices in South Australia?

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Throughout June and July there has been much media commentary on what is behind the recent wholesale electricity market spot price increases and general volatility, especially in South Australia. All those windmills are to blame, many say, and they are government subsidised, too!

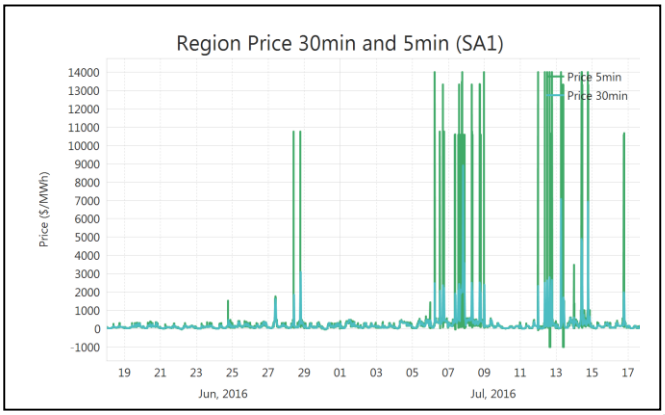
The purpose of this article is to highlight the range of relevant factors affecting recent National Electricity Market (NEM) outcomes, if only to demonstrate that things are never quite as simple as some believe.

Visualising how prices have changed

The NEM publishes lots of data. We at IES use our data visualisation tool NEO and lots of behind-the-scenes analysis to help understand what is going on in the NEM.

The first thing we can do is look at the pattern of recent prices. Let's focus on South Australia, the region attracting the most commentary at present. Here is the pattern over of 5 and 30 minute prices the month to 17 July 2016.

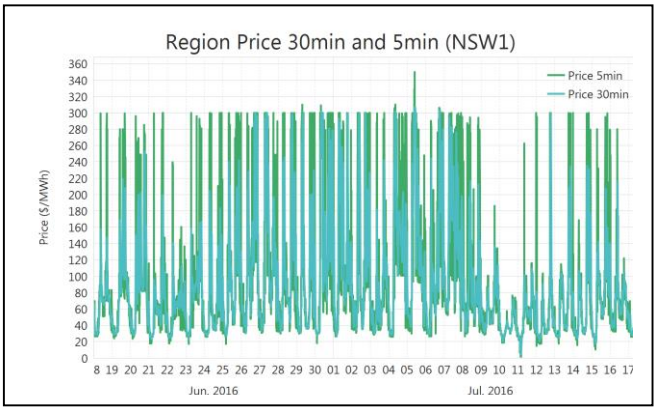
Figure 1



The chart tends to highlight the 5 minute prices, which are more volatile than 30 minute prices. There are many grouped periods of 5 minute prices reaching the cap of $14,000/MWh, although these spikes will tend to average out to a lower level for a 30-minute trading interval.

If we look at NSW for the same period as shown in Figure 2, the pattern is quite different. Note the difference in vertical scales between Figure 1 and Figure 2.

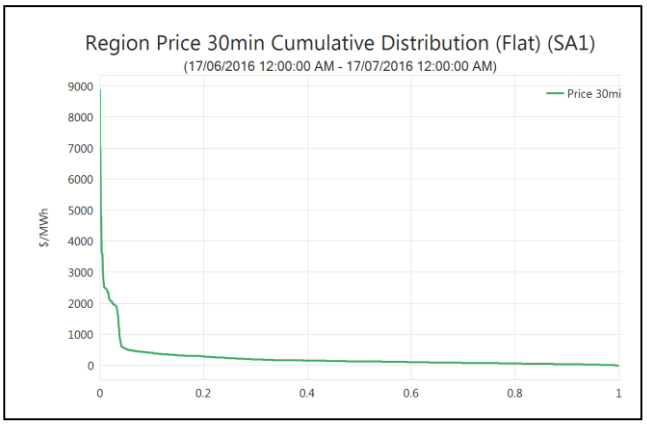
Figure 2



Five minute prices in NSW over the period are quite clearly capped at $300/MWh, frequently reaching that level. More typical NEM prices in recent years have been around $60/MWh, only occasionally spiking to higher levels.

These charts give an impression but do not support an easy comparison between different regions or different times. A commonly used chart to summarise the pattern of prices is a cumulative distribution, shown for South Australia over the same period (the month to 17 July 2016) in Figure 3 following.

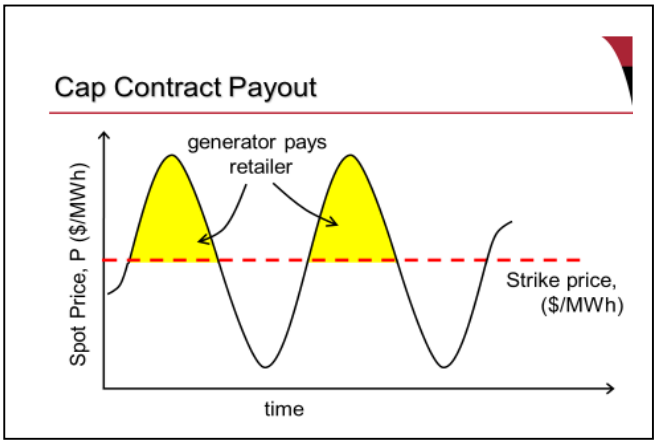
Figure 3



The chart is based on 30-minute settlement prices, so less extreme than the 5 minute prices in Figure 1.

These cumulative distribution charts may not be all that enlightening. Much more useful is a standard chart in NEO called a premium chart. This displays the results of a calculation similar to the calculation of the premium on a cap contract, which is the average area between a nominated strike price and the spot price, if that spot price is higher. It is the time average of the yellow area shown in Figure 4 below.

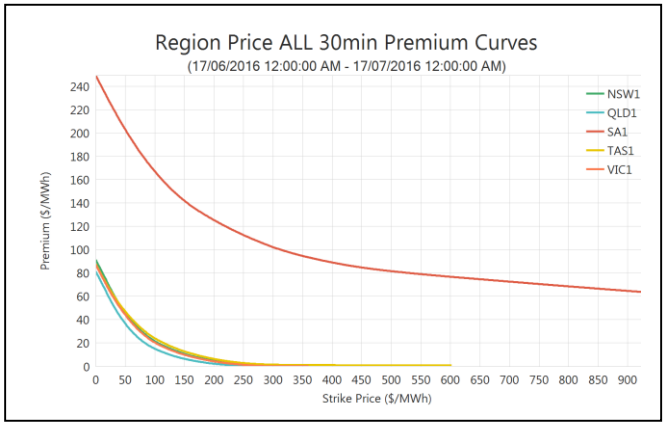
Figure 4



The premium can be thought of as the average operating margin of a small, flexible unit operating in the spot market, whose marginal operating cost is the strike price.

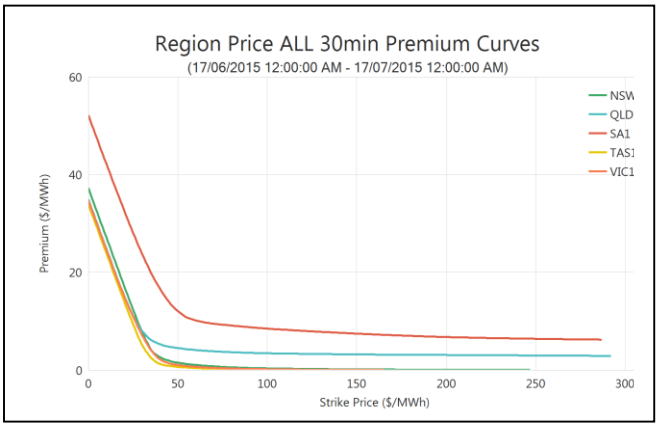
Figure 5 shows a premium chart for all regions of the NEM covering the one month period to 17 July 2016, the same period covered by the earlier charts. It shows the half-hourly dollar premiums at range of strike prices for the period selected. It highlights and quantifies several features of these NEM price patterns that are evident but not easily quantified by other plots. Some observations follow.

Figure 5



1. The average price in each region is the premium at a zero strike price. While most of the NEM is at around $80-$90/MWh, South Australia is around $250/MWh
2. Cap contracts are typically set at a strike price of around $300/MWh. For South Australia, the premium at this strike price is $100/MWh over this period and very close to zero in other regions over this period.
3. However premiums at strike prices between $100/MWh and $300/MWh been frequent throughout the NEM, indicating extended periods of prices within this range. In South Australia, these intermediate prices have contributed to the average price about as much the much extreme price spikes over this month.
4. Flows into South Australia must have been heavily constrained to drive these price differences.

Figure 6



We can compare and contrast this chart with one for the equivalent month in the previous year (2015) in Figure 6. Note the different scales on both axes between Figures 5 and 6. The differences in these curves is striking. Some highlights in Figure 6, covering the 2015 month:

1. Average prices within and outside South Australia were markedly lower in 2015, although there was still a $15/MWh average price margin in South Australia over the rest of the NEM.
2. In 2015, both South Australia and Queensland showed a significant premium at a strike price of $300/MWh, although much less than for South Australia in the recent month.

What Factors Could be in Play?

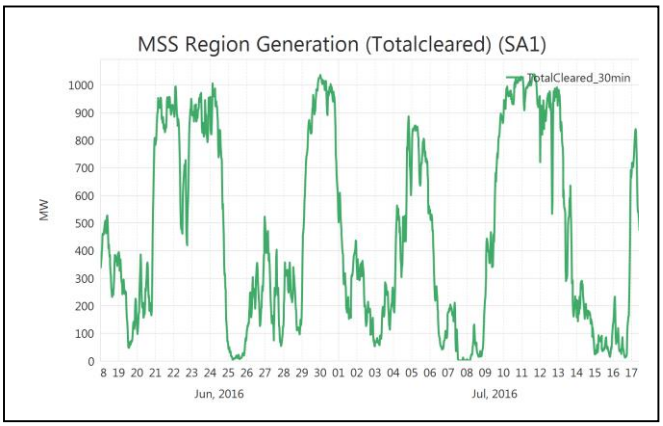
We can isolate a host of factors that together might work to deliver high prices in South Australia and elsewhere, not just the one or two demonised in the popular press. I'll list them here with some popular beliefs and elaborate on them later.

1. Too much wind. By media vote, the most popular culprit. But is wind power the guilty party?
2. Northern Power Station shutdown. Removed from the market since May 2016, its absence leaves South Australia exposed to a tighter electricity supply situation. Did wind power shut it down?
3. Interconnector shutdown and upgrade. Imports into South Australia from the Victoria have been curtailed for most of July while an upgrade of the AC interconnector is in progress. That's around 450MW of supply not available over most of July.
4. Weather. The colder the weather, the higher the load. Cold weather spells are normal, but when they coincide with supply constraints, prices can climb.
5. Gas prices and availability. Since LNG exports have ramped up in Queensland, gas supply in the rest of the country has tightened up, driving up prices. Moratoria on gas exploration in some states are also cited as culprits. More temporary gas supply constraints may have also contributed.
6. Good old-fashioned market power. Sometimes you don't need an excuse. If you can put your prices up and not fear retribution, why not do it?

Too Much Wind?

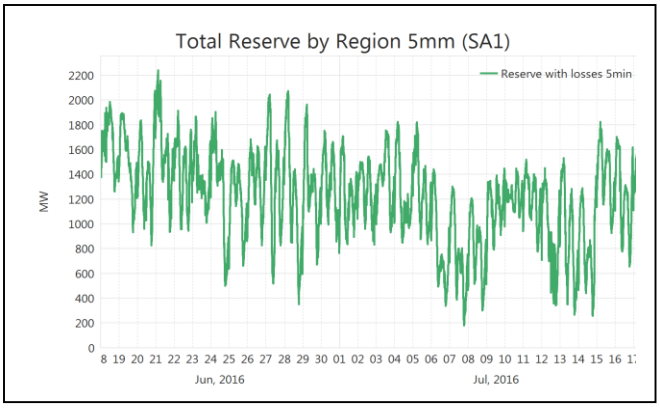
Growing levels of wind power certainly present challenges. In a specific region such as South Australia, wind cannot be counted as firm capacity. This is illustrated clearly in Figure 7, which shows South Australian total wind generation (Market Semi-Scheduled, or MSS) over the month of interest. The chart shows extended periods where output is very low and sometimes at or close to zero.

Figure 7



Compare this with the NEO calculation and plot of total regional reserve in Figure 8 – that is, the reserve available in South Australia taking account of support through the interconnectors into South Australia.

Figure 8



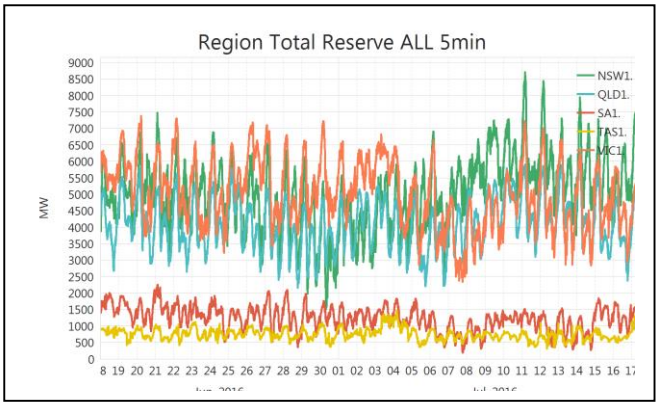
The plot shows the daily variation of reserve that results from the ups and downs of the daily load profile.

Surprisingly, the variation in wind output shown in Figure 7 is not particularly evident in Figure 8, especially in the first part of the month. Why is that? It turns out that much South Australian wind generation is located partway along the VIC-SA interconnector so that when wind output is high, transfer from Victoria tends to be constrained to a low level.

Thus the variability of reserve in South Australia due to the high penetration of wind is not particularly striking. It is difficult to ascribe high energy costs in South Australia specifically this factor.

To highlight this point, Figure 9 shows the total regional reserve for all NEM regions for month to 17 July 2016 that we are studying.

Figure 9



Regions other than Tasmania and South Australia show much large reserve levels as they are much larger sub-systems and the interconnections between them are typically unconstrained. However, there is a wide variation in reserve everywhere. In relative terms, South Australia does not stand out. So it is not wind output variability by itself that is driving prices unusually high in South Australia. However, the uncertainty in that variability may be a factor, to be discussed later.

It is noticeable that South Australian reserve levels have reduced from 5 July 2016. There is a clear and simple reason for this – a planned interconnector outage for implementing an interconnector capacity upgrade, also to be discussed later.

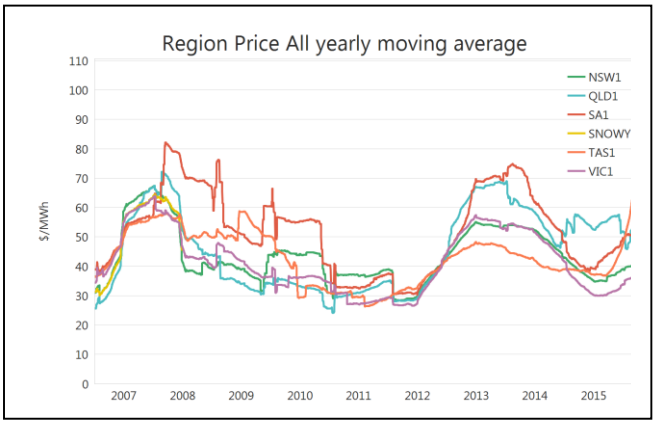
Northern Power Station Shutdown

The RET review under the Abbott government found, somewhat reluctantly if you read between the lines, that the RET actually promotes lower wholesale prices in the short term. In the short to medium term, the RET was assessed to lower retail prices, even after the cost of the scheme is factored into retail tariffs. A 2014 IES Insider article described how the RET, for better or worse, is likely to be paid for by incumbent generators[1], through lower wholesale prices than would otherwise be the case.

Until very recently, the NEM has delivered relatively low and competitive wholesale prices, with occasional periods of elevation. Over the last seven years or so, this can be partly attributed to the renewable Energy Target (RET), but also to energy efficiency and the de-industrialisation of the Australian economy driven by the mining boom and trade policy, as well documented by AEMO and many others.

One year moving average prices for the last 10 years are shown in Figure 10.

Figure 10



Generally, South Australia has tracked a little above the national average over the whole period, due to higher cost generation being required in South Australia when the interconnector with Victoria is constrained, which is quite frequently. So it is very hard to argue that price pressures on baseload generators (which are exposed to average

[1] "Who Wins and Who Loses from Changing the LRET" Insider Issue 17: Reference

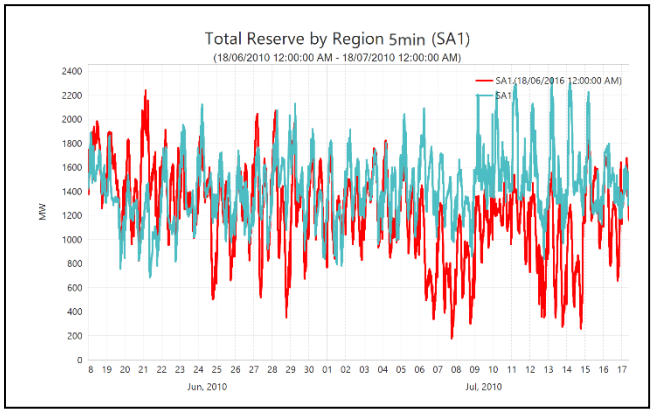
prices) are unique to South Australia or the result of the high penetration of wind generation in South Australia.

It's also worth noting also that the recent steep uplift in yearly moving averages is not at all unusual. Yearly moving averages have been higher in the past, and so has the steepness of those rises due to to occasional high price incidents, usually due to an outage of some kind.

With declining demand and low prices (until relatively recently), some generators in the NEM have been under pressure to close. Northern Power Station was one of them. The key factors in this closure were likely the age of the plant as well as the cost of mining its coal. The open cut resource Leigh Creek is a dipping seam, requiring more overburden to be removed for each additional tonne of coal mined. As time went on, it was inevitable that the cost of removing this overburden would become prohibitive.

One scenario to consider is that Northern, having been forced into closure, has left the system with lower reserves and much greater pressure on prices for that reason. To test this, Figure 11 shows a chart of total regional reserve for the month to July 17 in 2010, when there was little wind compared with the reserve over the same period in 2016. The month's data for the year 2016 is shown in red.

Figure 11



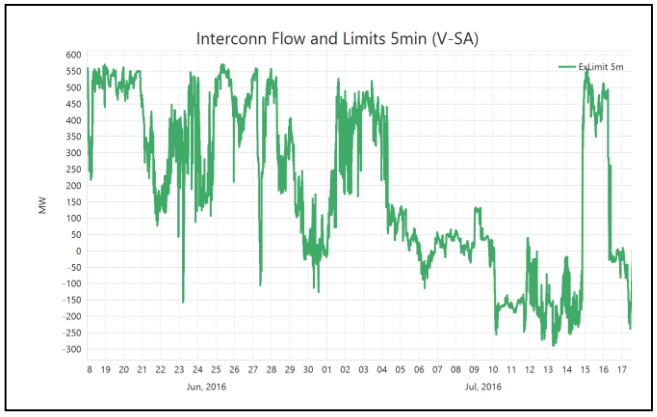
Up to July 5, reserve levels are generally similar, showing perhaps a little more variation for the equivalent month in 2016 than in 2010. From 5 July the reserve had dropped temporarily due mainly to interconnector shutdown.

Interconnector Shutdown and Upgrade

Supply from Victoria has always been a critical part of South Australia's electricity supply. AEMO's reliability criteria require each region to have sufficient reserve to be viable while operating alone, but an interconnector outage invariably means tighter supply and higher prices for the duration of that outage.

Figure 12 shows the export limit from Victoria to South Australia over the recent month of interest. Until July 5, the interconnector was in normal operation. The export limit typically defines the amount of power actually flowing into South Australia from Victoria. Variation in the limit arises from the wind generation installed part way along the interconnector in the south west of South Australia. High wind power output requires export from Victoria to be backed off.

Figure 12



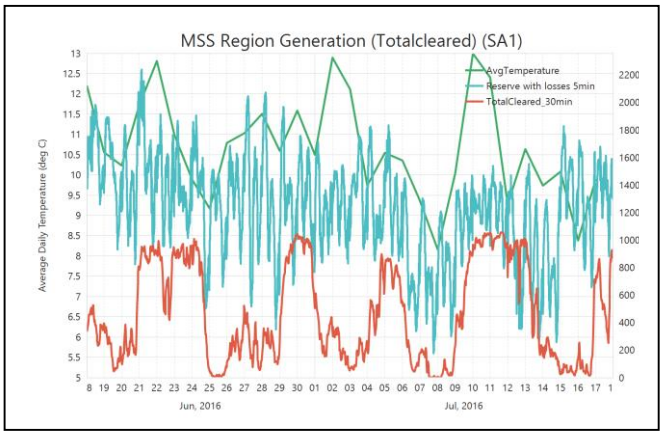
However, from July 5, 2016 the interconnector was taken out of service for an upgrade, as indicated by the dip in export lit from that date. Strangely, the limit even drops below zero to become negative. The reason is that some generation along the line has remained in service and exports to Victoria while the reminder of the line toward Adelaide is out of service. There is a brief period around July 15 and 16 where positive export resumes.

The line is being upgraded to a higher capacity of around 650 MW. With this import capacity in service, the dip in reserve evident in Figure 11 would be removed, which is of course the purpose of the upgrade. With higher reserves, the extreme prices evident in Figure 1 over this period would in all likelihood disappear.

Cold Weather

Hot and cold weather always drive increased electricity usage, lower reserves than would otherwise be the case and scope for higher prices while that cold weather persists. Figure 13 plots maximum daily temperature in Adelaide, regional wind (MSS) generation and total regional reserve on the same chart. Not shown directly is the interconnector outage from July 5.

Figure 13



Clearly shown are the low daily temperatures, low wind output and corresponding low reserve (as low as 200 MW) over the period July 6-9, bearing in mind the interconnector was out of service also. These conditions drive the extreme high prices in Figure 1 over that period. Less extreme low temperatures, low wind and no imports also applied over July 13-15, resulting in extreme prices.

These clustered extreme price events ended (at least temporarily) from July 15 when the interconnector was temporarily brought back into service. In addition, Pelican Point combined cycle plant was brought back into service from July 15, contributing a further 240 MW to reserve although its output appears to have been restricted to 160 MW over the period.

Gas Prices

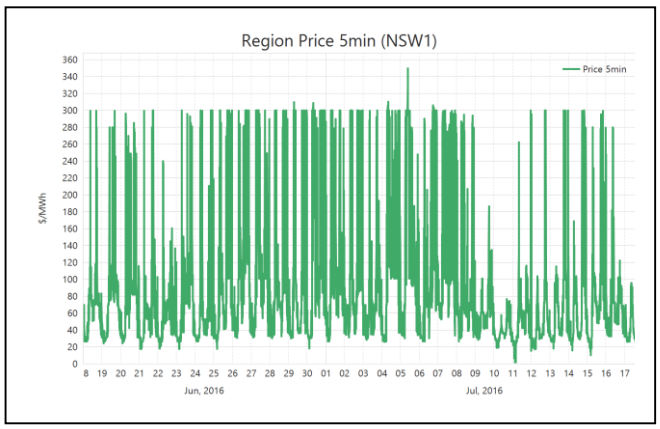
Australia's east coast pipeline system connects the whole east cost to the three LNG trains now exporting from Gladstone. Regardless of how much new gas is found and developed, gas prices are now linked to the export market unless there is some form of drastic policy intervention. As a result, gas prices are now likely to be higher than they used to be. This in turn flows through to electricity prices as gas plant is marginal for significant periods of time.

Medium to long term wholesale gas prices are typically projected to be around $8/GJ which translates to the order of $100/MWh for older open cycle plant. Shorter term gas prices can spike if there is some supply constraint so we could envisage twice that value from time to time.

Clearly, these marginal costs from higher gas prices do not explain extreme prices in the thousands of dollars per MWh, which are driven largely by tight reserve margins, rapid reserve margin changes (where online plant can't change output quickly), or sometimes market gaming.

Gas prices of this order explain, but only partially, the price patterns we are now seeing in the larger NEM regions. These have frequently exceeded $100/MWh and are generally capped at $300/MWh as illustrated in Figure 14 for NSW in the recent month of interest.

Figure 14



As illustrated in Figure 10, yearly rolling average prices have increased recently everywhere in the NEM, although not yet to the levels achieved in previous periods such as 2008 or even 2013-14. They might yet reach a peak but, outside of Tasmania, that hasn't happened yet, even in South Australia with its recent spate of high prices.

There is no escaping that export parity gas will lead to significantly higher wholesale electricity prices, given that gas plant is marginal in the NEM for much of the time. That would be true even if, in a hypothetical world that some would wish for, wind and solar could be replaced by a more traditional mix of coal; gas and hydro. Further,

given that there are three LNG expert trains to be fed with gas, policies that work simply to increment supply will not likely lead to lower domestic gas prices and lower electricity prices.

Market Power

When I was working on the Victorian electricity reform as project manager for the wholesale market in 1993, we debated at length how we could set up a competitive electricity market in such a small system, bearing in mind the NEM did not exist at the time. The answer: break up generation down to the power station level. To the credit of the then government, this was done, despite concerns that such policy action might reduce asset value. In Victoria at that time, the customer came first. As it turned out, the assets were also sold at a healthy price.

That legislative provision in Victoria, namely that no one party could own more than 20% of the state's generation assets, had a sunset clause of five years. Further, other states were far less enthusiastic about breaking up the generation business to that level for their own reasons. Fear of "destroying value" at the time of sale was one.

The story of the NEM since then has been one of ownership consolidation in generation and steady integration vertically of generation with retail. The ACCC has begun to resist this but a consolidation typically gets waved through on appeal.

So we cannot be surprised if some market power gets exercised when the time is right. The circumstances of the past few months in South Australia may have been such a time. Here are two matters to think about.

1. How is it that prices can be spiked for short periods to extreme levels? Answer: because traders can do it where there are few if any alternatives. One solution is increase the level of competition at the "top end" by encouraging fast response load management.
2. How is it that Pelican Point, a relatively new gas plant, was mothballed while the interconnector was out and electricity prices were likely to be volatile and high for a while? Presumably Pelican Point had a gas contract. Was its gas on-sold for a better price? What other benefits might have flowed to the owner while Pelican Point was out? We should be curious about all these possibilities before jumping to conclusions about the evils of wind power.

Who's Been Swimming Naked?

"Only when the tide goes out do you discover who's been swimming naked" - Warren Buffett

The wholesale market was and is designed to dispatch scheduled plant and to price energy efficiently while maintaining a secure system. Most trading parties are likely to be hedged or contracted on some form, so occasional periods of high price volatility, which can be expected from time to time for a multitude of reasons, affect relatively little sold energy. Occasional patches of $14,000/MWh spot prices are not nearly as dramatic an event as some writers portray them to be.

Some large electricity users with highly flexible plant operations may choose to be exposed directly to spot prices, feeling secure in the knowledge that they can reduce load when spot prices are high. Clearly, a sequence of extreme prices and ongoing elevated prices can be very painful under this strategy, manifested in public complaints about the workings of the market, even though the strategy may have worked quite well when viewed over a longer period.

Another scenario is a plant that takes on spot electricity exposure but is also well hedged longer term. If spot prices are expected to be volatile for a period, it may make business sense to close the plant for the duration and cash in on the hedges. This is financial engineering in action.

Looking from the outside, it's hard to tell what is going on either with industrial closures or, for that matter, with the mothballing of generation plant. "Follow the money trail" is good starting point for investigation.

Where to from Here?

Some of the more recent public commentary on wholesale electricity market outcomes in South Australia has been more nuanced than the flashy and simplistic condemnation of wind power that still abounds.

We can list the real and likely factors at work as:

- Interconnector outages (temporary)

- High gas prices (permanent to some degree)
- Mothballed plant (market power?)
- Insufficient "top end" competition (from shortcomings in market rules)

With these factors in play, wind, load and other generation variability are triggers for high price events that they would not otherwise be. It is the nature of complex systems that extreme events are driven by a confluence of multiple factors. Such events, while extreme, can be expected from time to time.

Propositions that have been advanced in public debate include the following:

1. The NEM cannot handle the current national and proposed state-based renewable energy targets and they increase costs to consumers, so they should be wound back.
2. The NEM needs a system of capacity payments to ensure that base load plant remains available for reliability, in the face of competition renewables.
3. The NEM needs more interconnectors, especially between Victoria, South Australia and Tasmania.

Most elements of Propositions 1 and 2 may struggle to stand up to careful scrutiny but will no doubt be examined by the COAG process now underway, triggered by the South Australian situation. It would be good to lay these matters to rest. However, the states might be cautious about pursuing state renewable targets ahead of the ability of market rules and system to adjust to them.

Proposition 3 is eminently reasonable in principle, as strong regional diversity of renewable sources and the ability to transmit their power will reduce variability. However, interconnectors are expensive and need to be justified against the cost of additional reliability support provided by gas turbines and other options. Studies of interconnection with increasing levels of renewable penetration will challenge current analytical techniques.

Here are some quite different policy prescriptions that I would draw from the recent South Australian events in the wholesale NEM. They recognise that increasing renewable penetration presents market design and industry structure challenges, but that they can be managed with a well-targeted programme of reform,

1. Improve the working the "top end" of the market to provide greater competition. AEMC is currently processing rule change proposals on 5 minute settlement and an improved demand management mechanism. Fast response options that would be supported by such a change would likely flatten out the extreme prices recently seen in South Australia. Other proposals under consideration by the AEMC appear designed to throw sand into the works. AEMC's determinations on these proposals will be a test of its ability to move the market forward.
2. Policy makers and regulators should keep a close eye on the level of market concentration both vertically and horizontally. Some adverse market behaviour such as mothballing plant that threatens reliability and raises prices isn't viable unless the owner has market power.
3. Implement technical changes to the NEM dispatch engine and real time system measurement and control to maximise the secure capability of the transmission network.

The flow on of export parity gas prices into electricity prices appears to be pretty much a done deal. Ironically, the wholesale and retail price impact of export parity gas prices will likely be similar to that of the much vilified and now abolished carbon tax, without the revenue to government coffers.

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