Sudden impact – revised version

SCRUTINISING THE WHOLESALE PRICE IMPACT OF ASSISTED CLOSURE OF BROWN COAL POWER STATIONS

This revised version corrects a mistake in the first draft of this note and clarifies the reason for modelling the removal of Hazelwood in one step. The error related to the levy determined by Jotzo and Mazouz. They assumed the levy would be for a one off rise for a year whereas we calculated the retail price effects with the levy continuing. This has been corrected but this correction does not change the conclusion that the retail price rises are much higher suggested by Jotzo and Mazouz. Our results were previously reported as the retail price would be between 25% and 8%, depending on which State and which year. With the change in the levy the conclusion is that retail prices would rise between 25% and 3%.

The other addition relates to the reason why we modelled the removal of Hazelwood in one step, which has been widely questioned. We did this because that is what the authors recommended in their paper. We have explained this on page 1 of this note.

All other points we made and results presented in the first draft of this note remain the same.

A proposal recently developed by the academic Frank Jotzo and a private consultant, Salim Mazouz actively encourages the exit of high emission brown coal generators in the National Electricity Market (NEM).

The authors assert that there will be a "..(small) electricity price impact.." on low income households from their scheme and that "The electricity price increase would also affect business, though again the magnitudes would likely be very small". Putting aside the question as to why such an arrangement is necessary when we observe that a number of high emission, low value thermal plants have already closed in recent years without such an interventionist mechanism, it is worth considering these assertions in more detail as this proposal may be adopted on the basis of these claims.

Jotzo and Mazouz's conclusions about the price impacts of closing large base load power stations do not ring true for those with an understanding of economics. Further, those with practical experience with the NEM will attest that spot prices rise dramatically if any large power station in the NEM suffers a major outage. There is a wealth of publicly available evidence to support this statement and it would have been straightforward for Jotzo and Mazouz to test their price impact

conclusions applying elementary statistical techniques to this freely available data. In practice whenever a major power station stops operating, the NEM price impacts are usually so large that the market regulator, the Australian Energy Regulator, routinely mounts an investigation into the causes of such severe price outcomes. These reports are publicly available.

A simple internet search would reveal how concerned South Australians are about the large price rises they have experienced upon the announcement of the closure of the high emission brown coal generator in South Australia, Northern Power Station. It is worth reiterating that Jotzo and Mazousz's interventionist mechanism was not required to achieve this outcome.

This client briefing seeks to remind policy makers to beware of proposals that promise to deliver great gains at negligible costs and price impacts - as the saying goes, there is no such thing as a free lunch. Independent analysis and review by experts is essential to ensure claims are valid. This is particularly the case where these proposals fall into the category of solutions looking for a problem.

A MISCONCIEVED PROPOSAL

Jotzo and Mazouz propose an approach[1] to remedy the 'market failure' they perceive in the exit of black coal-fired power stations as opposed to higher emitting brown coal-fired power stations from the National Electricity Market (NEM).

Their proposal involves a competitive tender whereby the four Victorian brown-coal-fired generators are compelled to bid to exit the market, with the cost of the winning bid funded via a levy on all remaining NEM generators in proportion to their future emissions. Jotzo and Mazouz correctly infer that a levy of this form would likely be passed through into wholesale prices by the remaining generators to some extent and quantify the impact as a $2-5/MWh increase in wholesale pool prices for a single year to fund a winning bid of up to $1 billion.

While Jotzo and Mazouz acknowledge that their proposal could "potentially" result in higher prices, they allay the readers concerns by saying these can be assessed by "fine-grained empirical modelling"[2] Perhaps the authors were consoled by the presence of overcapacity of base load generators in the NEM:

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1 Jotzo, F. and Mazouz, S. (2015), *Brown coal exit: a market mechanism for regulated closure of highly emissions intensive power stations*, Economic Analysis and Policy, 48 (2015) 71-81.

2 *Ibid*, p11

> *The starting point is that there is surplus capacity in coal fired power generation in Australia.*[3]

What if Jotzo and Mazouz are wrong in their judgement that the price rises from their proposal are "small" and instead prices rise materially as a result of exit? In this scenario, generators are likely to bid much higher prices into Jotzo and Mazouz's exit auction[4], pricing the higher foregone value of staying in the market when a competitor exits. This would then further increase wholesale prices over and above the direct impact of exit via Jotzo and Mazouz's levy, which of course will need to recover the higher cost of the winning bid. The total wholesale and retail price impact on consumers could be very significant and not "small" as suggested by Jotzo and Mazouz.

How likely is it that price rises will be small? A starting point would be to consider that over the last 12 months the aggregate production of every wind farm and utility solar facility in the NEM was responsible for 5.3% of total NEM production.[5] This compares to the Hazelwood Power Station, one of the power stations targeted by Jotzo and Mazouz, which produced 5.4% alone.[6]

What is perplexing about the conclusions that Jotzo and Mazouz come to about the likely "small" price increase resulting from the closure of a large base load power station is that recently Jotzo expressed concern for consumers welfare from the 'watering down' of the RET:

> *"If the RET is watered down, that will have an upward effect on wholesale prices in the national electricity market, because you will get less renewable energy into the grid than you otherwise would".*[7]

In contrast when it comes to the removal of a large base load coal-fired generator from the NEM, such as Hazelwood, which produces about the same as all NEM wind farms combined, then Jotzo and Mazouz curiously expect the price effect to be "small".

THE IMPACT OF EXIT

The exit of a major brown coal-fired generator in Victoria would represent a significant supply shock to Victoria and the NEM. Hazelwood Power Station is

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3 *Ibid*, p1

4 This is exactly what led to the failure of the Government's Contract for Closure program in 2011.

5 Based on AER data for the 2014/15 year, see https://www.aer.gov.au/wholesale-markets/wholesale-statistics/generation-capacity-and-output-by-fuel-source for source data.

6 Based on Frontier Economics analysis of Australia Energy Market Operator data over the period March 2015 to April 2016, see www.nemweb.com.au for source data.

7 Canberra Times, *ACT will pay less to become green energy beacon*, 5 July 2014, see weblink: http://www.canberratimes.com.au/act-news/act-will-pay-less-to-become-green-energy-beacon-20140703-zsupt.html

the most emissions-intensive generator but is also a very low cost source of baseload supply in Victoria and the wider NEM, and consistently produces at least 10,000 GWh of energy per annum representing about 20% of Victorian production and 5.4% of production across the entire NEM.[8] Basic economics suggests that removing such a large, low cost source of supply, even if managed to some extent, is likely to have a material impact on prices. This intuition is borne out by actual market prices and detailed market modelling undertaken by Frontier Economics and others.

The impact of a large, low cost power stationing exiting the NEM results in three effects:

- **A short term cost shock.** When a major, low-cost facility exits the NEM, supply from other existing generators responds to fill the gap. Given brown coal power stations are the cheapest thermal plants to run in the NEM, it follows that the removal of these power stations will result in higher cost generation running more to meet demand. In the case of a Victorian brown coal power station, replacement supply will likely come from: increased output from the remaining brown coal generators (at similar cost); increased imports from other NEM regions which would likely arise from increased output at the New South Wales black coal generators (at higher cost); or increased production from gas-fired plant in Victoria and elsewhere (at yet higher cost). This short term shock will persist until some form of investment response occurs, which is likely to be the entry of gas and/or renewable generation in Victoria.
- **A short term increase in generator market power.** The removal of a large power station in any part of the NEM will increase the market power of all remaining generators. It is just a matter of how much market power will increase and how persistent it may be. In practical terms, generator market power is exercised by generators offering their capacity at higher prices. This means that in addition to the short term cost structure changes driving prices up, generators successfully demanding higher prices to operate will exacerbate cost-induced price rises from the Jotzo and Mazouz proposal.
- **A long term structural change.** Once an investment response has, to some degree, mitigated the short term shock, the market is left with a different supply function. To the extent that a higher cost baseload generator has entered the market (as would be likely in the event of material price rise in Victoria) the supply function for the market will reflect higher cost generators, leading to structurally higher prices into the long term.

These effects are well understood across the industry and easily verifiable.

8 Op. cit. and consistent with the generation figures tabled in Jotzo (2015).

A STARK EXAMPLE OF THE JOTZO/MAZOUZ MODEL

Current events provide an almost perfect natural experiment that demonstrates the short term shock effect discussed above. The Northern Power Station in South Australia is on the cusp of exiting the market in early May 2016, as announced[9] by its owners. Northern Power Station is a low cost high emission brown coal power station, the very type of power station the Jotzo and Mazouz scheme is designed to close.

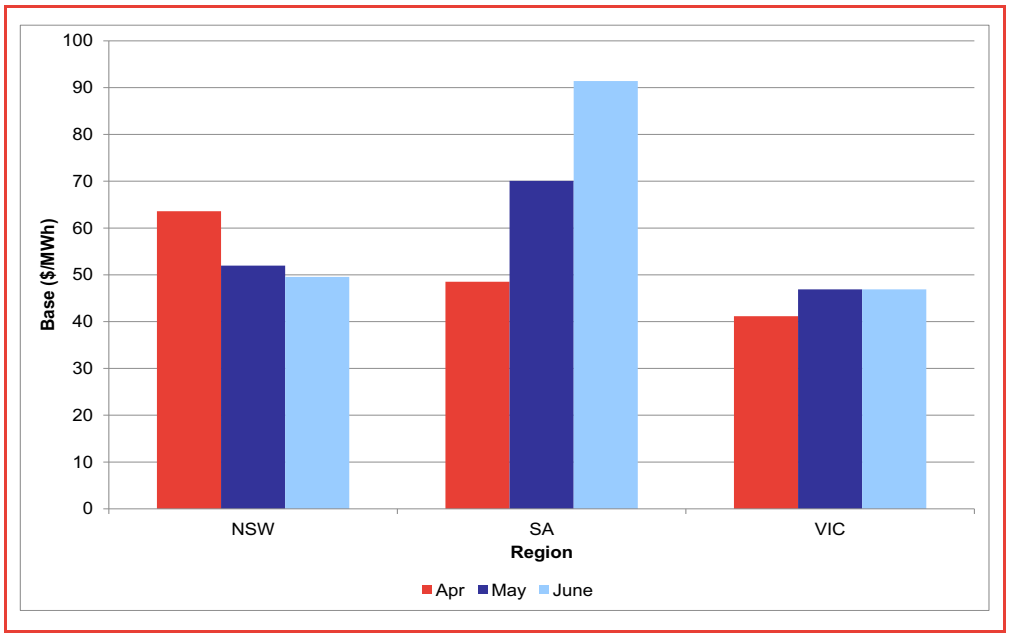
Forward contracts for baseload energy in South Australia clearly show the market expects a wholesale price shock to arise from this exit. Figure 1 shows that South Australian monthly baseload contracts are trading at rapidly escalating prices for April to June contracts, with the $91/MWh June contracts trading at prices 88% higher than April's $49/MWh contracts. This price rise can only be explained by the imminent closure of Northern Power Station. It stretches credulity to call an 85% rise in the wholesale price as "small".

Similar results were seen during the extended partial outage at Yallourn Power Station during June and July 2012 as a result of a major mine flood.[10]

9 Alinta, Final Coal Hauled for Flinders Operations, 28 April 2016, see weblink: https://alintaenergy.com.au/about-us/news/final-coal-hauled-for-flinders-operations

10 The flood began in early June and led to price rises of 30-50% over June. See weblinks: http://www.abc.net.au/local/stories/2012/06/07/3520109.htm & http://www.aemo.com.au/Electricity/Data/Price-and-Demand/Average-Price-Tables/Daily-Price-Tables?year=2012&month=06

Figure 1: South Australian baseload contract prices



Source: Frontier Economics analysis of ASX Energy data as of 28 April 2016.

A "FINE-GRAINED" EMPIRICAL MODELLING EXERCISE

Jotzo and Mazouz recommended that a "fine-grained" empirical modelling exercise be conducted to help understand the effects of closing a large based load power station.

We have done exactly this using Frontier Economics' widely used and tested electricity market models *WHIRLYGIG* and *SPARK*[11]. We have assumed that Hazelwood permanently exits the market entirely on 1 July 2017. This is consistent with the authors view about the "…importance of moving quickly from announcement to implementation of any such policy".[12]

Our modelling quantifies the extent to which new generation capacity is built to replace Hazelwood, the change in generation dispatch in the market to make up for the lost production of Hazelwood and the change in market power, all of which combine to affect wholesale spot prices.

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11 *WHIRLYGIG*, *SPARK* and our wider approach to electricity market forecasting has been extensively documented and scrutinised via our work. A key point is that our modelling approach does not rest on subjective bidding assumptions or calibration to historical outcomes but rather uses Game Theory to forecast responses to changes in the market. Our most recent documentary example is:

Frontier Economics, 2015 Residential Electricity Price Trends Reports, November 2015, see weblink: http://www.aemc.gov.au/getattachment/c0d9afe1-d082-471e-ba89-c36b342838a3/Frontier-Economics-%E2%80%93-2015-Residential-Electricity.aspx

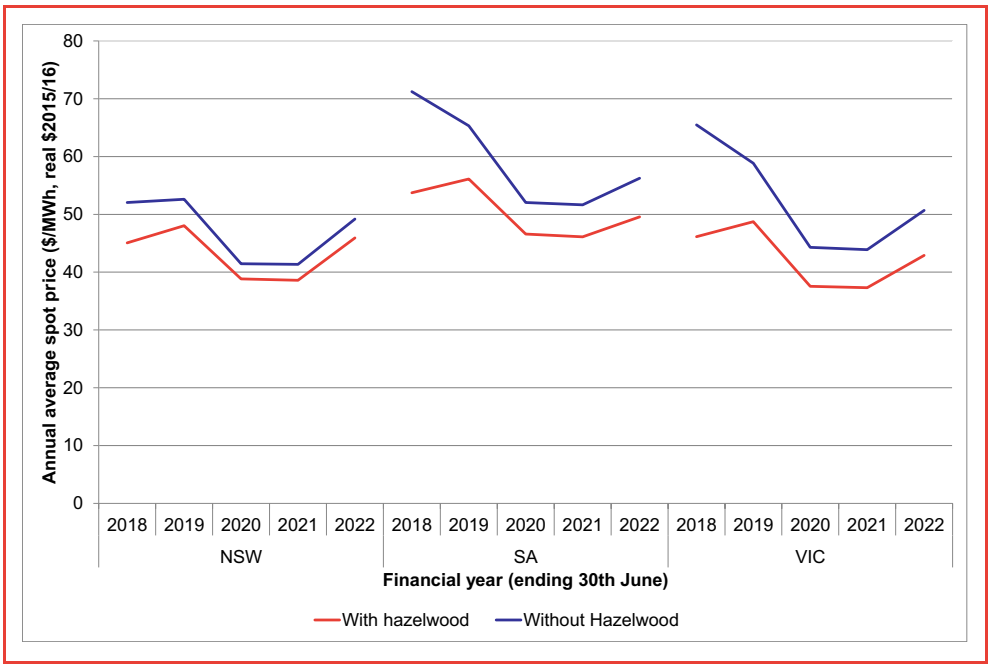
12 *Op Cit*, Jotzo and Mazouz (2015), p11.

Figure 2 shows our forecast annual average prices for NSW, South Australia and Victoria for 2017/18 to 2021/22 with and without Hazelwood. This forecast shows the three effects identified above.

In 2017/18 there is a short term price shock in Victoria and to a lesser extent the adjacent regions of South Australia and NSW. Victorian wholesale prices are forecast to rise by 42% in 2017/18. This is a result of only a small amount of new wind investment being able to respond to the exit of Hazelwood immediately (given the short lead time involved) and the need to run higher cost generators both in Victoria and across the wider NEM to replace the lost Hazelwood dispatch.

We forecast accelerated wind investment (starting immediately in 2017/18 to the extent possible given project lead times) and, critically, investment in baseload gas-fired CCGT plant in Victoria from 2018/19.[13] This incremental investment acts to somewhat mitigate the price impact of Hazelwood's exit and by 2019/20 only the longer-term structural impact remains. For 2019/20 to 2021/22 we forecast Victorian prices to be 18% higher as a result of the new entrant CCGT generator in Victoria setting higher spot prices for large parts of the year.

Figure 2: Frontier Economics current forecast of annual average NEM spot prices – with and without Hazelwood exit



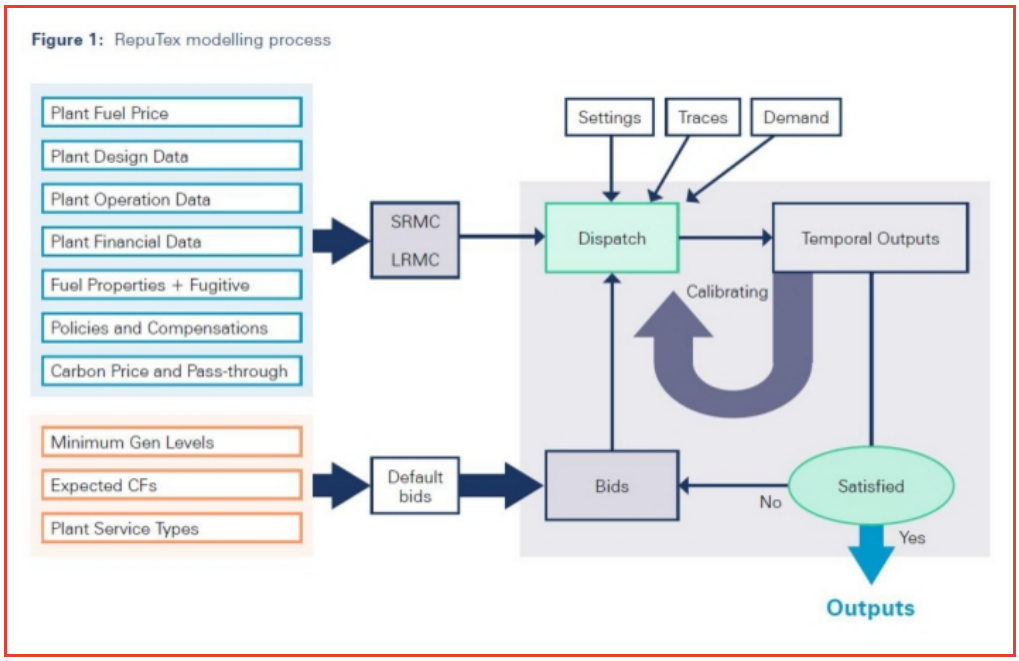
Source: Frontier Economics

13 We assumed that new CCGT plant could be operational from 2018/19 at the earliest, in practice commissioning such plant may take longer, prolonging short term price impacts of Hazelwood exit.

We note that Reputex has recently modelled the Jotzo/Mazouz proposal[14] and forecasts only a 3% increase in pool prices for a brown coal exit in 2017/18. We find this result difficult to reconcile given the basic intuition regarding the impact of a major supply shock (as described above), the natural experiment currently playing out in South Australia, along with previous major outages, and our own modelling results.

We believe Reputex's forecast is likely underestimating the impact of brown coal exit for a number of reasons, the most importantly of which is their deeply flawed approach to bidding in their market model. Reputex makes subjective assumptions about each participants bidding and iteratively changes these bidding assumptions until they are "satisfied" as shown in Figure 3 below.

Figure 3: Reputex modelling approach



Source: Reputex, see weblink: http://www.reputex.com/reputex-nem-generation-model/

Reputex states that 'satisfaction' involves:

> *…checking the validity of model outputs including cross checks against historical output at plant level…*[15]

This raises the obvious question, in the absence of any historical period to compare against, how can Reputex calibrate their model without subjectively assuming the

14 Reputex, Powering Down? Electricity price impacts of coal generation exit from the NEM, 27 April 2016, see weblink: http://www.reputex.com/research-insights/powering-up-or-powering-down-electricity-price-impacts-of-coal-generation-exit-from-the-nem/

15 See weblink: http://www.reputex.com/reputex-nem-generation-model/

extent of the price impact arising from a brown coal exit? We infer that a 3% price increase was sufficient to 'satisfy' Reputex.

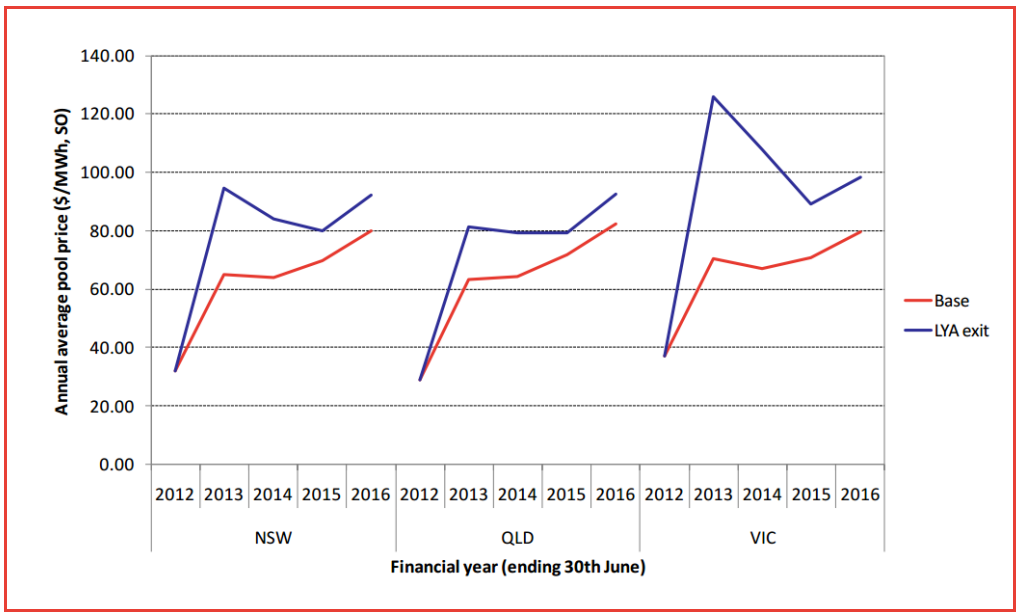
SCIENCE OF CLOSURE SETTLED?

This is not the first time that we, and others, have modelled the price impact of a brown coal exit in Victoria. As part of our advice to the then Commonwealth Department of Resources, Energy and Tourism (DRET) on its 2011 National Energy Security Assessment we were asked to forecast the impact of a sudden and permanent closure of Loy Yang A (a larger and lower cost brown coal generator than Hazelwood).

Our modelling at the time showed the same impact as the forecast presented above – a short term shock followed by a long term structural increase in prices. The effect was larger due to Loy Yang A being a larger facility that is the lowest cost brown coal producer in Victoria and the assumption of generally tighter supply and demand conditions across the NEM at the time. We forecasted[16] a short term increase in Victorian annual average prices of 79% falling to a longer term structural impact of approximately 25%. This is shown in Figure 4.

16 Frontier Economics, *NESA – electricity shock scenario*, September 2011, see weblink: http://www.industry.gov.au/energy/Documents/Energy-Security/nesa/Electricity-Shock-Scenario-Report-2011.pdf

Figure 4: Frontier Economics 2011 NESA forecast of annual average NEM spot prices – with and without Loy Yang A exit



Source: Frontier Economics, NESA – electricity shock scenario*, September 2011, see weblink:* http://www.industry.gov.au/energy/Documents/Energy-Security/nesa/Electricity-Shock-Scenario-Report-2011.pdf

Our modelling did not forecast a material increase in unserved energy (i.e. blackouts), which was in part a consequence of technical assumptions made in the modelling. Additional to our analysis, DRET also asked AEMO to model the impact of the same Loy Yang A exit with a focus on unserved energy. AEMO found that

> *…with no investment response, there would likely be unserved energy in excess of the reliability standard in Victoria, New South Wales and Queensland…*[17]

AEMO's modelling can be interpreted as our approach *underestimating* the magnitude of the price impact of a major baseload exit.

17 Department of Resources, Energy and Tourism, National Energy Security Assessment, 2011, p92, see weblink: http://www.industry.gov.au/energy/Documents/Energy-Security/nesa/National-Energy-Security-Assessment-2011.pdf

RETAIL IMPACT

Frontier Economics has calculated an overall retail price impact as driven by the following components.

- The primary wholesale price impact of supply exit. We have used the estimated wholesale price impacts from our current modelling as shown in Figure 2.
- The secondary wholesale price impact of the auction levy being passed through. As discussed above, we expect generators will bid to exit at a level that reflects the gains of staying in operation, which would be higher than the upper bound of $1 billion considered by Jotzo and Mazouz. However, we have conservatively assumed that a bid of $1 billion is fully passed through via the levy at a level of $5/MWh, the upper range of the Jotzo and Mazouz estimate.
- The extent to which wholesale price rises are passed through to retail prices. Australia enjoys a competitive retail electricity market and wholesale costs are generally passed through in full.[18] We have assumed that wholesale price rises are fully passed through into retail prices.[19]

Combining these factors allows us to estimate overall retail price impacts as shown in Table 1. Retail price rises are again largest in Victoria at 25% in 2017/18 immediately after the exit falling to a persistent rise of 9% in later years. This is about the same as the impact of the carbon price on Victorian retail prices (of around 10%). The persistent effect in NSW is about 3% and in South Australia it is 5%.

18 This was certainly the case with the carbon price, which reflected a wholesale price shock of similar magnitude.

19 We have assumed a wholesale price to total electricity price based on AEMC, *2015 Residential Electricity Price Trends*, 4 December 2015, figures B.2, D.2 and E.2 and assumed retail costs represent 10% of the total bill in all jurisdictions (as the AEMC does not report wholesale and retail costs separately).

Table 1: Retail price impacts

Region	FY (ending 30 June)	With Hazelwood	Without Hazelwood	Levy	Wholesale price impact	Wholesale proportion of total bill	Retail price impact
VIC	2018	$46	$65	$5	53%	48%	25%
	2019	$49	$59		21%	48%	10%
	2020	$38	$44		18%	48%	9%
	2021	$37	$44		18%	48%	9%
	2022	$43	$51		18%	48%	9%
SA	2018	$54	$71	$5	42%	34%	14%
	2019	$56	$65		16%	34%	6%
	2020	$47	$52		12%	34%	4%
	2021	$46	$52		12%	34%	4%
	2022	$50	$56		14%	34%	5%
NSW	2018	$45	$52	$5	27%	47%	13%
	2019	$48	$53		9%	47%	4%
	2020	$39	$41		7%	47%	3%
	2021	$39	$41		7%	47%	3%
	2022	$46	$49		7%	47%	3%

Source: Frontier Economics

CONCLUSION

Given the laundry list of plant exit over recent years, culminating with Northern Power Station next month, it is not clear that there is in fact any market failure to be remedied with regard to efficient exit of power stations in the NEM.

What is certain is that regulating the exit of the lowest-cost sources of baseload supply, even if they are the most emissions intensive, will have a material impact on market prices. This result is consistent with basic economics regarding supply shocks, actual events in the market occurring currently and in the past and credible modelling forecasts.

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