

Market power in the National Electricity Market following the closure of the Hazelwood power station

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**Victoria
Energy Policy
Centre**



**VICTORIA
UNIVERSITY**

MELBOURNE AUSTRALIA

Outline

- ▶ **Background**
- ▶ **Prices and volumes**
- ▶ **Contrived or genuine scarcity?**
- ▶ **What can we learn from market power indices?**
 - ▶ Hirschmann-Herfindahl (HHI),
 - ▶ Lerner,
 - ▶ Residual Supply Index (RSI),
 - ▶ Return on Withholding Capacity Index (RWC)

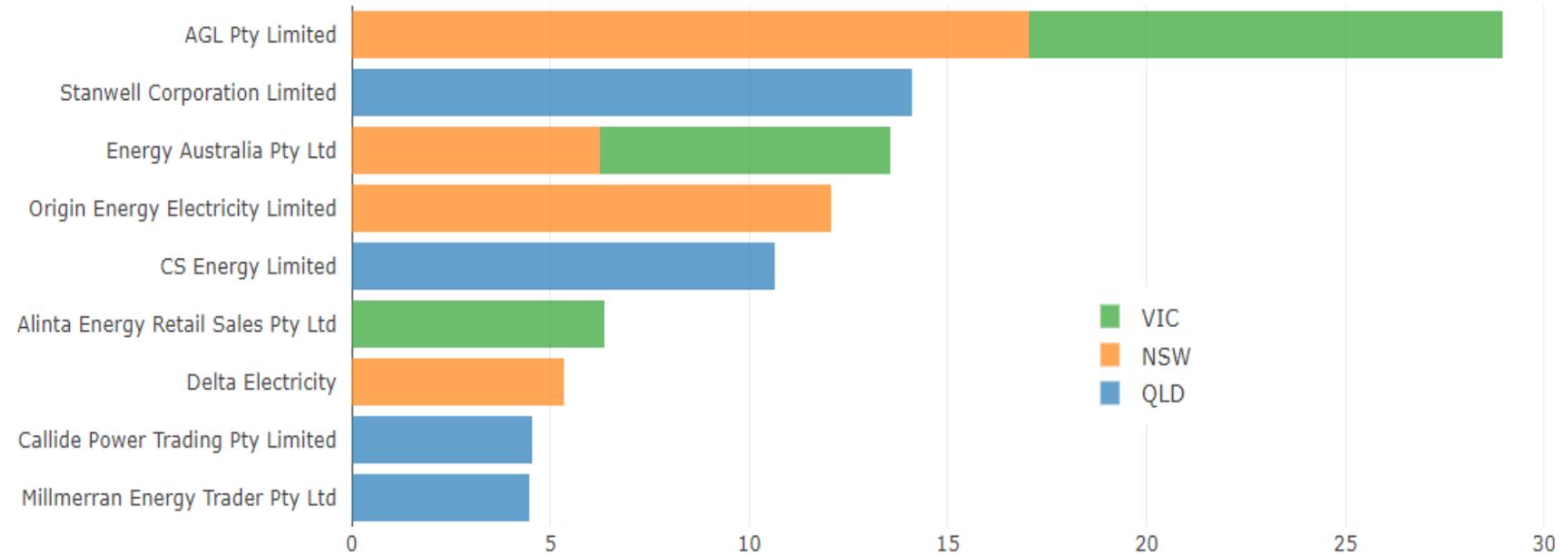


Source: AEMO

The National Energy Market

- ▶ Five regions with five interconnectors
- ▶ 77% of energy from coal, 9% from gas
- ▶ Black coal generation in NSW and QLD, brown coal in VIC.
- ▶ 5 Minute dispatch, 30 minute spot price
- ▶ Hazelwood Power Station closed on 31 March 2017 (5% of NEM production, 20% of Victoria production)

Top four coal generators account for 70% of national coal gen; even more concentrated in each regional markets



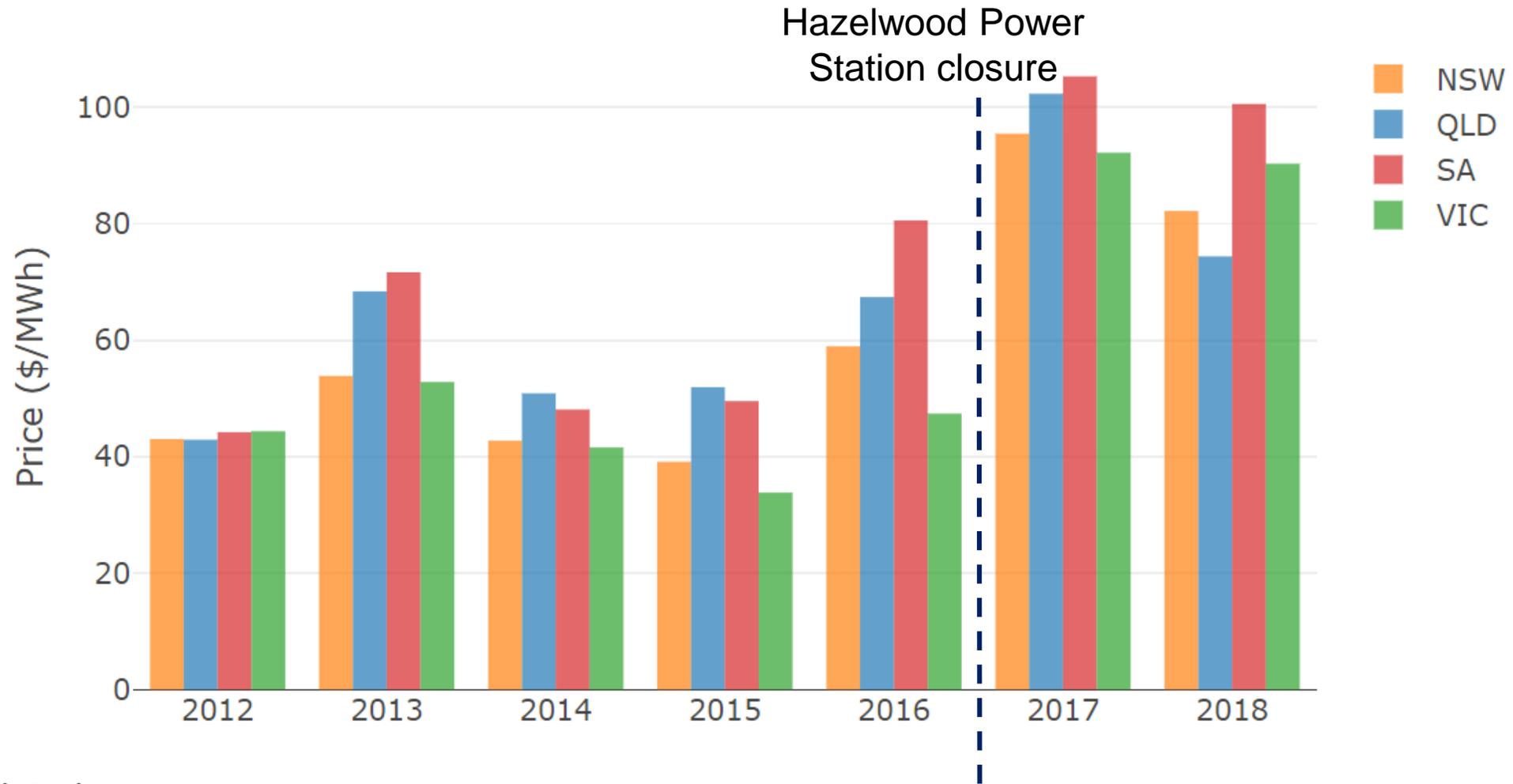
2018 Percentage of NEM Coal Market Generation (%)

The Victorian
1,600MW
Hazelwood Power
Station closed on 31
March 2017

	VIC	NSW	QLD	TOTAL
Coal generation year after HW closed (TWh)	36	57	52	146
Coal generation year before HW closed (TWh)	45	54	50	151
Difference	-9.5	3.2	1.9	-4.4
	-26%	5%	4%	-3%

NSW and QLD increased production a bit to replace part of lost Hazelwood production. Coal generation 3% lower NEM-wide one year after H. closed

NEM-wide prices increased sharply after HW closed

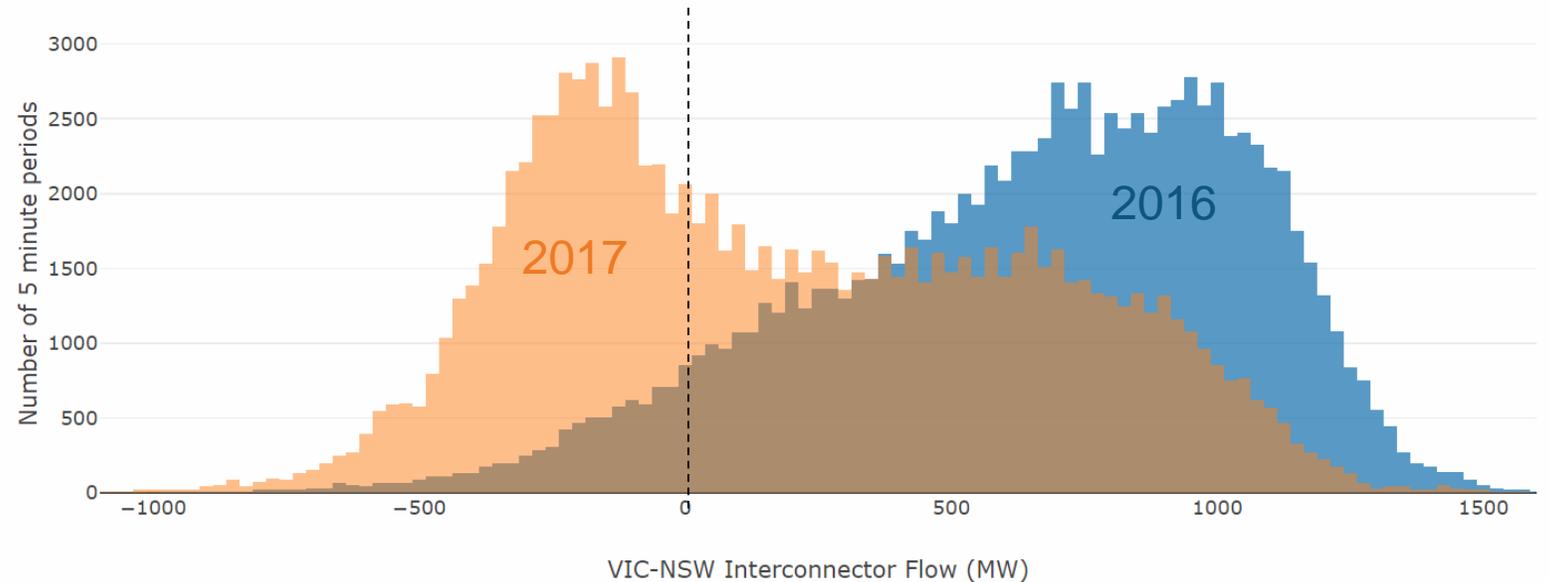


Regional Interconnectors

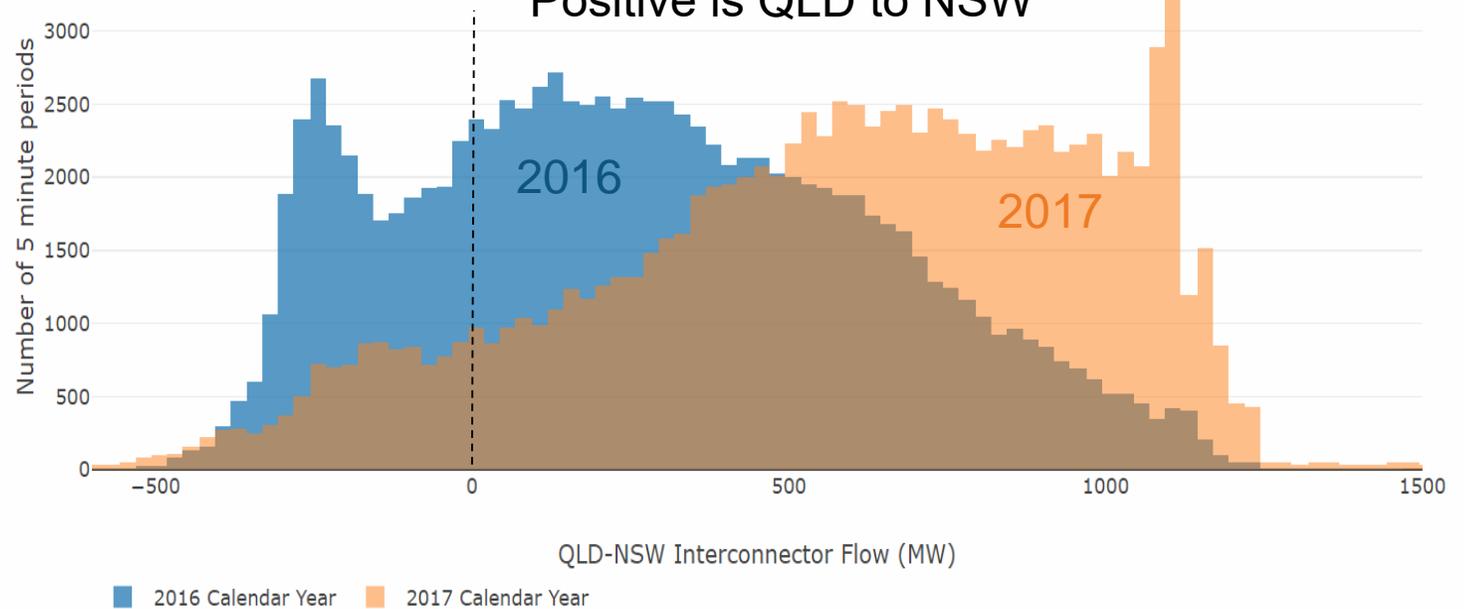
After Hazelwood closed NSW was frequently exporting electricity to Victoria

After Hazelwood closed NSW was more frequently importing electricity from Queensland

Positive is VIC to NSW



Positive is QLD to NSW



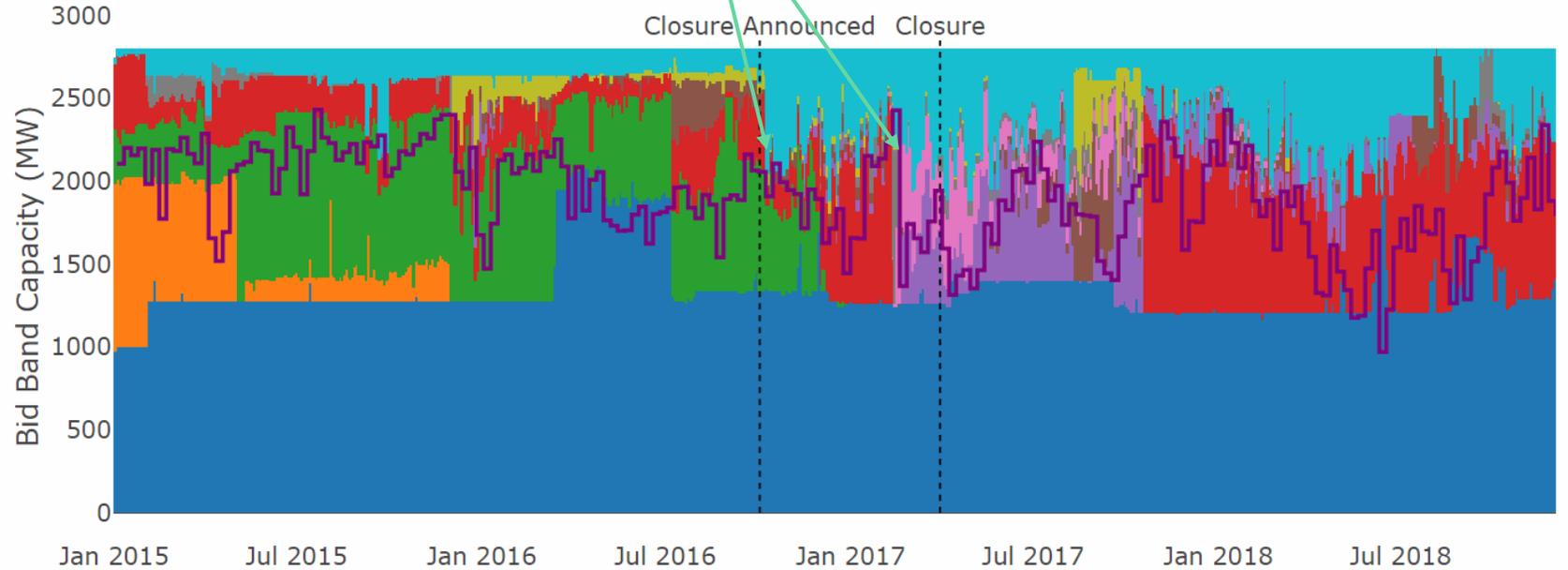
Establishing market power: our initial thoughts

- ▶ Assessment of market competitiveness is an empirical question that requires judgement.
- ▶ Oligopolistic competition - following Woerman (2018) - provides a model to evaluate generator behavior:
 - ▶ Objective function is the maximisation, across firms, of the difference between revenues and costs.
 - ▶ Optimal mark-up rule (differential of objective function with respect to offer price) occurs when:
 - ▶ Inframarginal rent is maximised (i.e. does a generator price its output so as to maximise inframarginal rent?); and
 - ▶ Residual demand is inelastic (does a generator seek to exercise market power when its competitors are least able to respond?).
- ▶ So, if $p \gg c$ and bidding behavior consistent with the optimal market-up rule and not explained by exogenous factors, conclusion of market power possible.

NSW

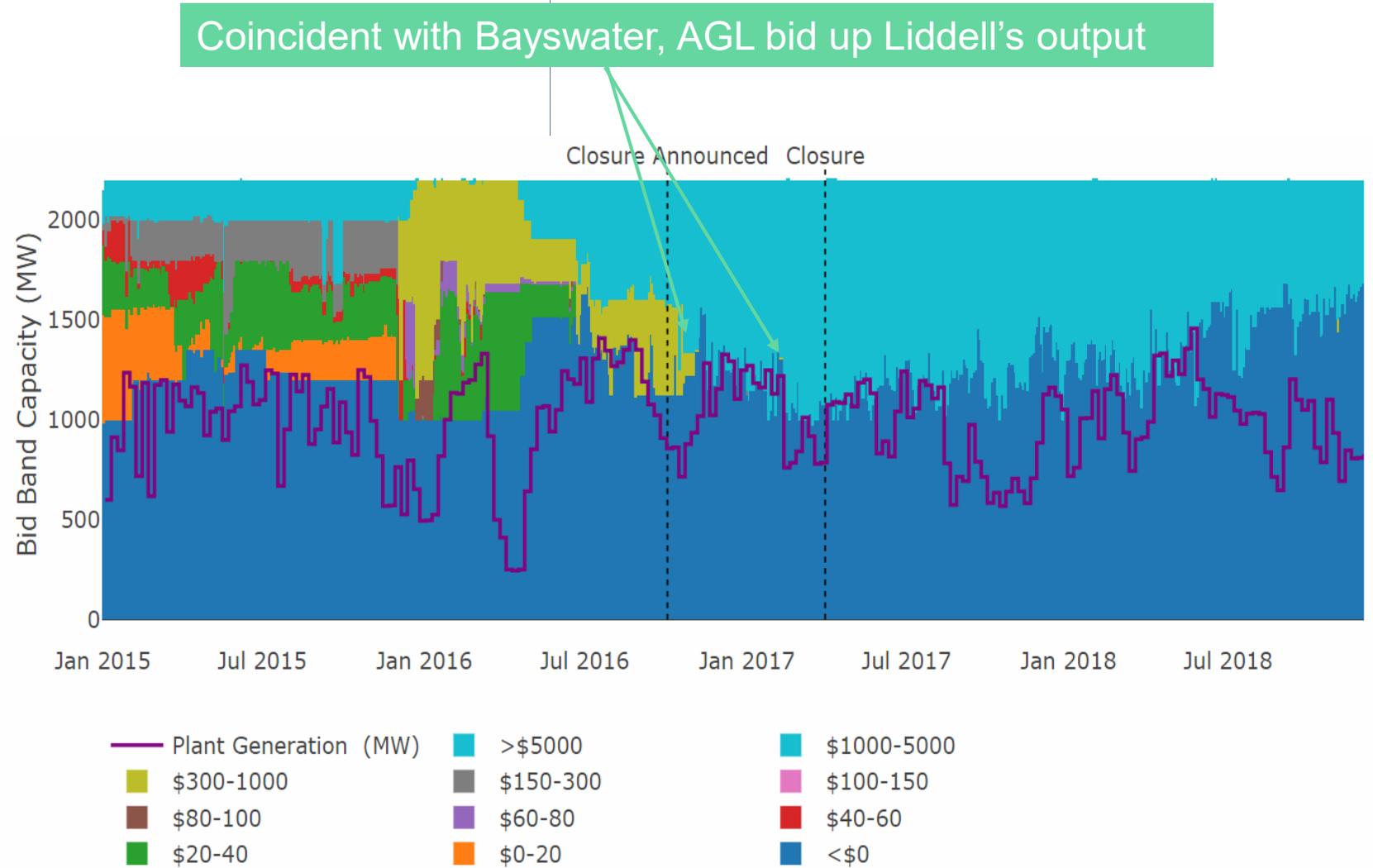
Bayswater Power Station (AGL)

AGL increased Bayswater prices



- Plant Generation (MW)
- >\$5000
- \$300-1000
- \$150-300
- \$100-150
- \$80-100
- \$60-80
- \$40-60
- \$20-40
- \$0-20
- <\$0

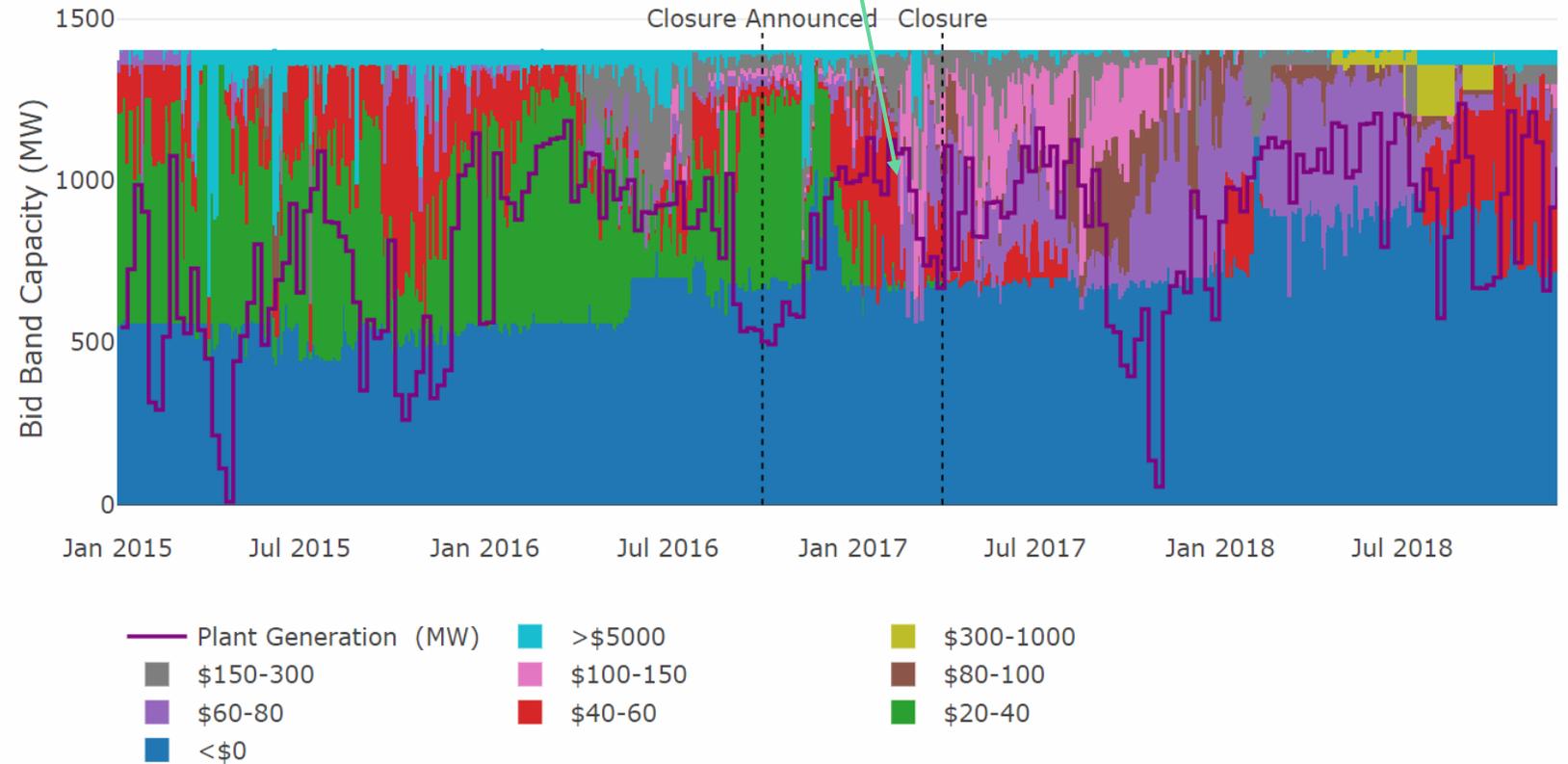
NSW
Liddell Power
Station (AGL)



NSW Coal Generator

Mt Piper Power Station (Energy Australia)

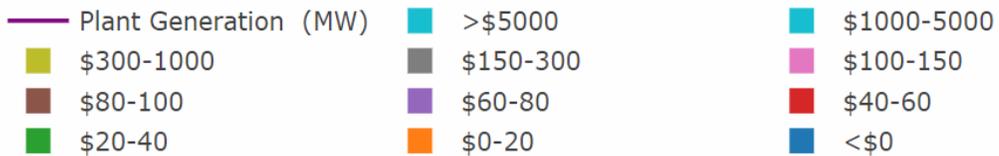
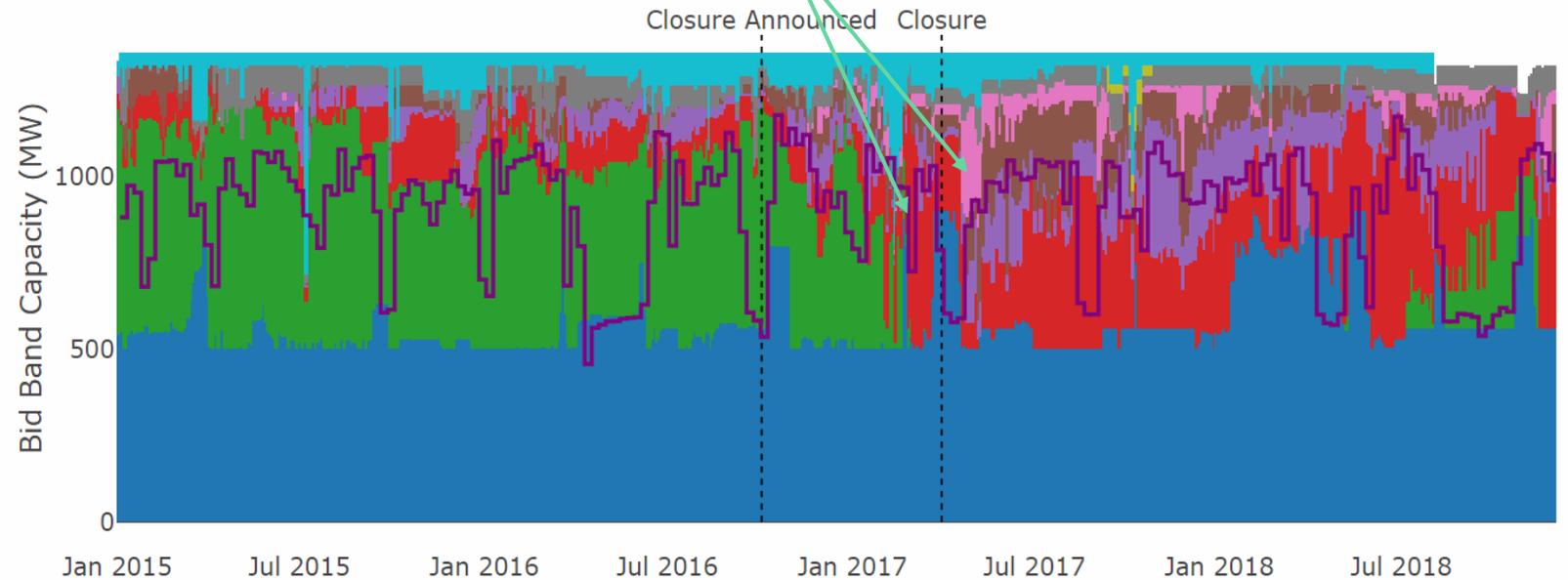
Energy Australia stepped up Mt Piper bids after Bayswater



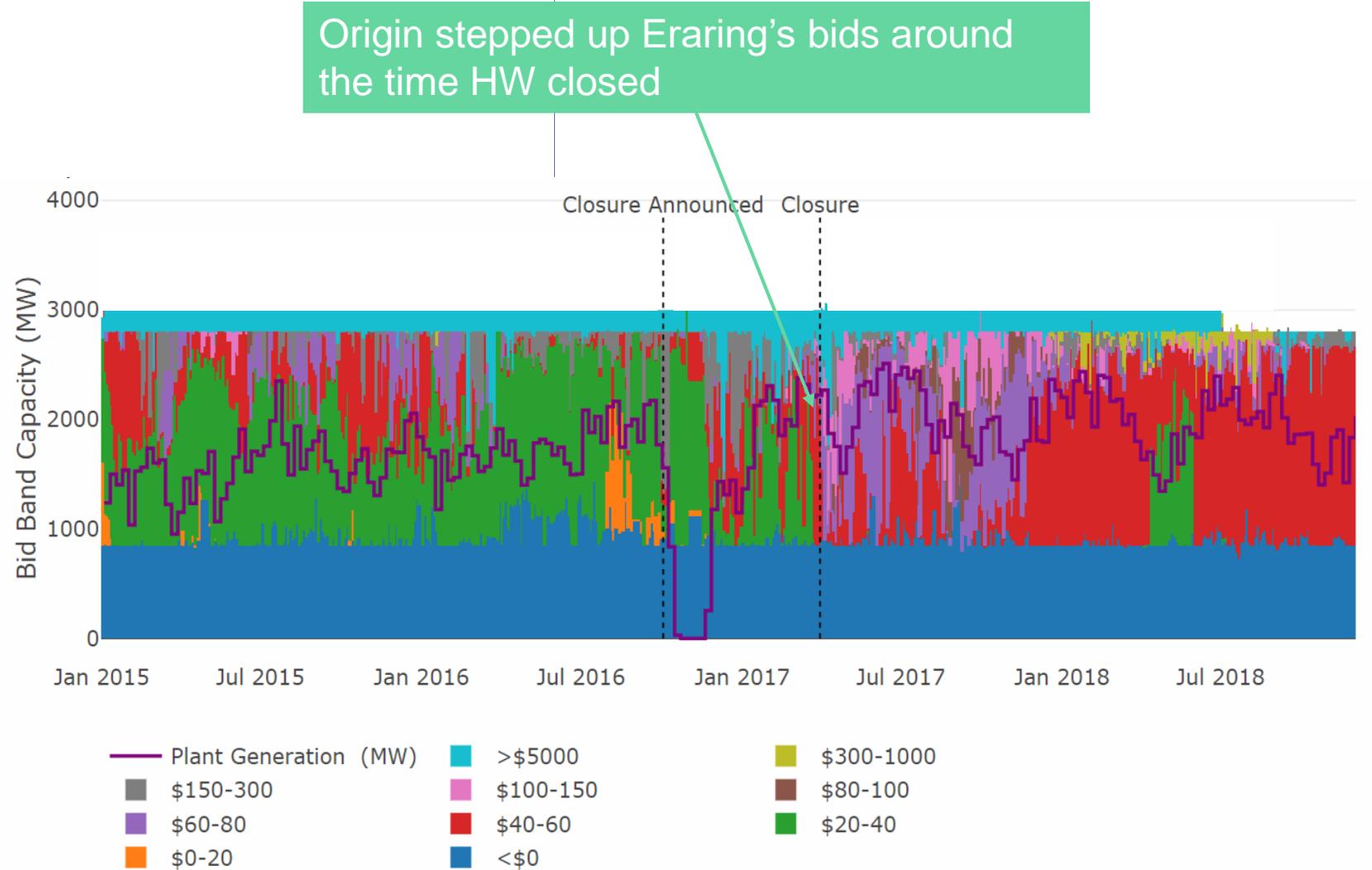
NSW

Vales Point "B" Power Station (Delta/Sunset Power)

Delta stepped up Vales Point bids after
Bayswater

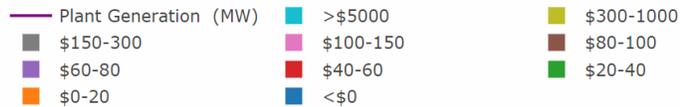
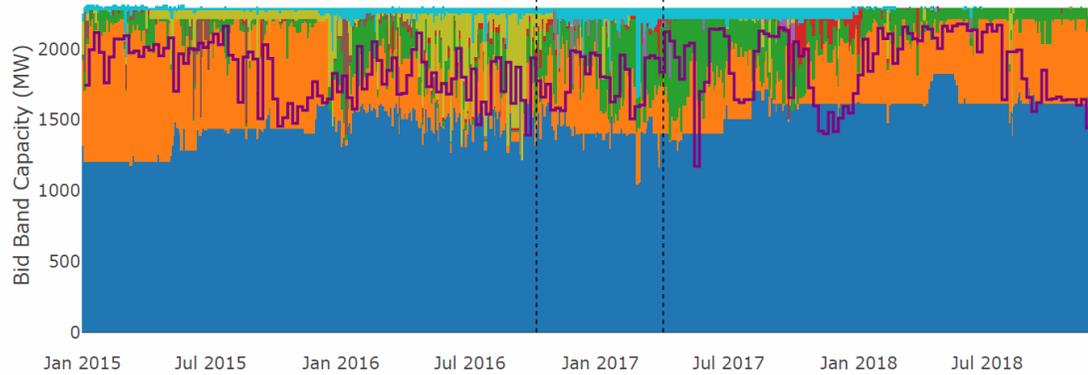


NSW Coal Generator Eraring Power Station (Origin)

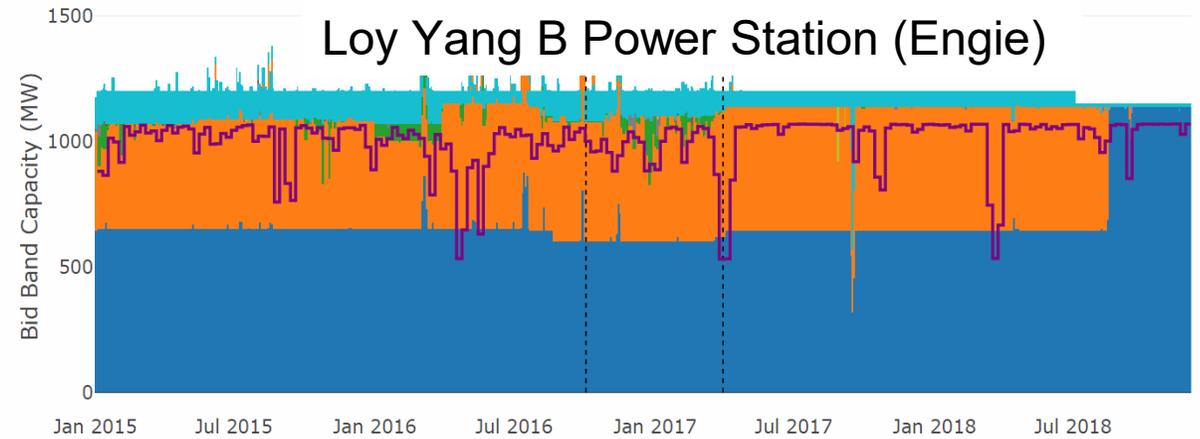


How did the Victoria generators respond?

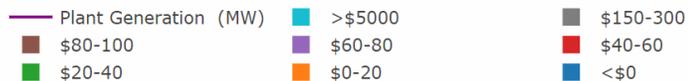
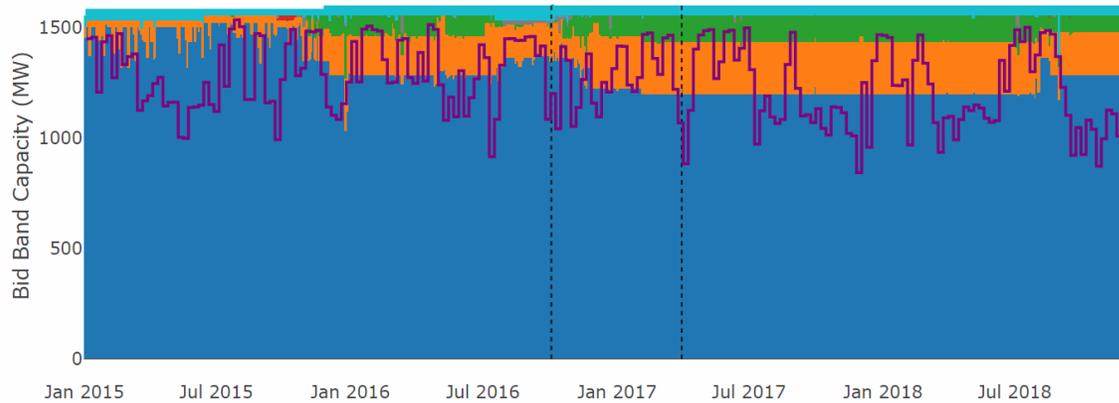
Loy Yang A Power Station (AGL)



Loy Yang B Power Station (Engie)



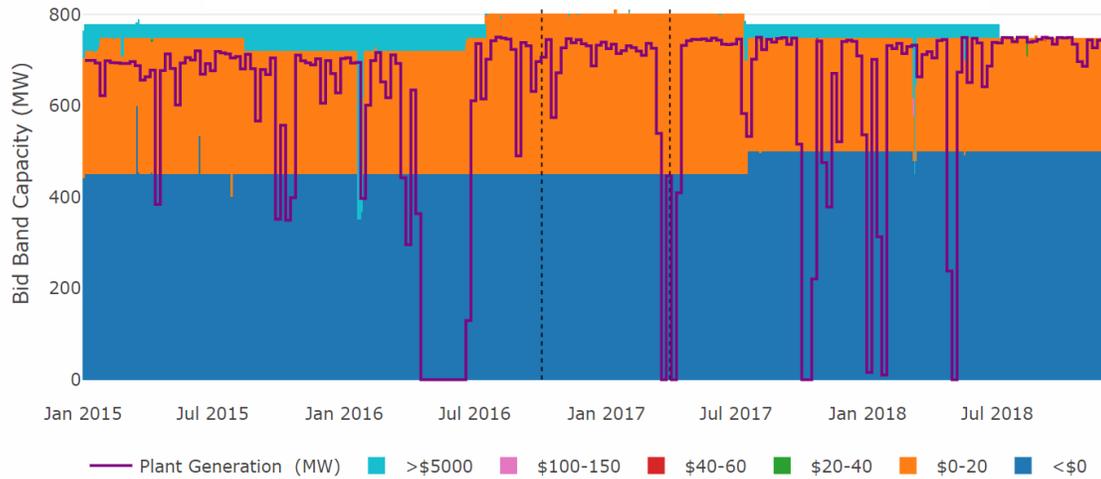
Yallourn 'W' Power Station (Energy Australia)



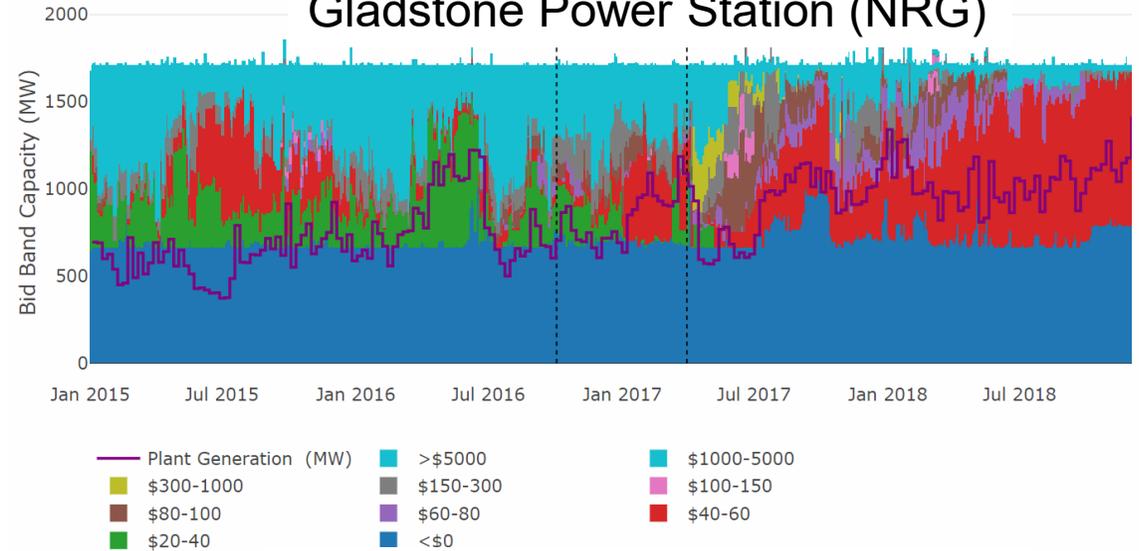
No significant change
in Victoria bids

How did the Queensland generators respond?

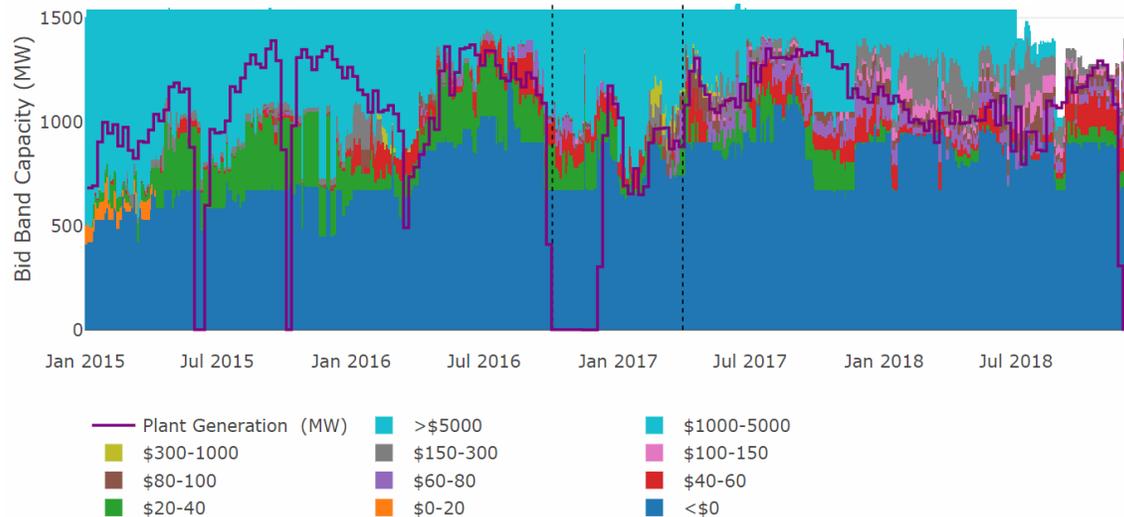
Millmerran Power Plant (InterGen)



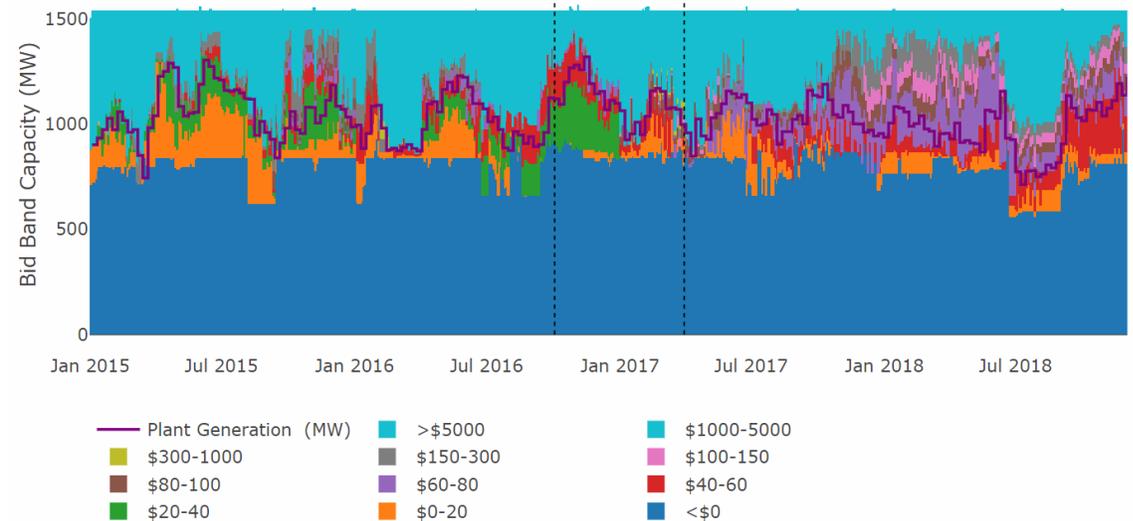
Gladstone Power Station (NRG)



Tarong Power Station (Stanwell)



Stanwell Power Station (Stanwell)

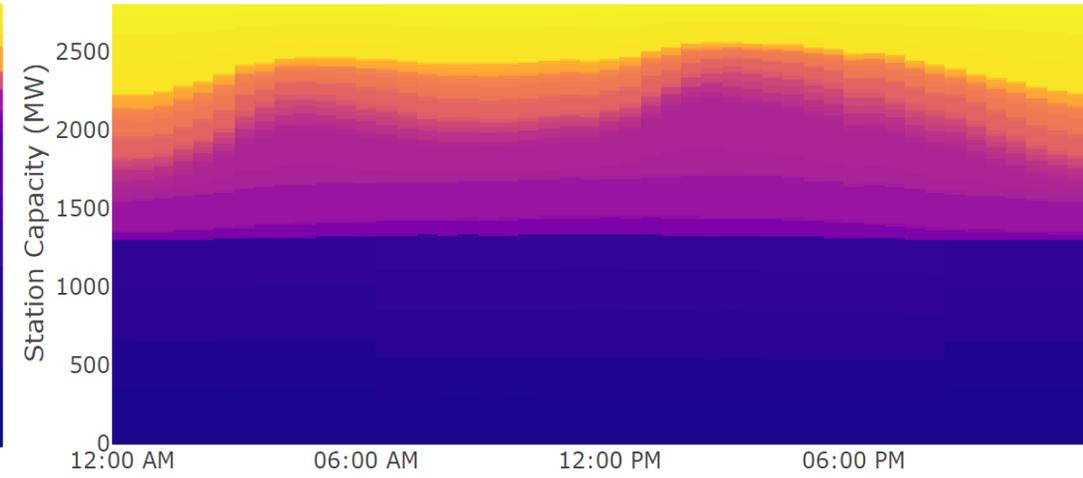
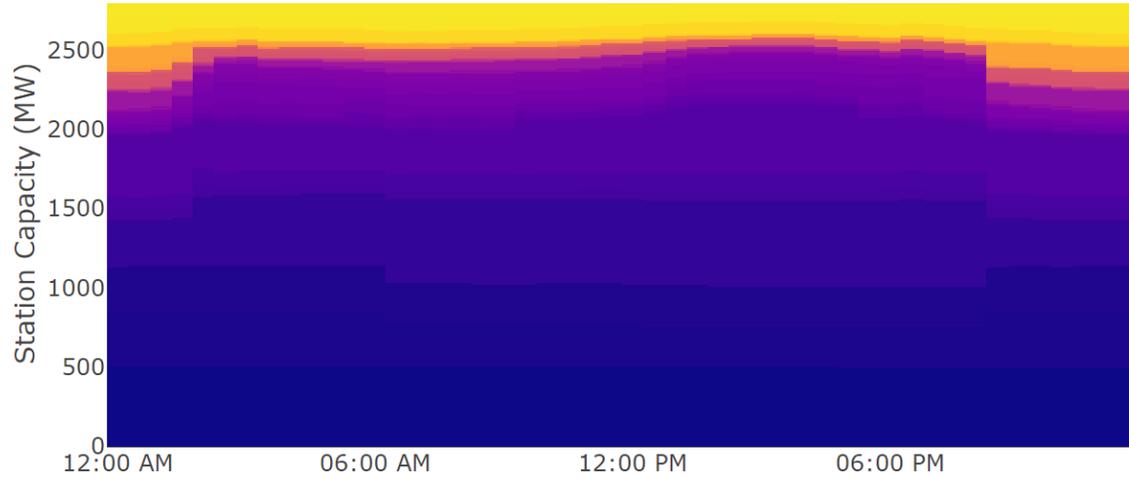


How did the average Bayswater and Liddell bids change throughout the day?

2016

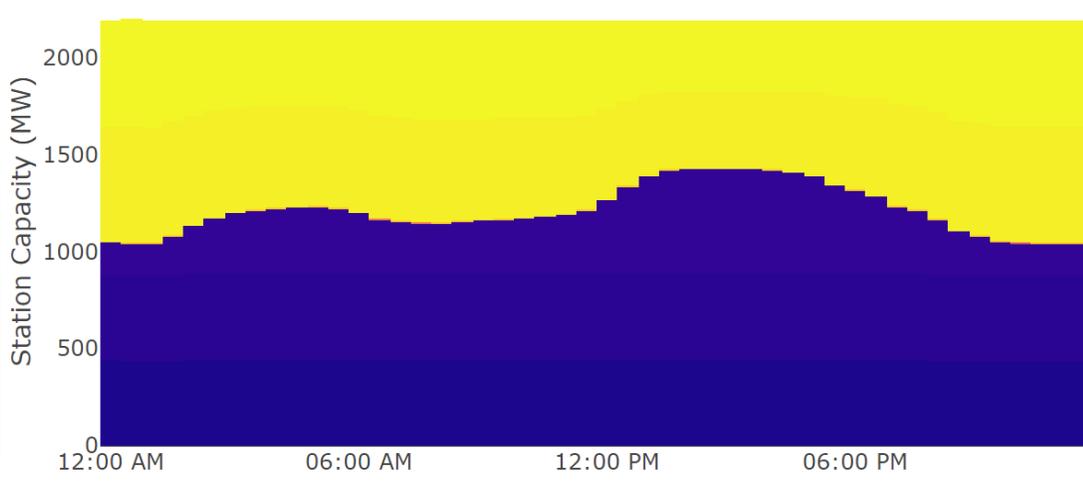
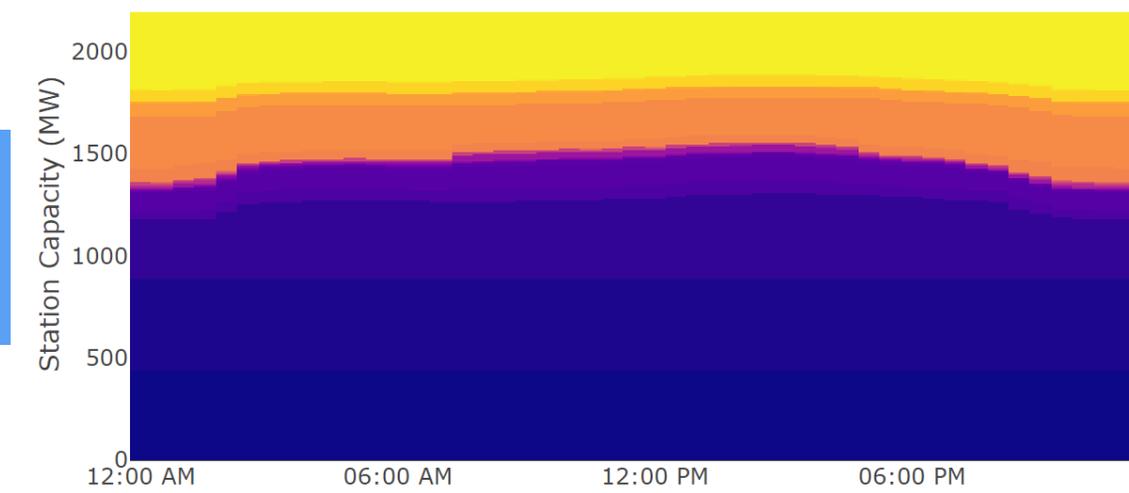
2017

Bayswater



- \$14,000/MWh
- \$400/MWh
- \$100/MWh
- \$75/MWh
- \$30/MWh
- \$-1000/MWh

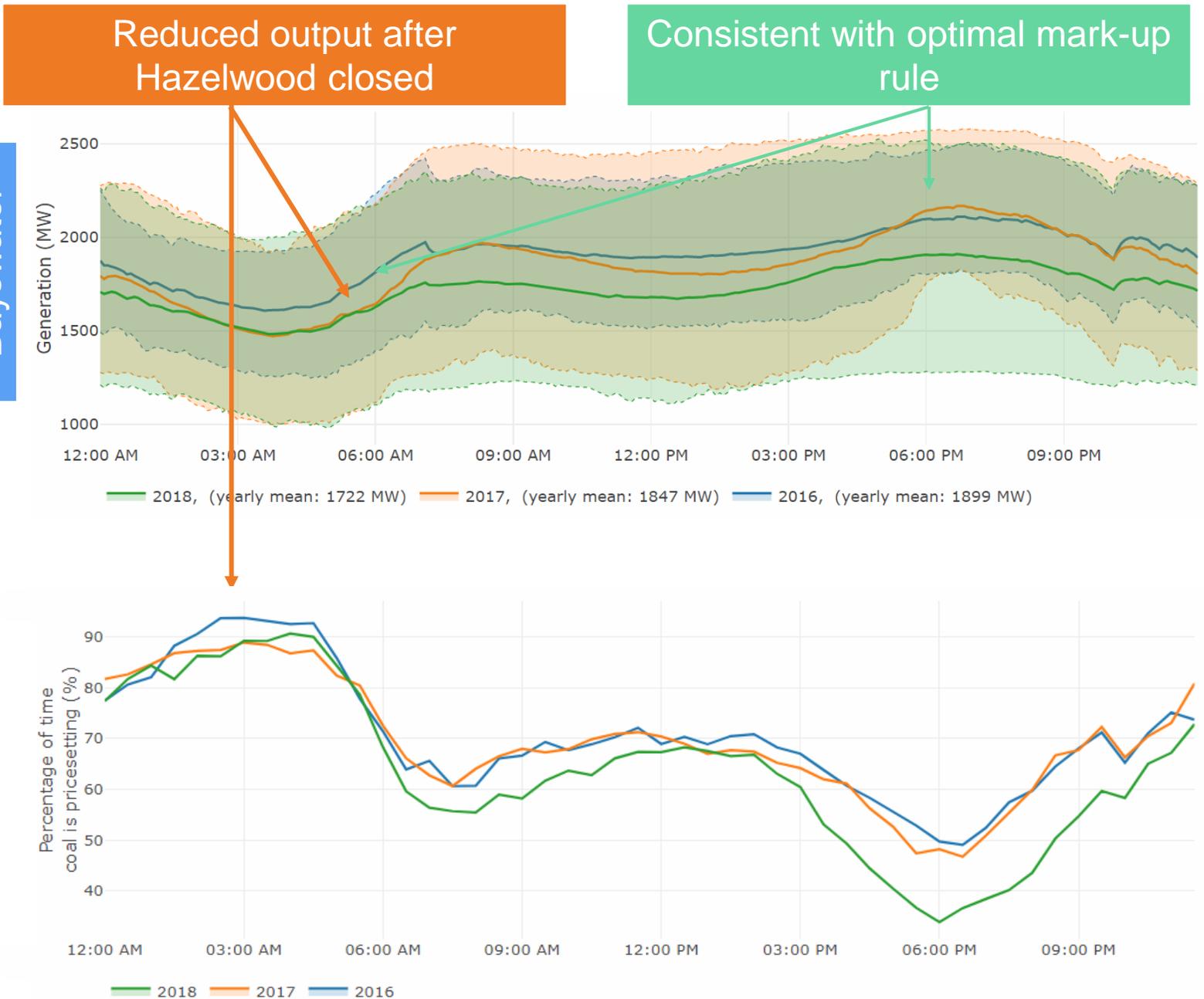
Liddell



- \$14,000/MWh
- \$400/MWh
- \$100/MWh
- \$75/MWh
- \$30/MWh
- \$-1000/MWh

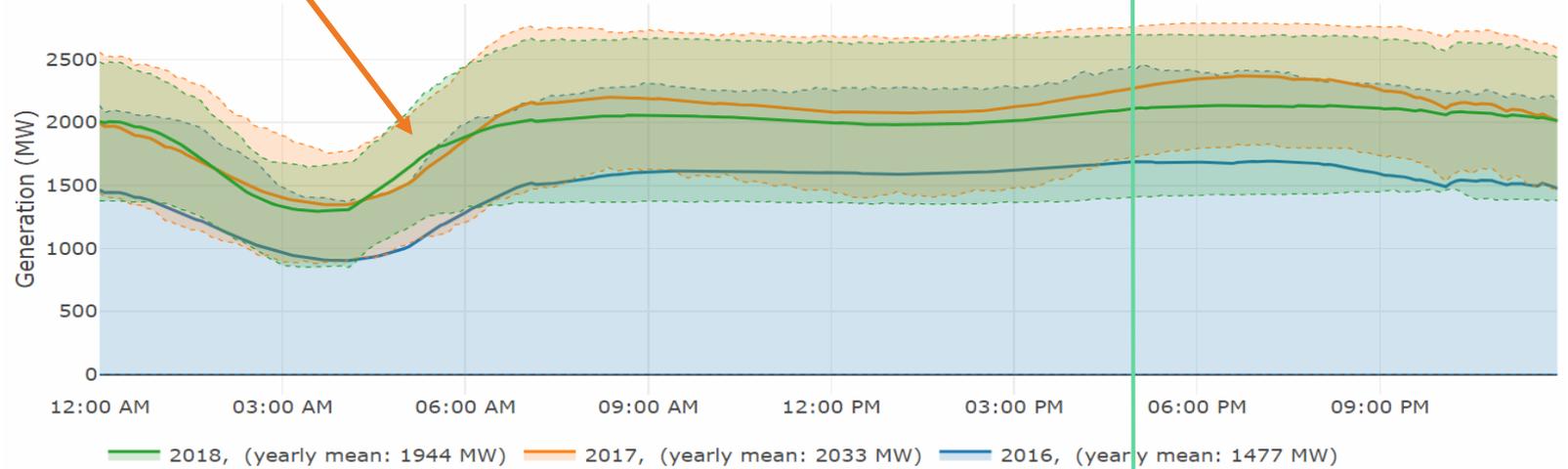
What did the average daily output of the AGL generators look like?

Bayswater

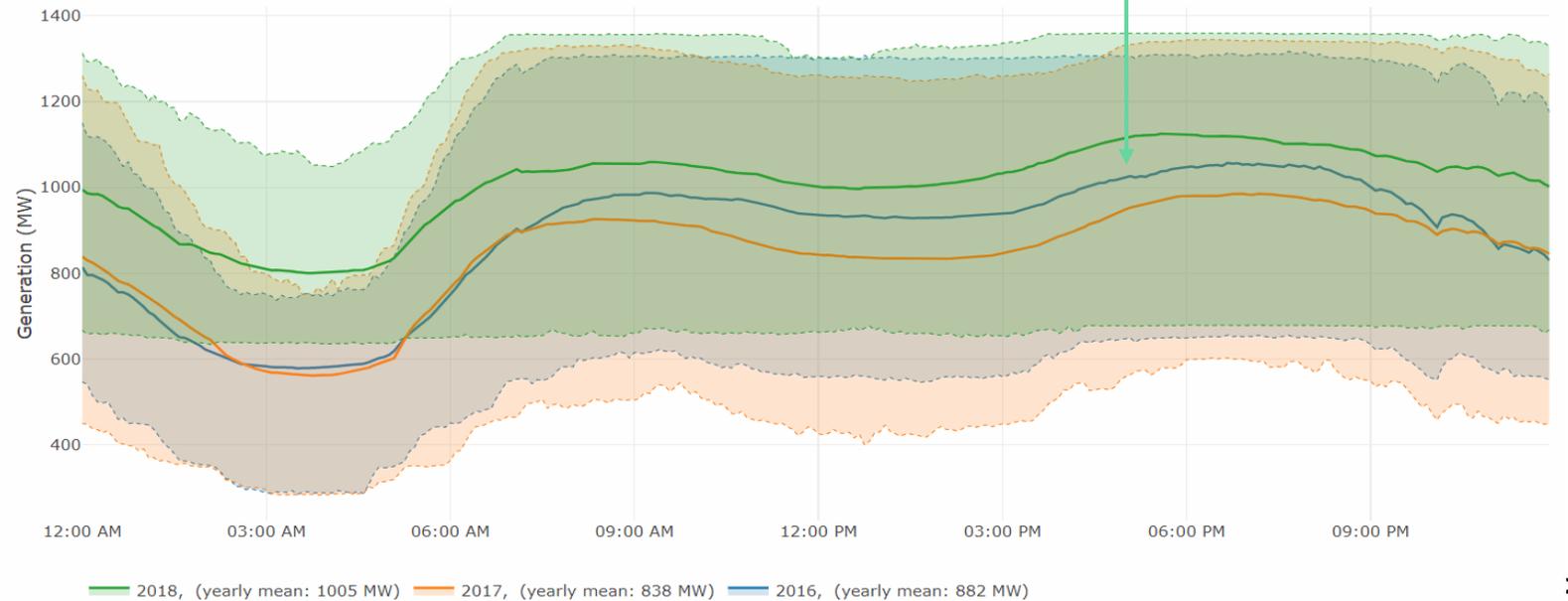


What did the daily output of the other NSW generators look like?

Eraring

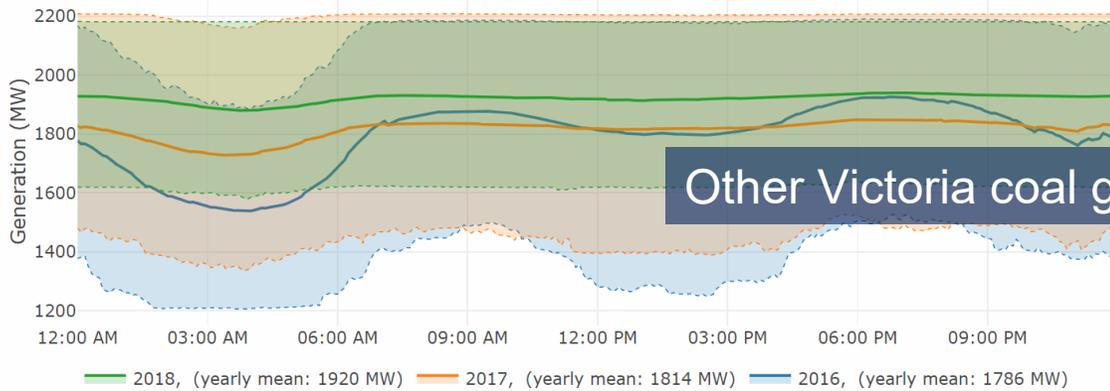


Mount Piper

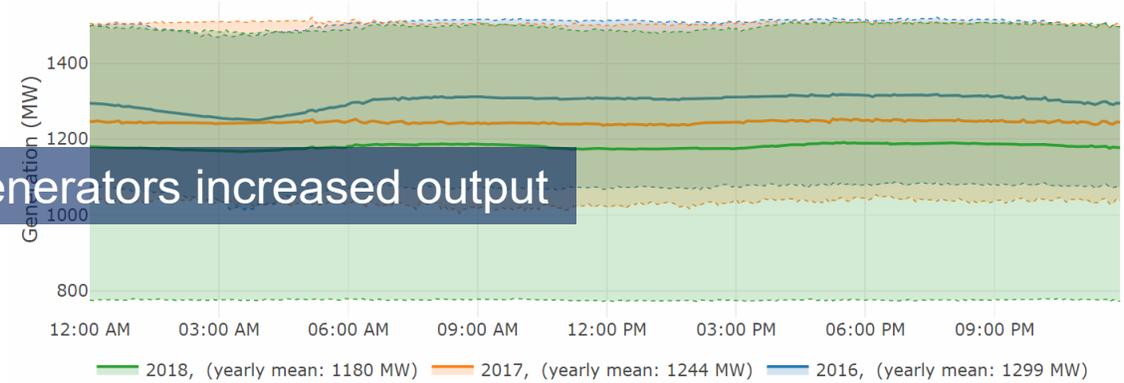


What about Victoria and Queensland?

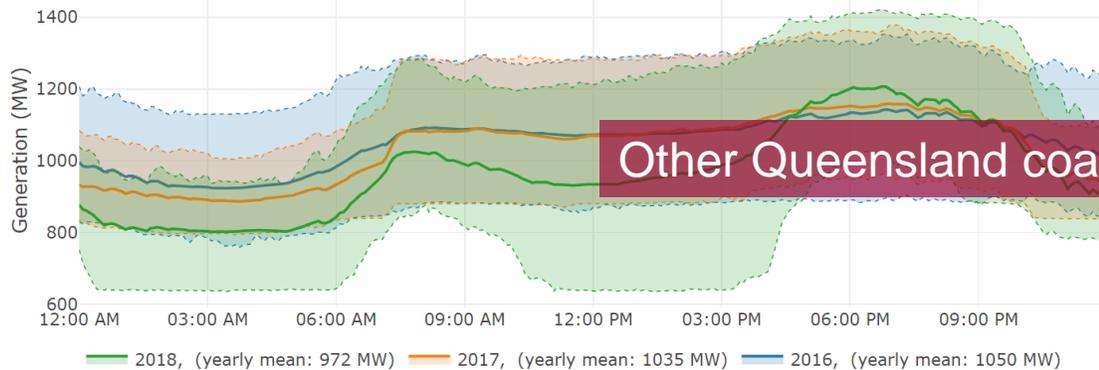
Loy Yang A - Increased



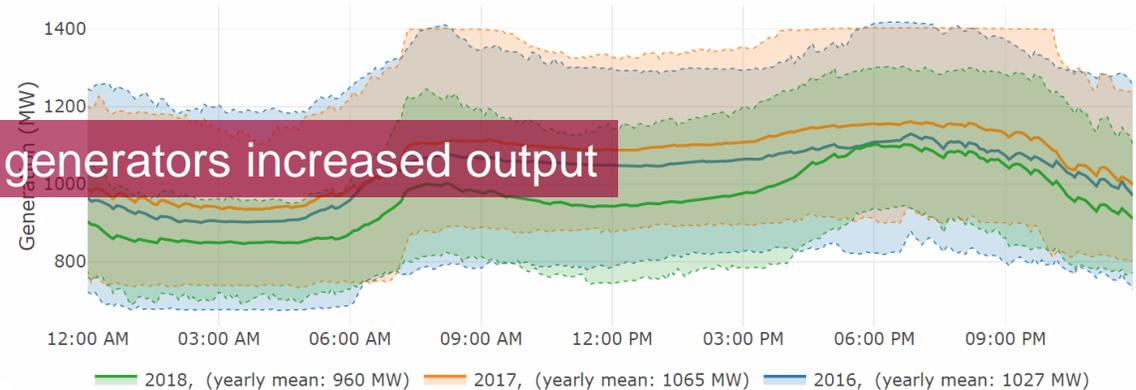
Yallourn 'W' - Reduced



Stanwell Power Station – Approx. the same

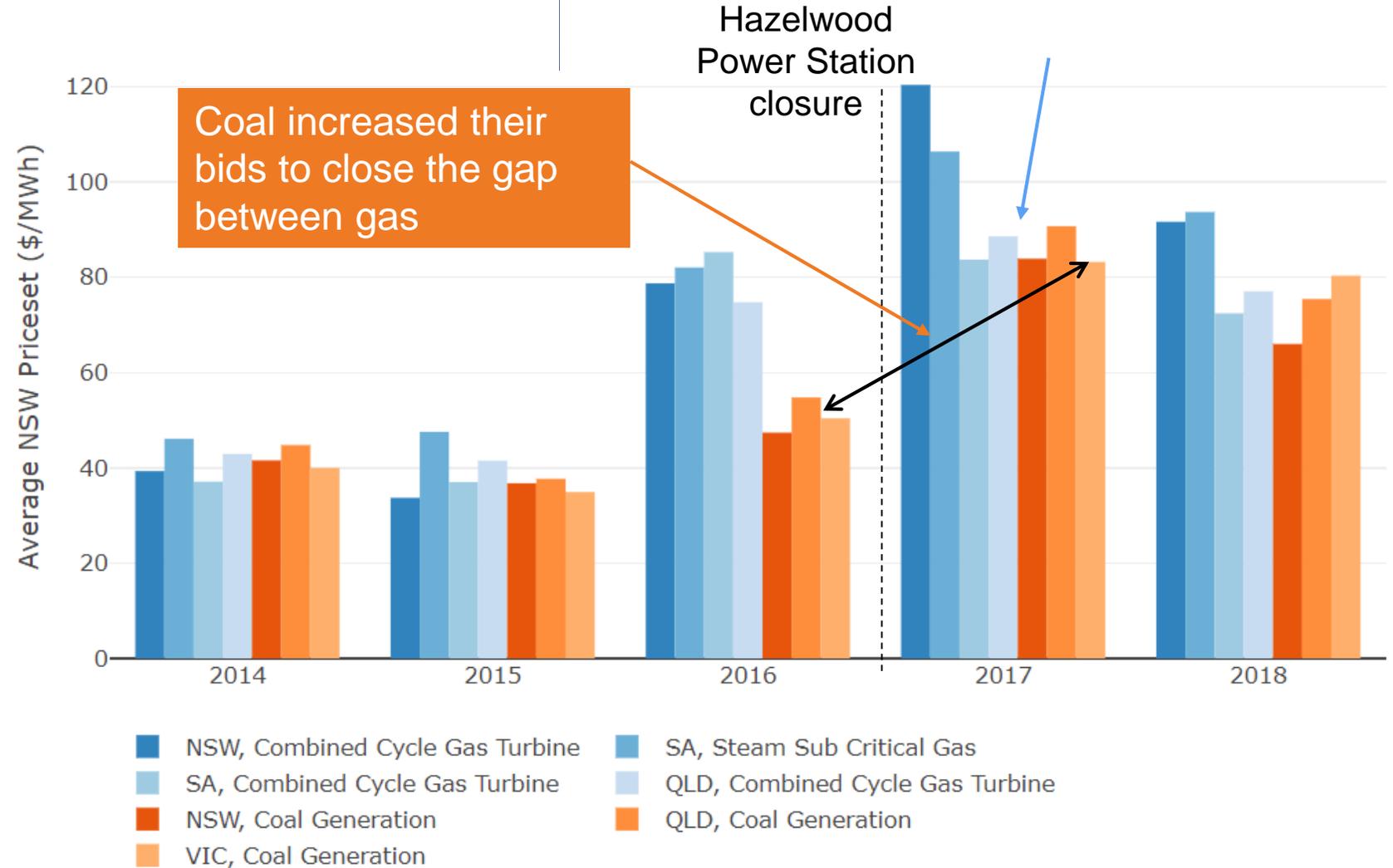


Tarong – Increased in 2017 and reduced 2018

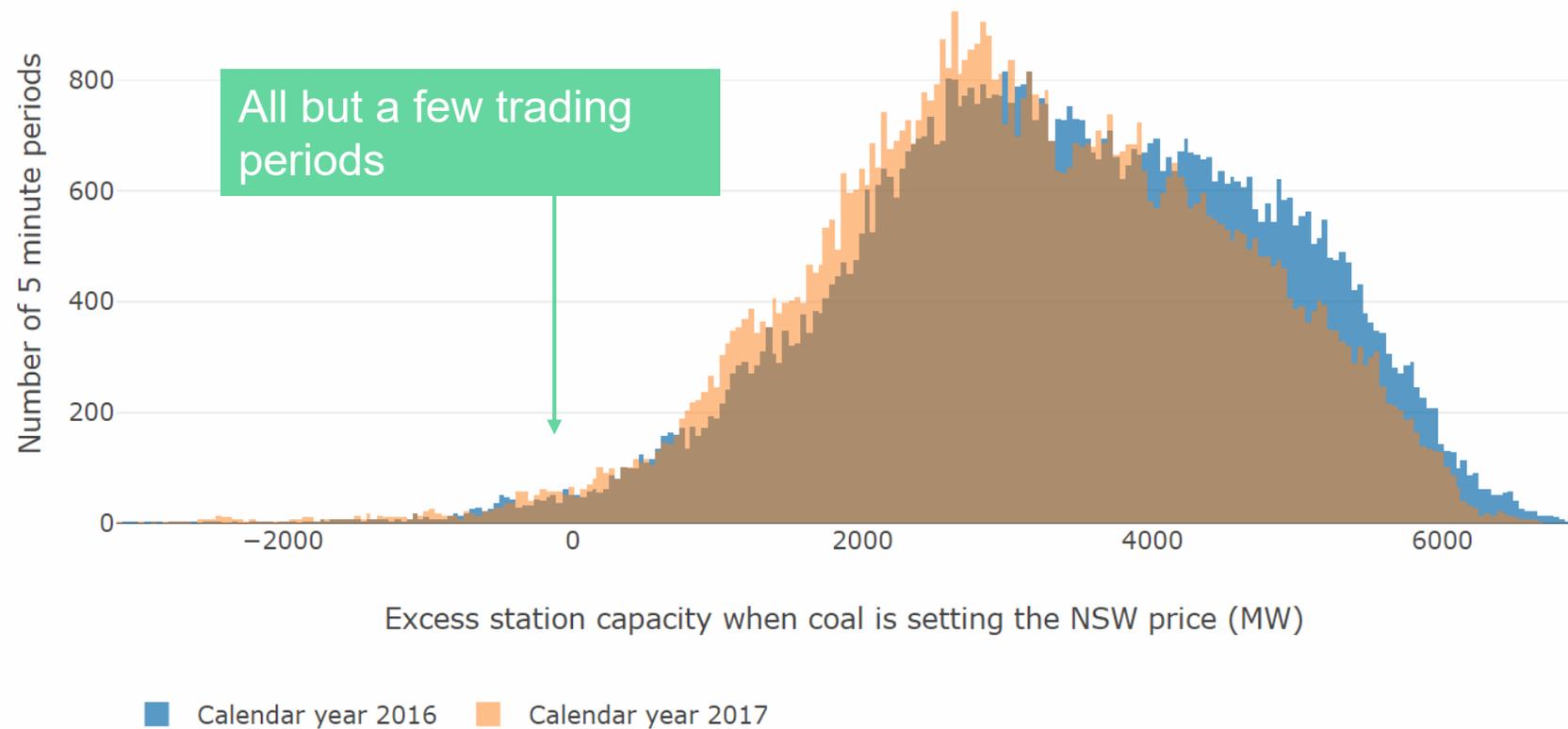


How have NSW spot prices changed when coal and gas generators set the price ?

The difference between gas and coal has shrunk



No shortage of production capacity at most times when coal setting prices



Is P >> C?

		Bayswater	Eraring	Liddell	Mt Piper	Vales Point
Average price (\$/MWh) received in 2017 when setting spot		\$86	\$ 77	\$107	\$78	\$85
Upper estimate of short term price	Using Newcastle coal spot price	\$48	\$48	\$51	\$47	\$49
Estimate based on contract costs	Using Wood Mackenzie coal price forecast	\$14	\$22	\$15	\$22	\$22
Estimate based on contract costs	Using AGL Entitlement Issue coal price estimates in 2017	\$13	\$25	\$14	\$24	\$24

Exogenous factors (e.g. coal supply constraints) ?

Do coal supply constraints explain bidding behaviour ?

1. **Vales Point** produced after Hazelwood closed much as it did before. Boiler limitations on sustained high production seem credible;
2. **Mt Piper** seemed to have had reasonable concerns with its Springvale mine to explain initial post-Hazel reduction (and Mt Piper has since raised production);
3. **Eraring** increased production by a little over a third in the year after Hazelwood closure relative to before;
4. By comparison AGL boasted of its superior coal supply arrangements (three suppliers, direct rail access, excellent conveyors and coal handling) relative to its competitors when it acquired the Macquarie Generation assets. Its pricing of **Bayswater and Liddell** after Hazelwood closure (and even now two years' later) if consistent with market power and/or coal supply constraints. But where are those constraints? AGL said commercial-in-confidence (and explained in detail to ACCC and AER).

Hirschmann-Herfindahl: coal generation market is highly concentrated

$$HHI = \sum_{i=1}^N MS_i^2$$

Coal generators only

	New South Wales	Queensland	Victoria	All regions
2016	3229	3224	2637	1494
2017	3105	3240	3114	1536

Not well suited to establishing market power in electricity markets (Newbery, 2009).

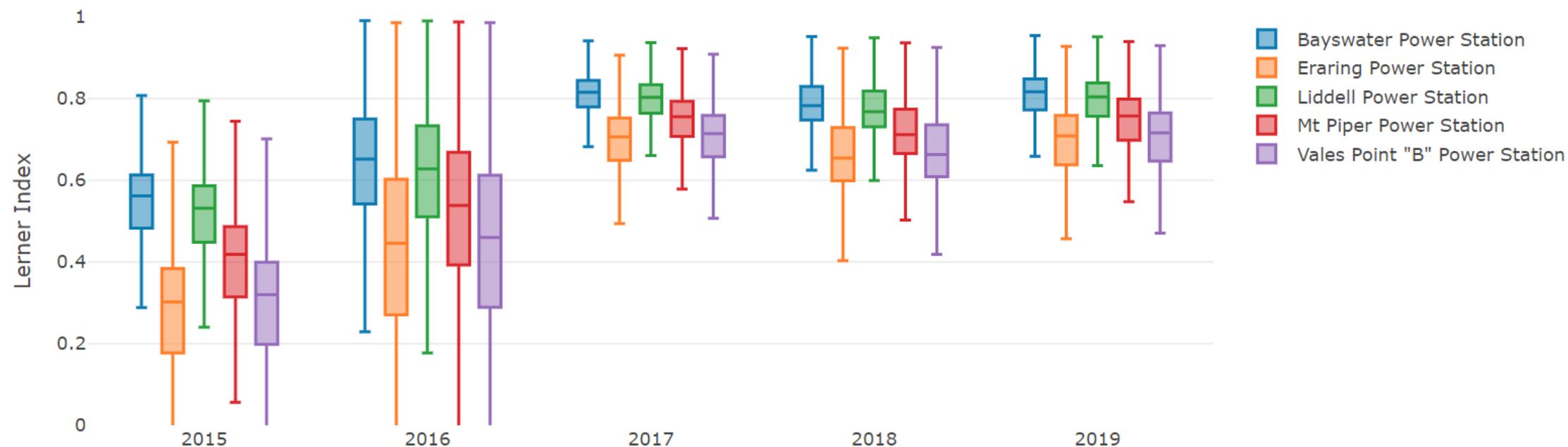
Lerner

$$\begin{aligned} \text{Lerner Index} &= \text{Price-Cost Mark-up}_{i,t} \\ &= (\text{Price}_t - \text{Cost}_{i,t}) / \text{Price}_t \text{ for firm (i) and time (t)} \end{aligned}$$

“P” (at least spot price) easy to establish, but “C” much harder (e.g. spot fuel price v contract price; how to account for start costs; conversion efficiencies).

Cost data and conversion efficiencies usually confidential and firms’ treatment of non-fuel operating costs is subjective.

Lerner Index, NSW Coal Generators



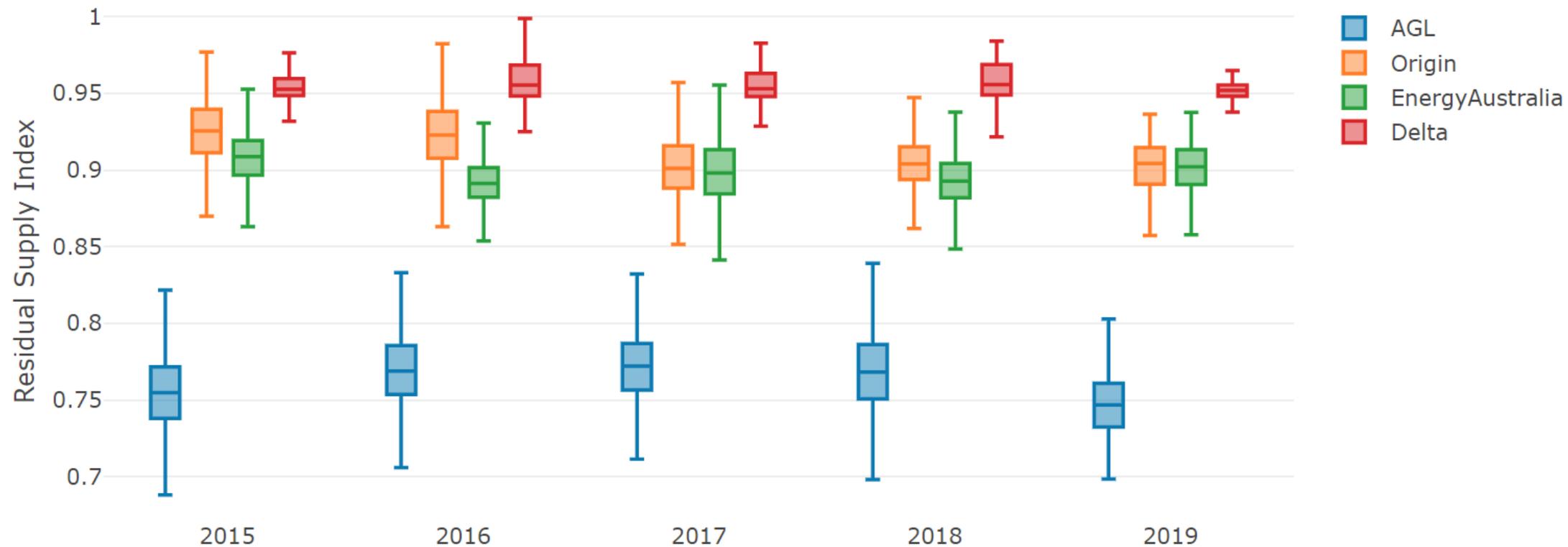
Residual Supply Index

Based on Sheffrin (2002): measures dominance based on proportion of market supplied by a firm

$RSI_{i,t} = (\sum_{i=1 \text{ to } n} \text{Production}_{i,t} - \text{Production}_{i,t}) / \sum_{i=1 \text{ to } n} \text{Production}_{i,t}$ for firm (i) and time (t)

But dominant position does not necessarily imply incentive to influence market price; and RSI provides no insight into impact of technology limitations (ramp rates, minimum stable generation, start costs) or costs that affect incentives and operation.

NEM wide when single NEM – Coal only



Return on Withholding Capacity Index (RWC)

We adopt a variation of the Return on Withholding Capacity (RWC) Index based on Bataille et al (2019).

Motivating idea: establish incentive to withhold capacity by relating “abuse rent” ($\Delta P \cdot (\text{production}_{i,t} - 1)$) to lost profit ($\text{market price}_t - \text{avoidable production cost}_{i,t}$) for firm (i) and trading interval (t).

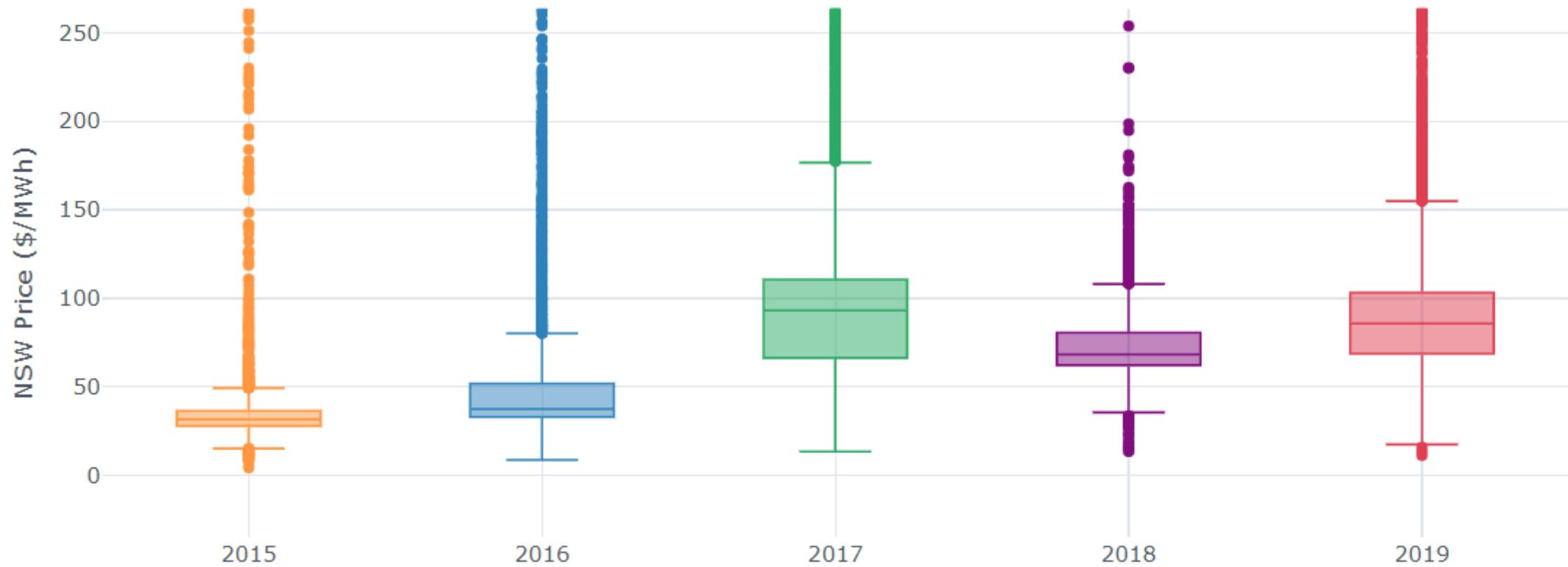
$$\text{RWC}_{i,t} = \Delta P \cdot (\text{production}_{i,t} - 1) / (\text{market price}_t - \text{avoidable production cost}_{i,t})$$

Where:

- ΔP = incremental price associated with withholding 1 MWh of production
= first difference of relationship between residual load and price.
- $\text{production}_{i,t}$ = total dispatched production for firm (i) in trading interval (t)
- market price_t = spot price in trading interval (t)
- $\text{avoidable production cost}_{i,t}$ = fuel cost (\$/MWh) for selected generator of firm (i) in trading interval (t)

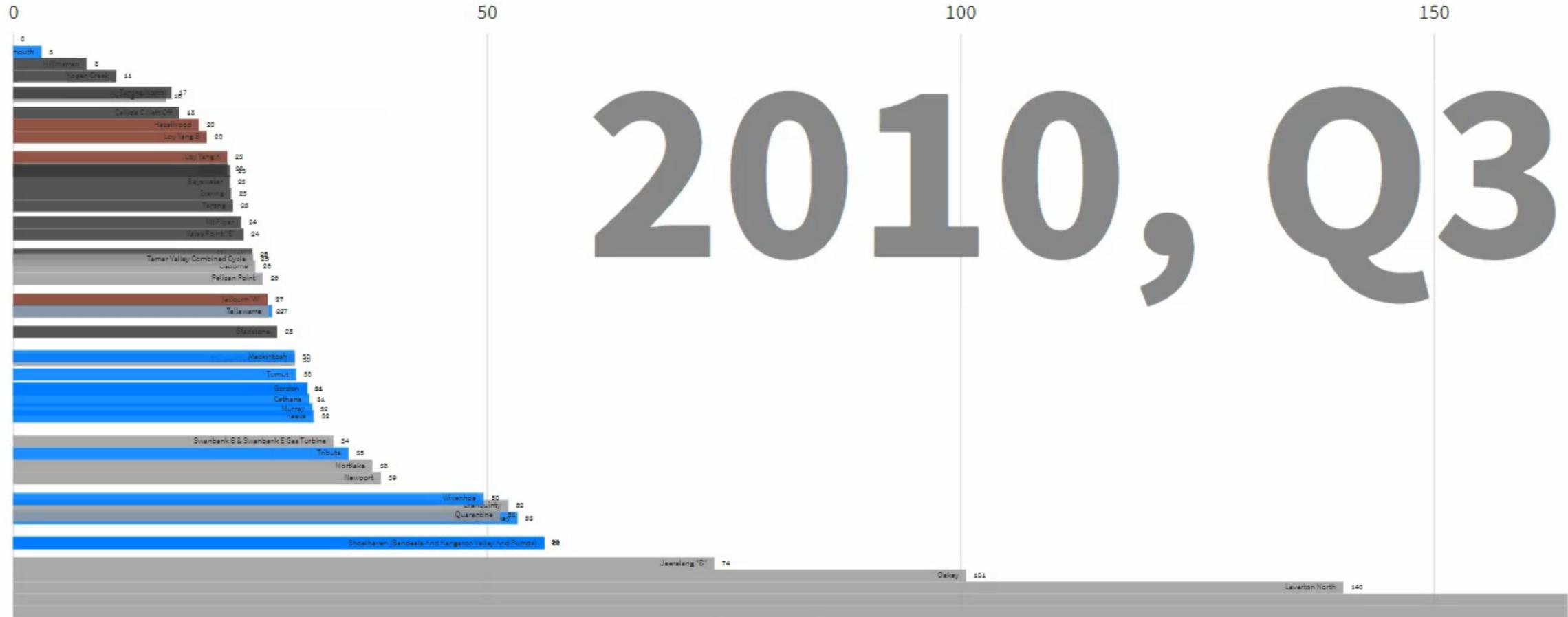
RWC > 1 says firm gains more from “abuse rent” than they lose in “lost profit” for incremental capacity withholding

NSW Price



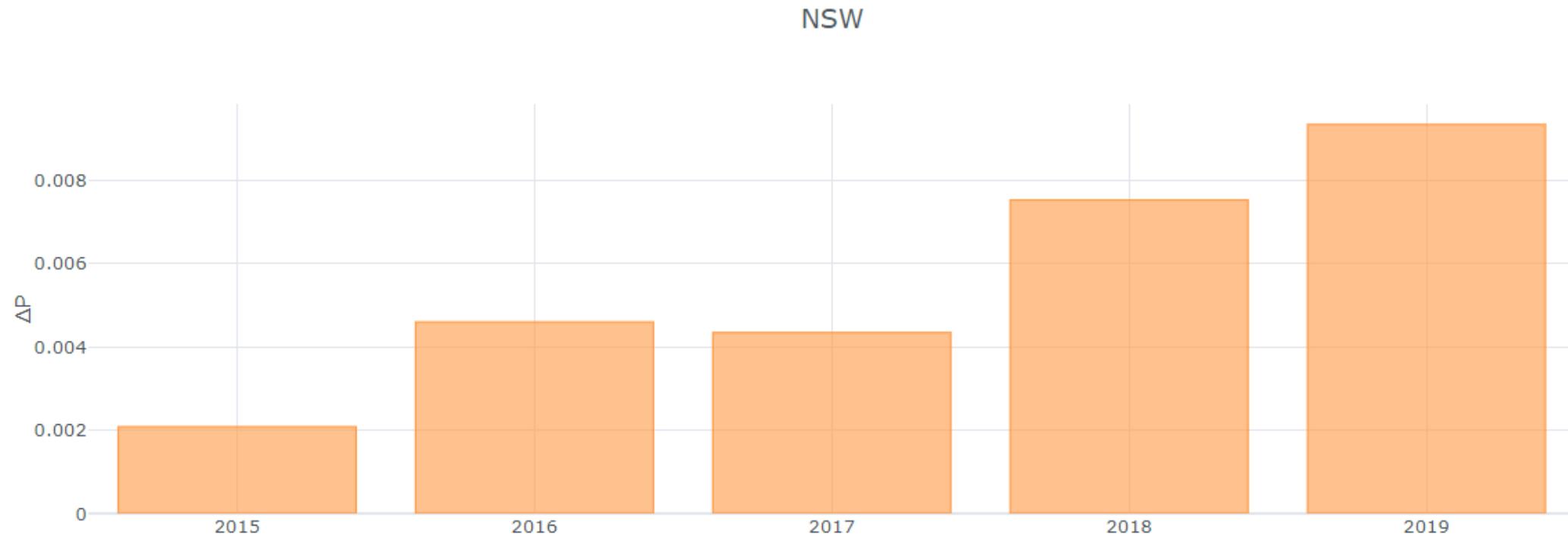
Generation Merit Order (\$/MWh)

■ Natural Gas ■ Water ■ Brown Coal ■ Black Coal

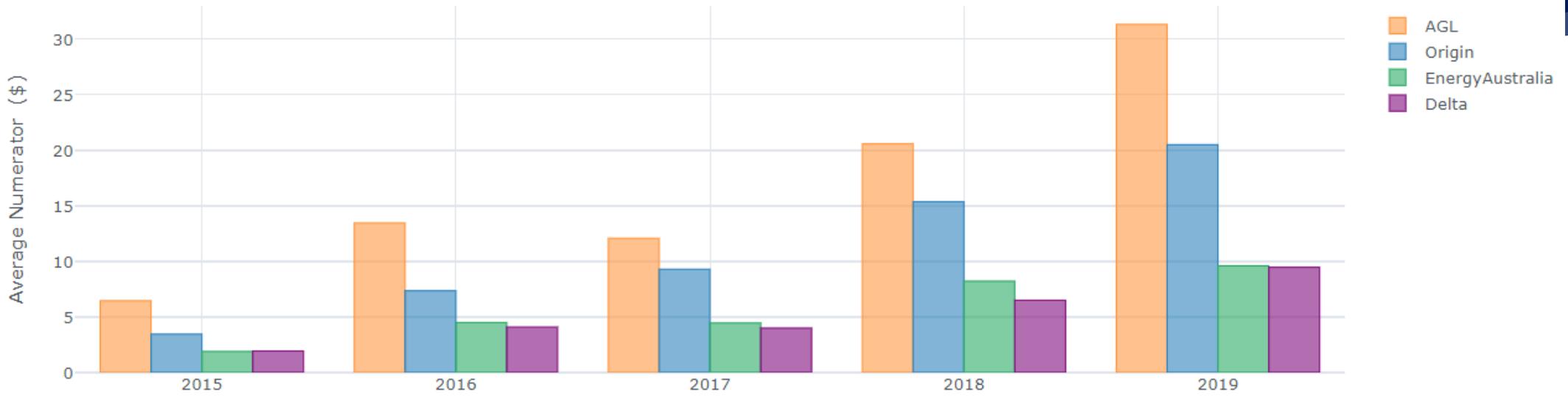


Replay

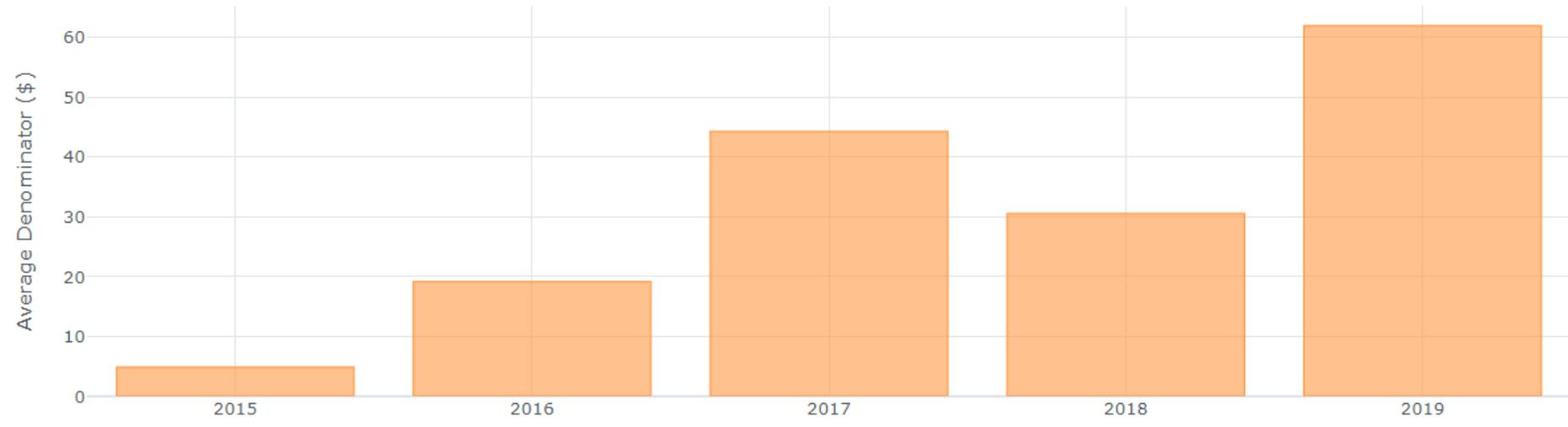
DeltaP: NSW, all dispatch intervals, controlling for gas price



NSW (all dispatch intervals)
($\Delta P \times (\text{RunningCapacity}-1)$)



NSW (all dispatch intervals)
(Price-VariableCost)



RWC estimates

	Percentiles	AGL	Origin	EnergyAustralia	Delta
2015	Median	0.3	0.2	0.1	0.1
	75%	1.3	0.8	0.4	0.4
	90%	4.4	2.3	1.2	1.4
2016	Median	0.3	0.2	0.1	0.1
	75%	1.4	0.7	0.5	0.4
	90%	4.7	2.3	1.5	1.5
2017	Median	0.3	0.3	0.1	0.1
	75%	0.6	0.4	0.2	0.2
	90%	1	0.7	0.3	0.3
2018	Median	0.9	0.6	0.3	0.3
	75%	1.8	1.3	0.7	0.6
	90%	3.2	2.3	1.2	1.1
2019	Median	0.7	0.4	0.2	0.2
	75%	0.9	0.6	0.3	0.3
	90%	1.4	0.9	0.4	0.4