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)

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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)

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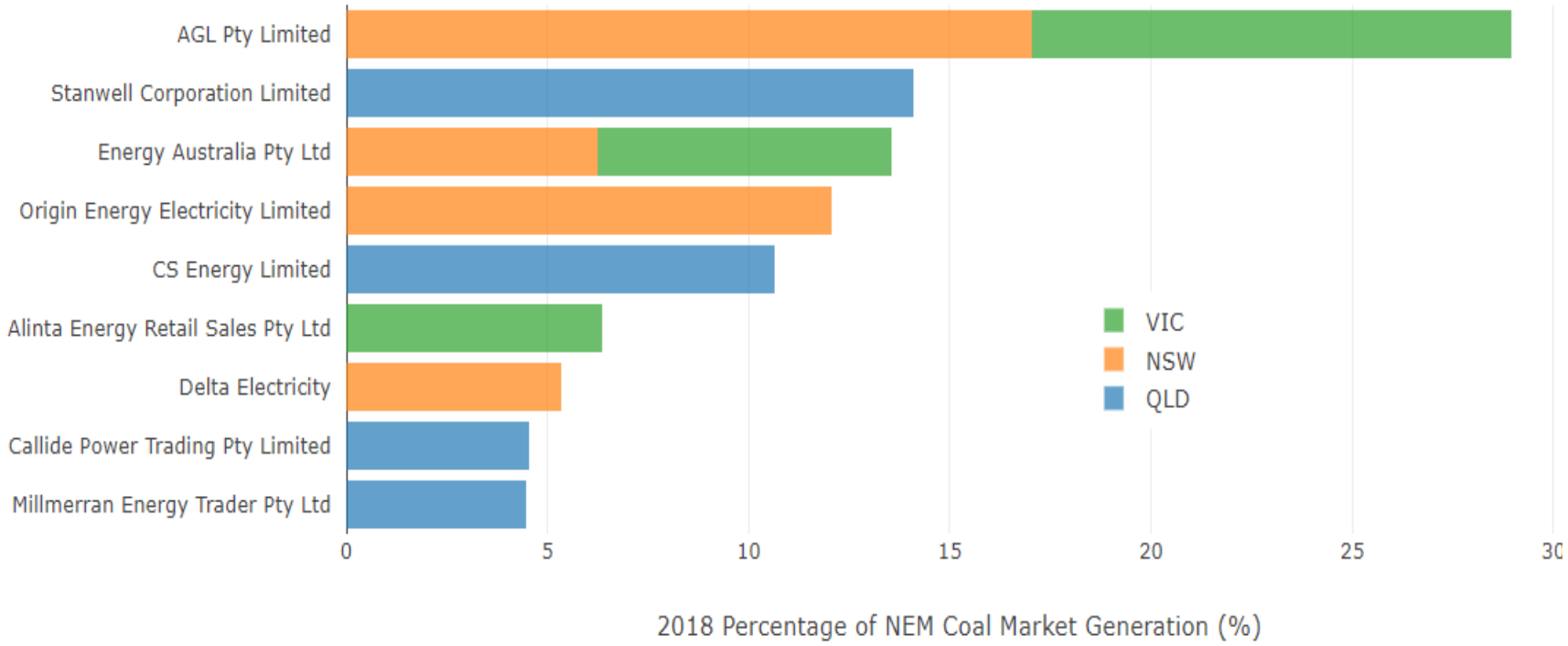
Top four coal generators account for 70% of national coal gen; even more concentrated in each regional markets



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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

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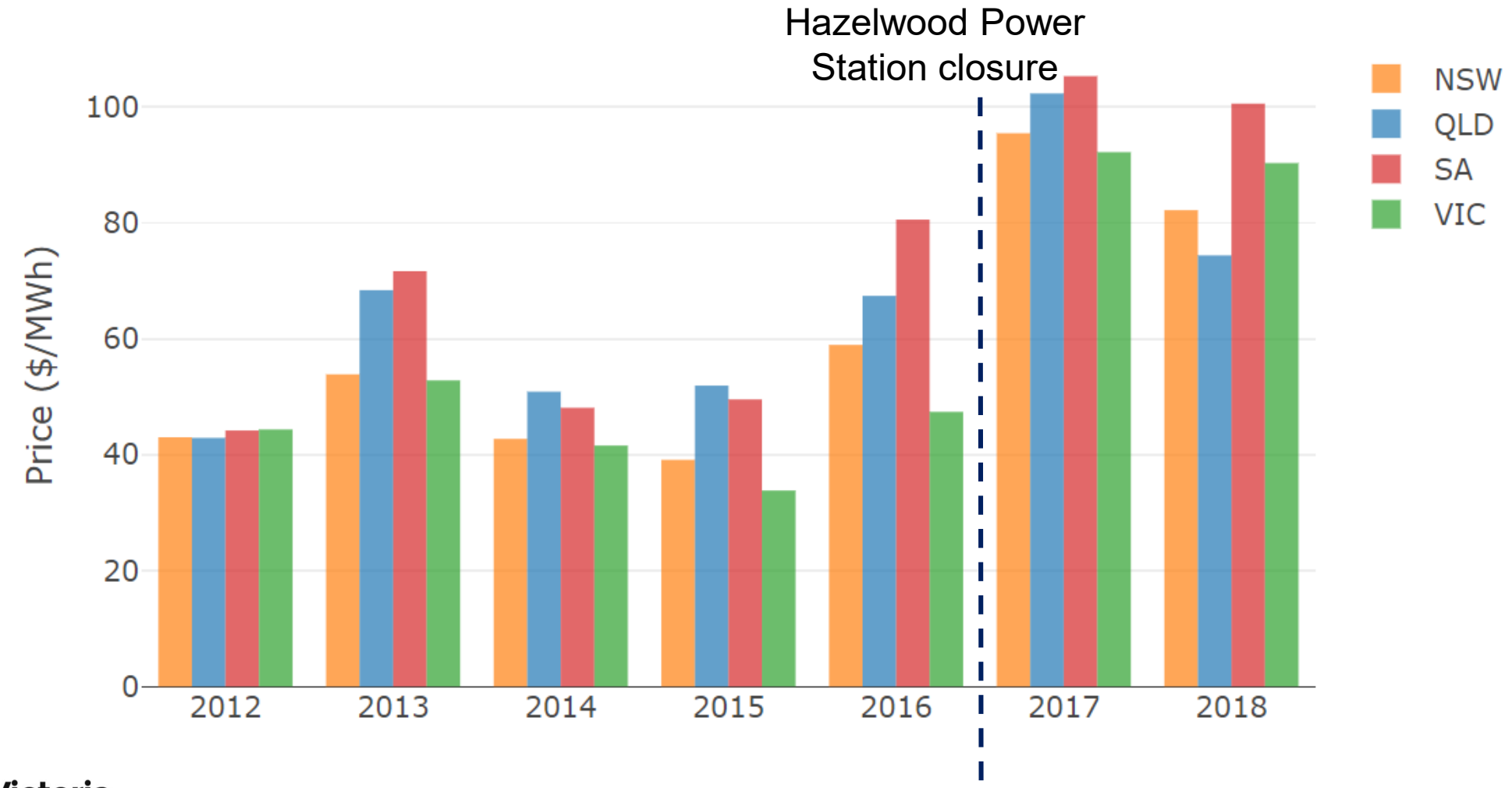
NEM-wide prices increased sharply after HW closed



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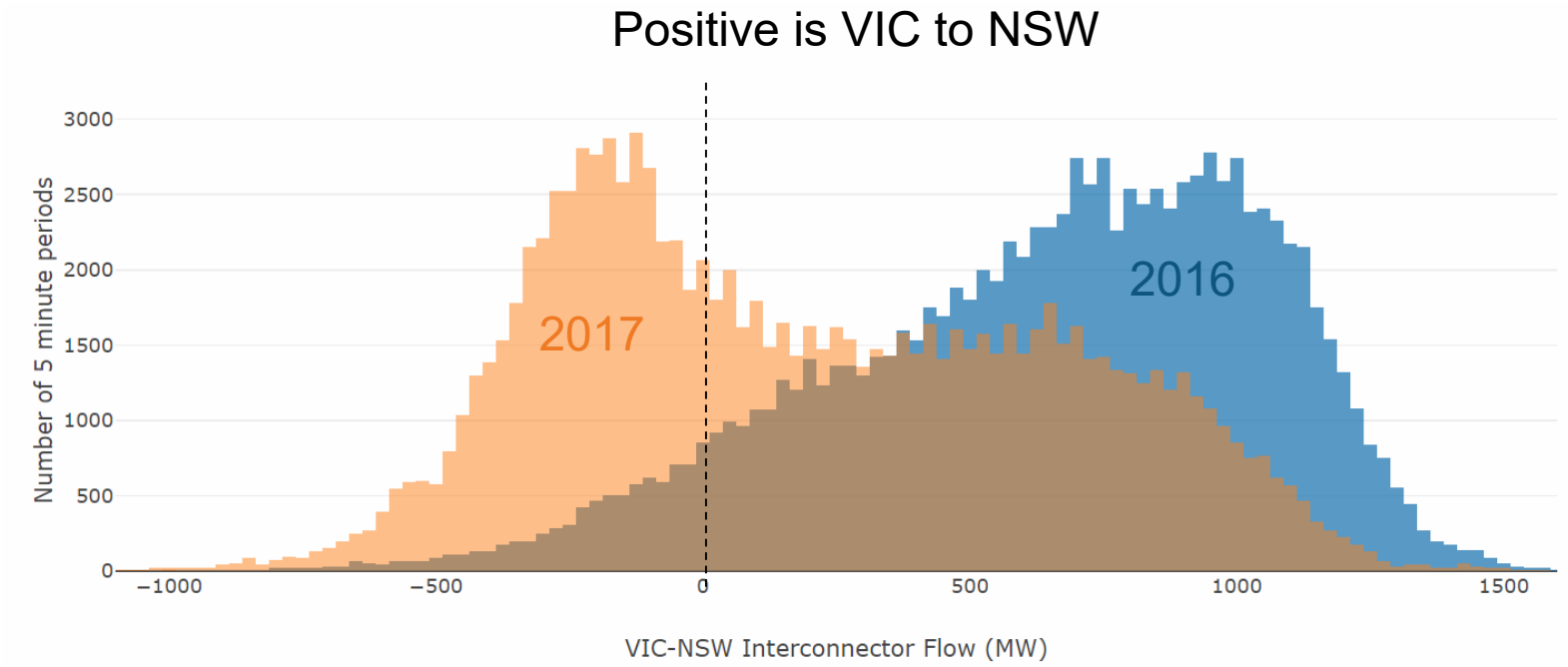
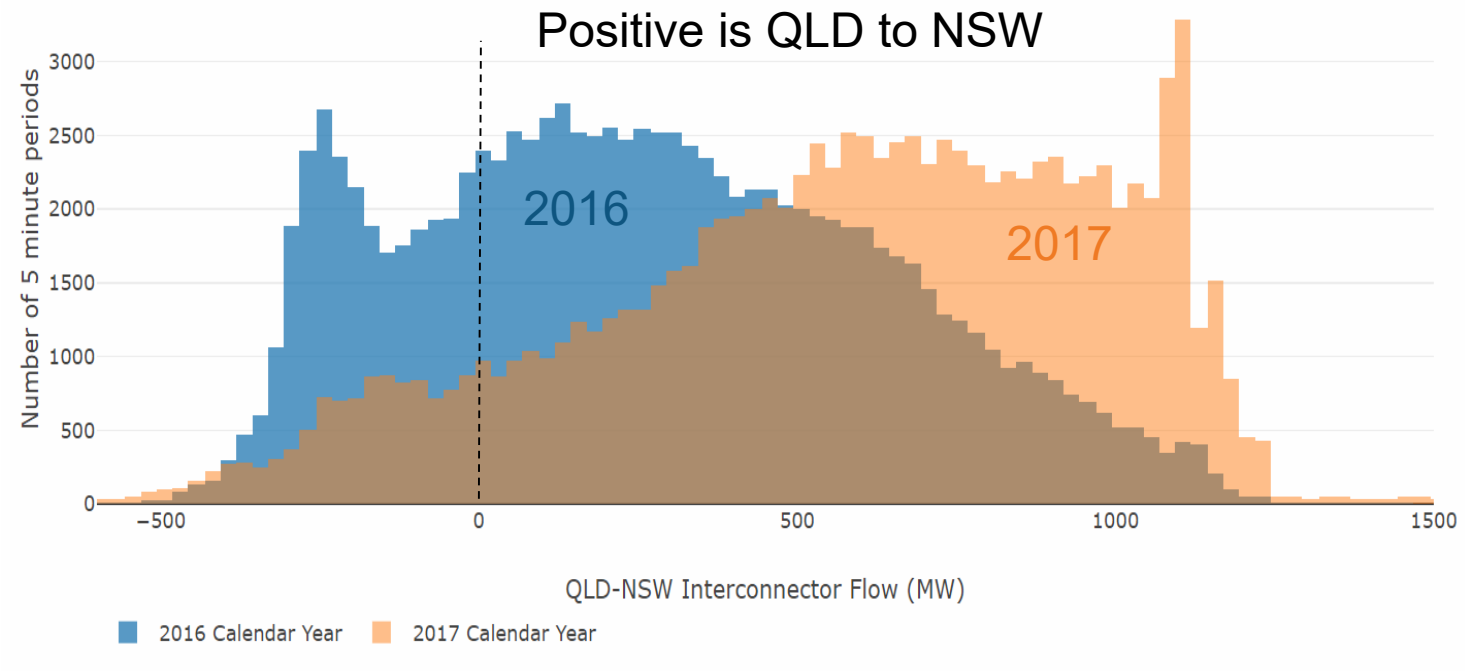
Regional Interconnectors

After Hazelwood closed NSW was frequently exporting electricity to Victoria

After Hazelwood closed NSW was more frequently importing electricity from Queensland



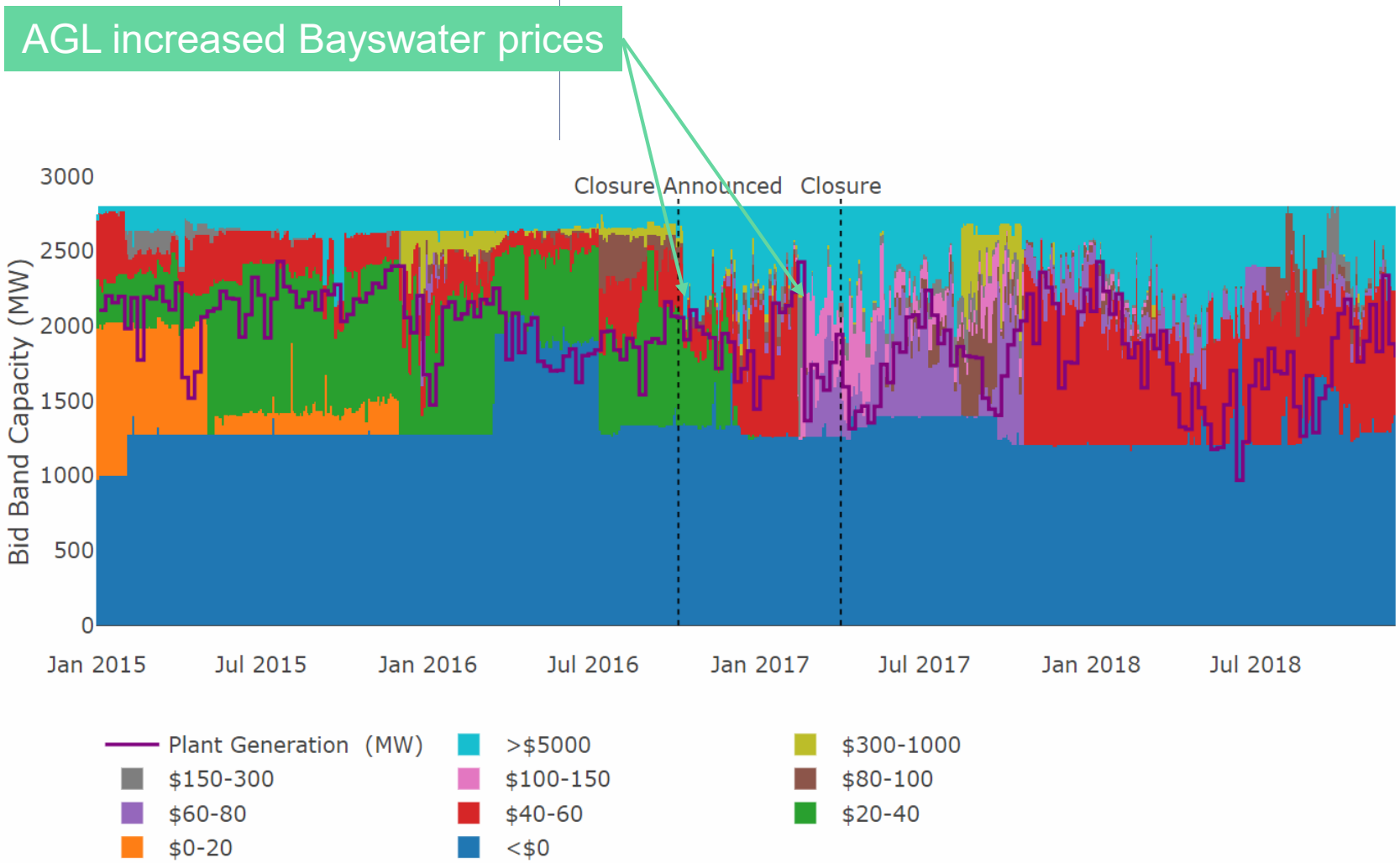


Establishing market power: our initial thoughts

- 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>>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)



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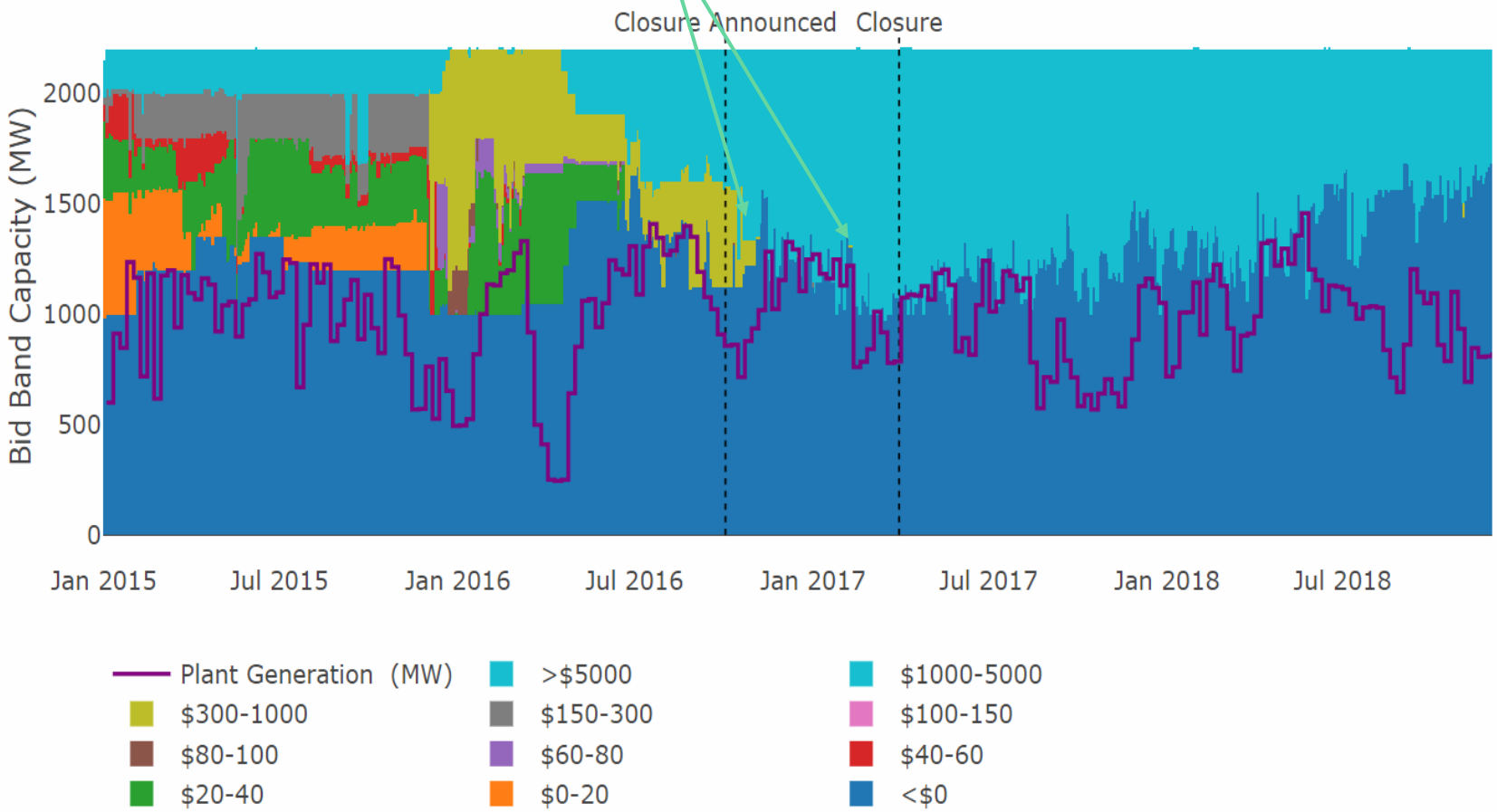
NSW

Liddell Power Station (AGL)

Coincident with Bayswater, AGL bid up Liddell's output



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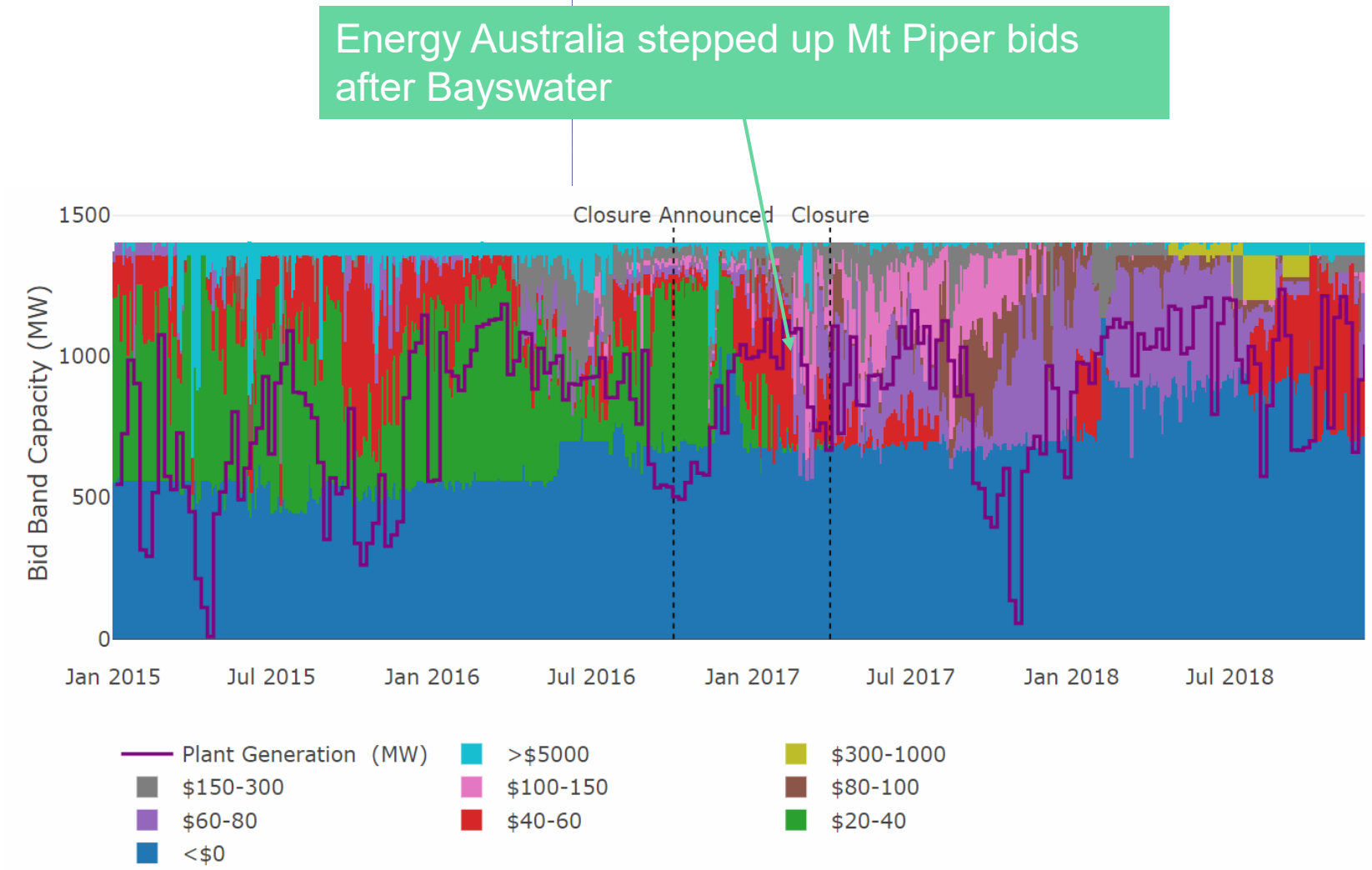
NSW Coal Generator

Mt Piper Power Station (Energy Australia)



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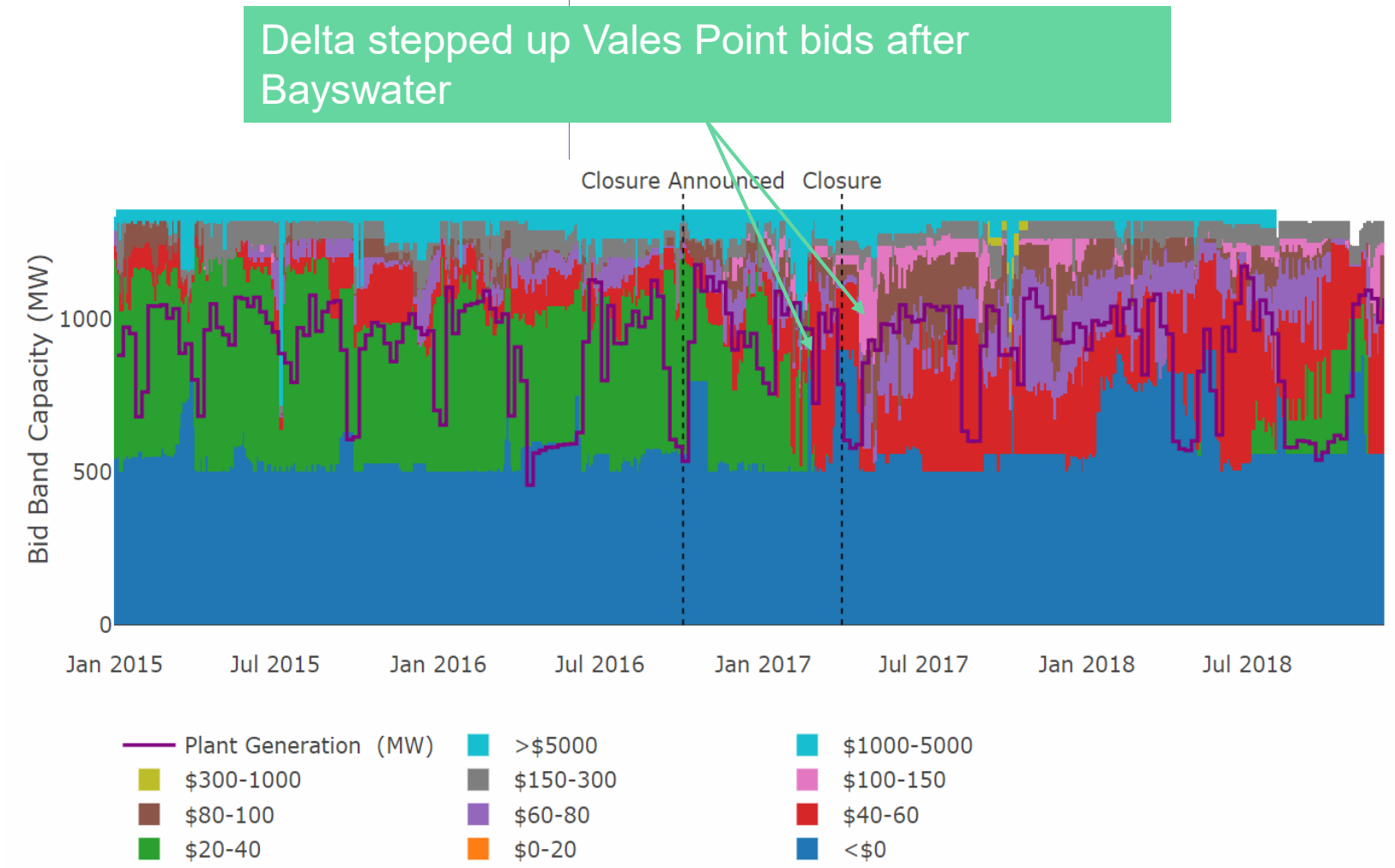
NSW

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



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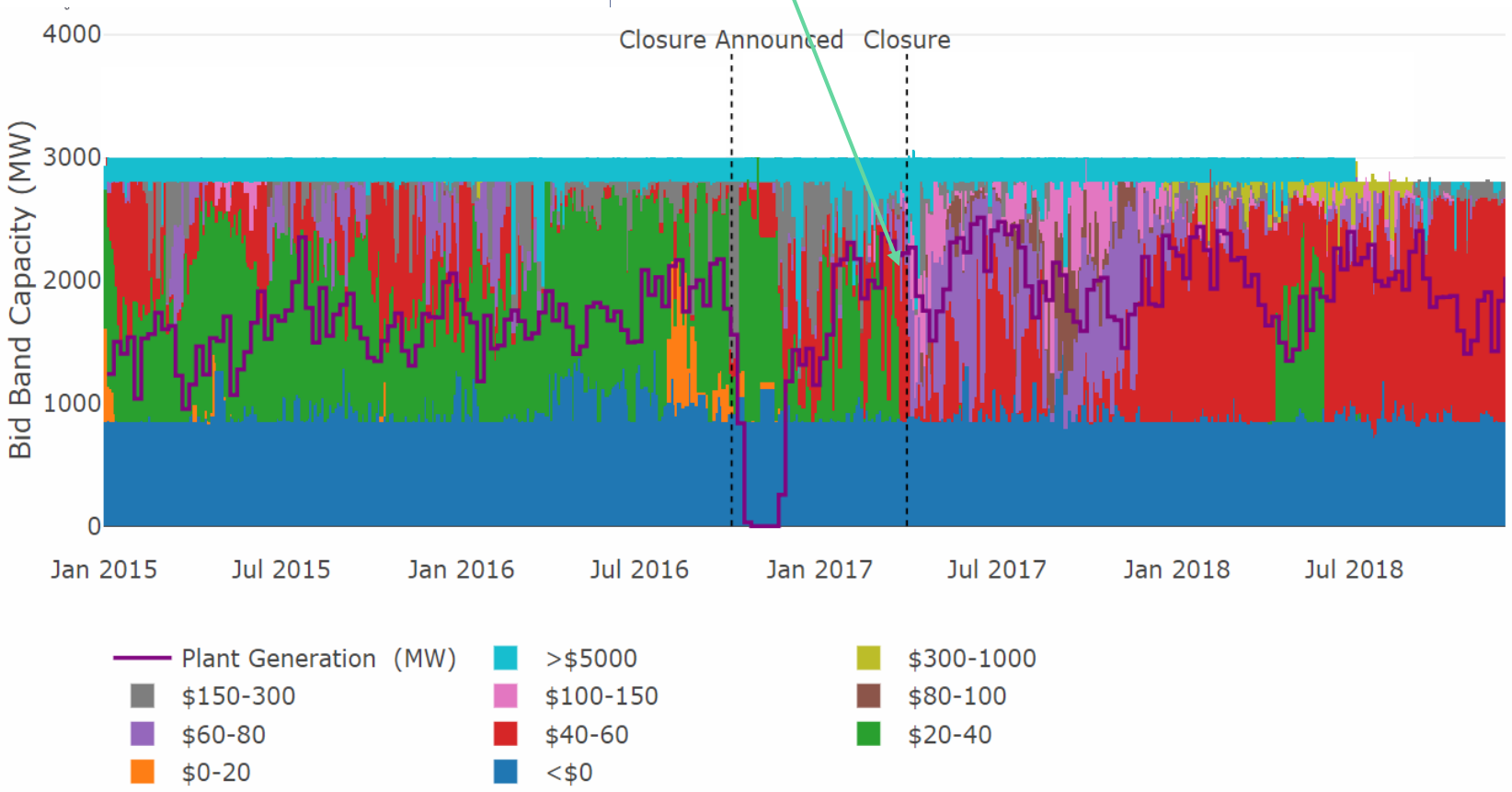
NSW Coal Generator

Eraring Power Station (Origin)

Origin stepped up Eraring's bids around the time HW closed



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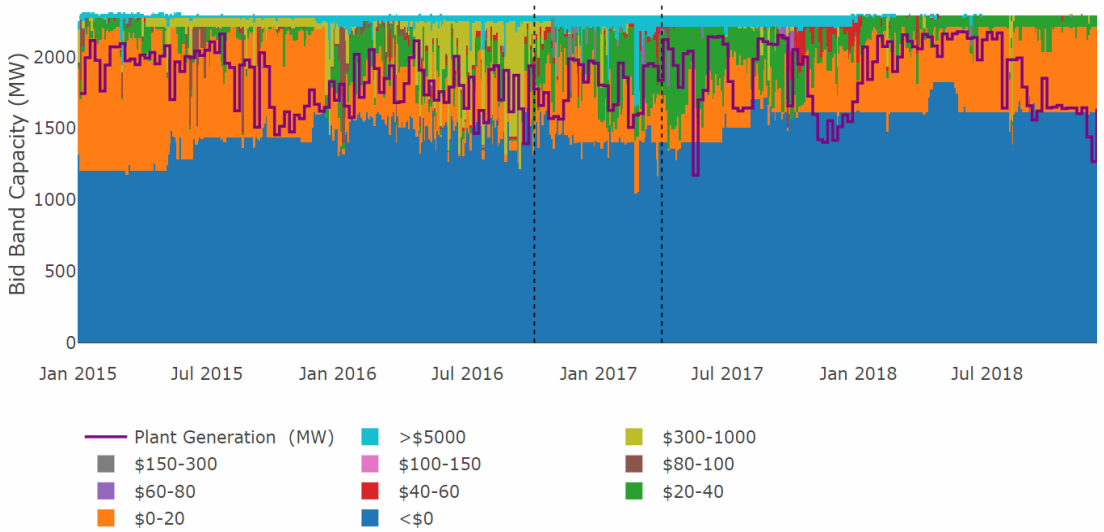
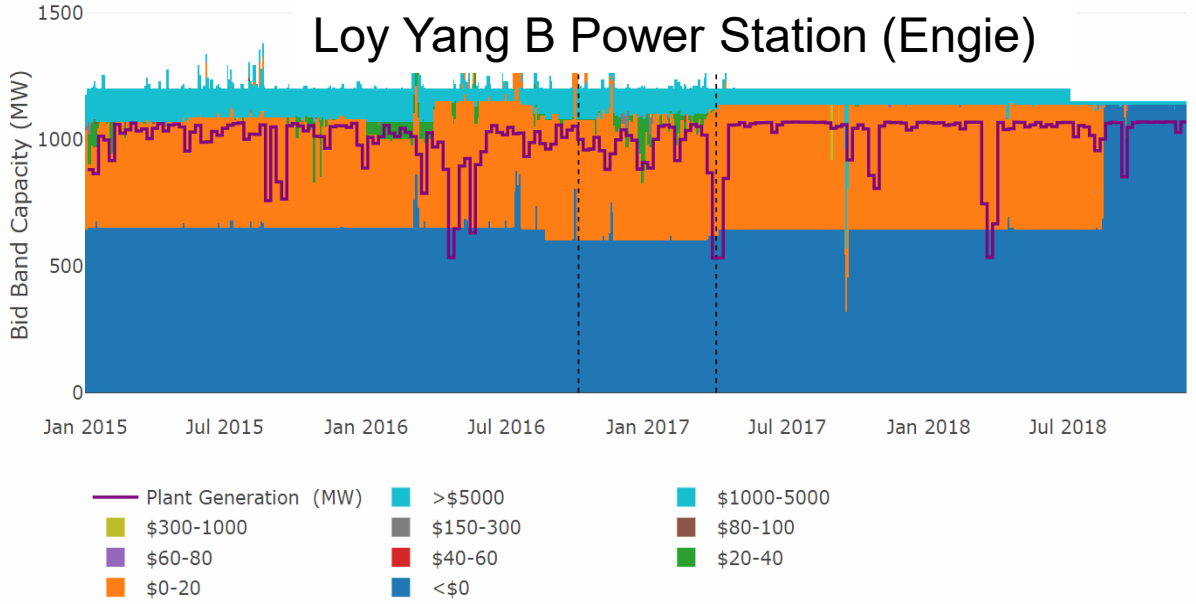
How did the Victoria generators respond?

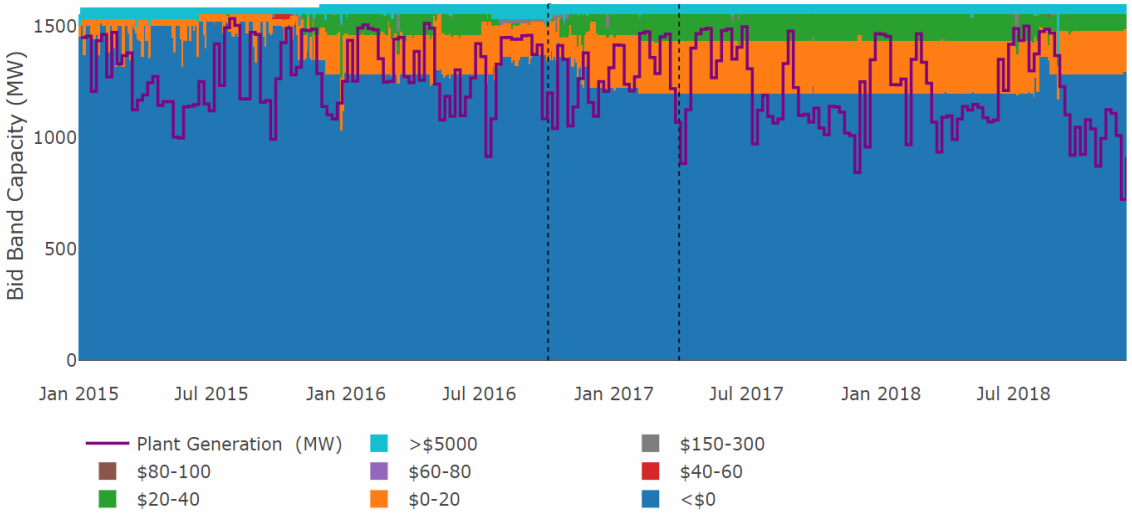
Loy Yang A Power Station (AGL)



Loy Yang B Power Station (Engie)



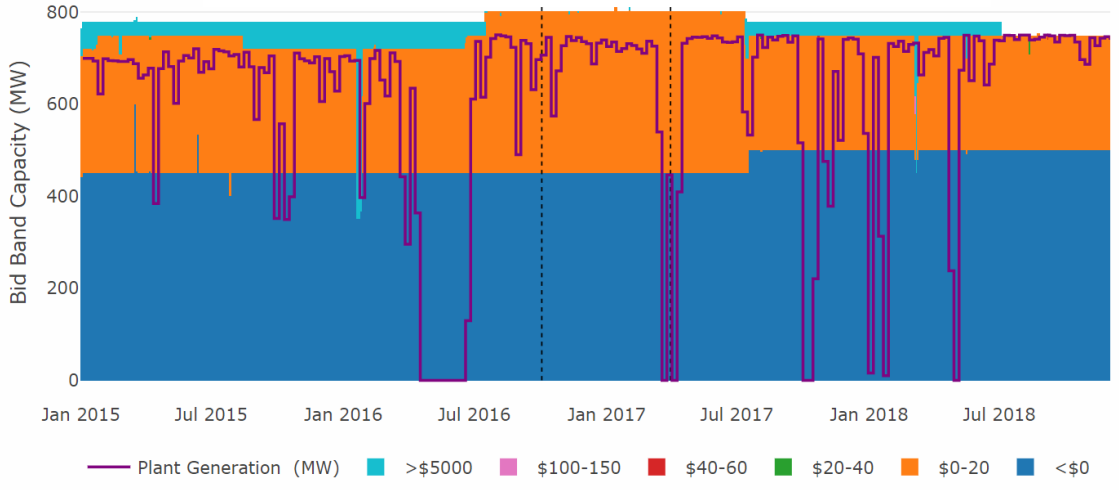
Yallourn 'W' Power Station(Energy Australia)



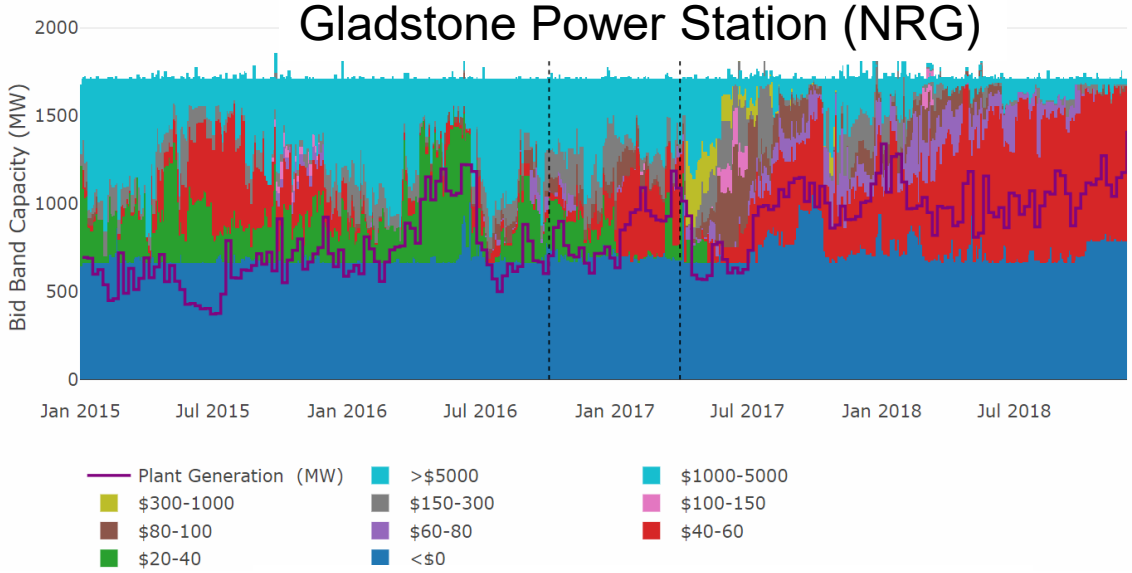
No significant change in Victoria bids

How did the Queensland generators respond?

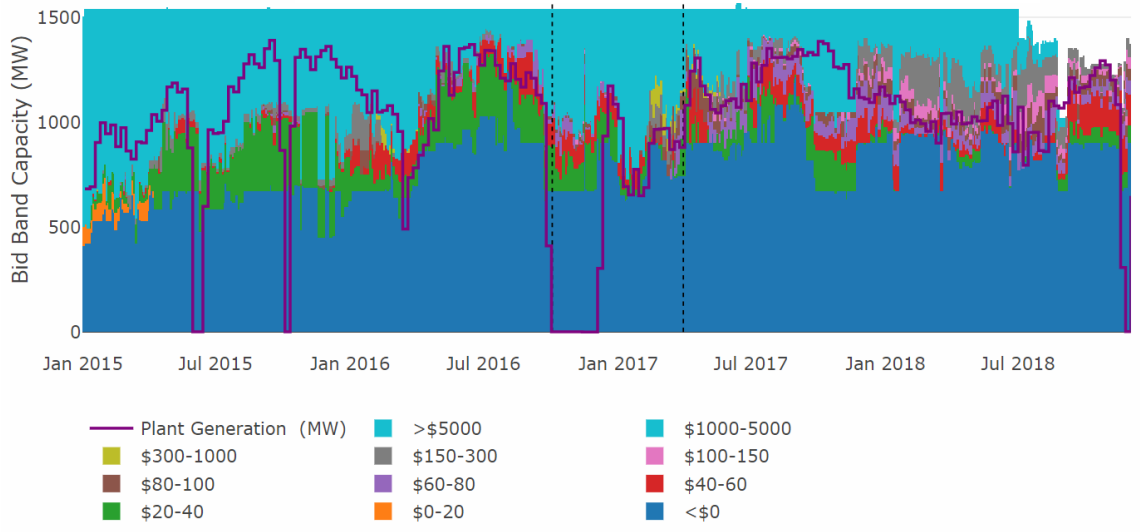
Millmerran Power Plant (InterGen)



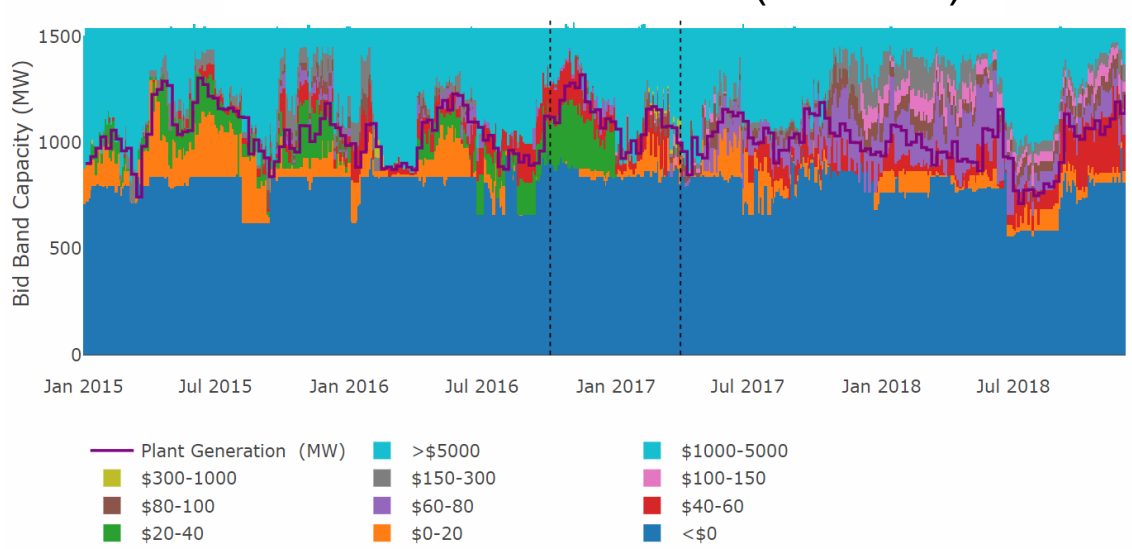
Gladstone Power Station (NRG)



Tarong Power Station (Stanwell)



Stanwell Power Station (Stanwell)

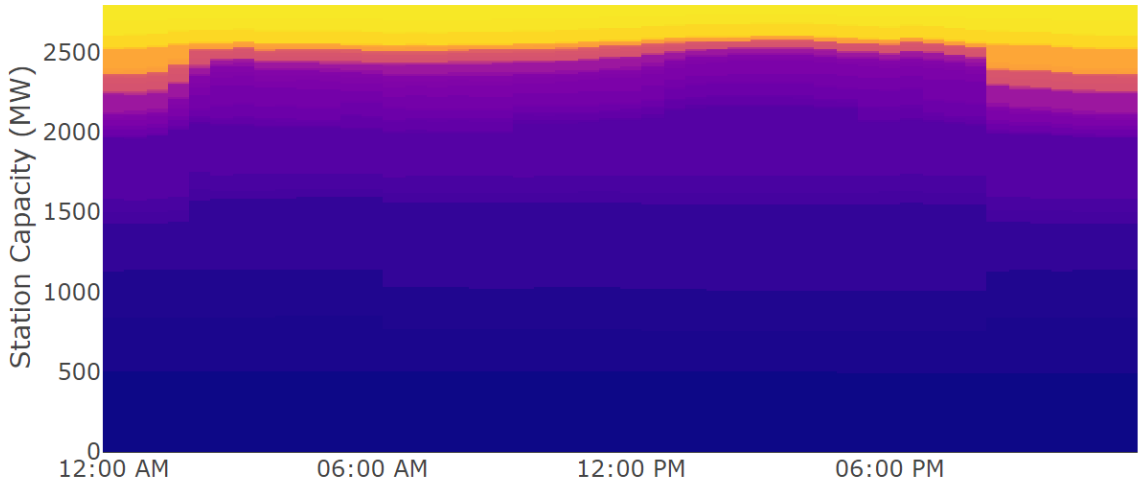


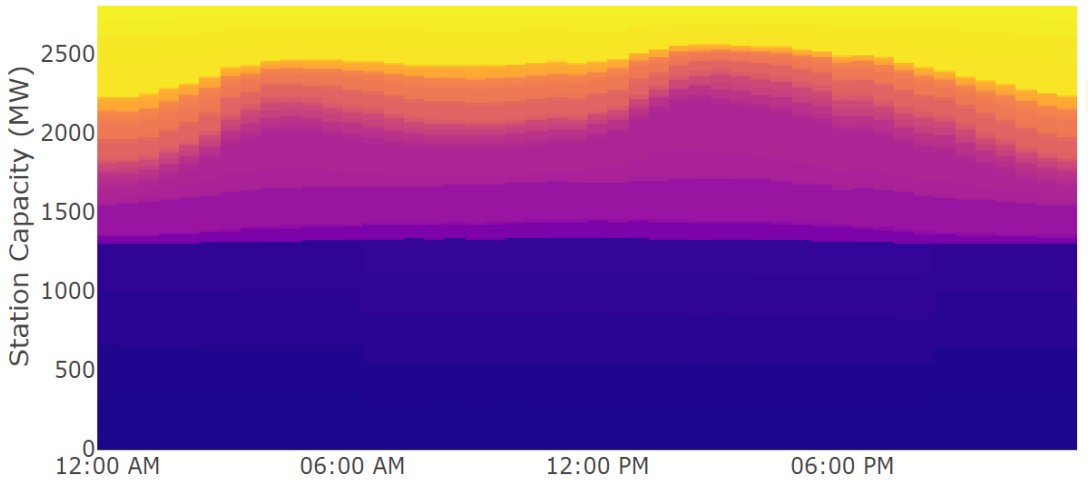
How did the average Bayswater and Liddell bids change throughout the day?

2016

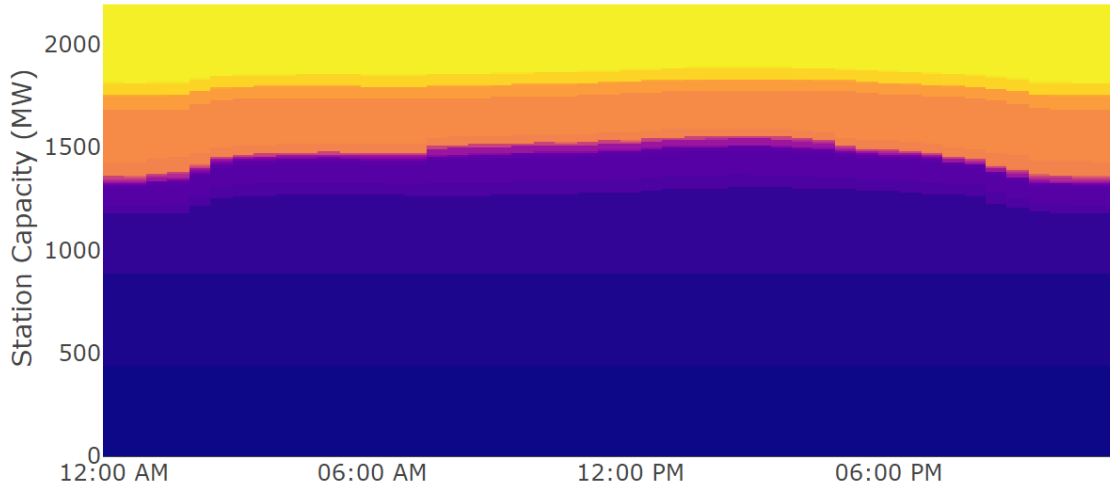
2017

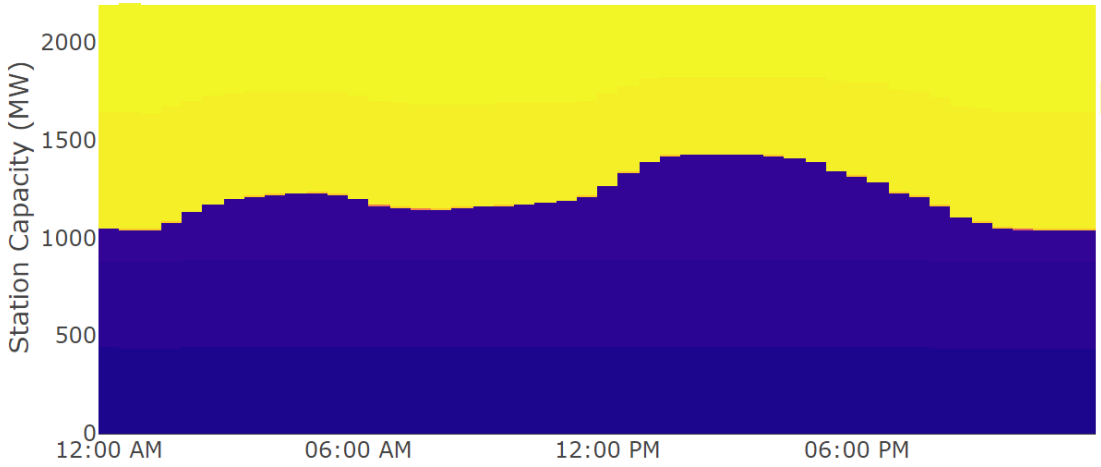
Bayswater





Liddell



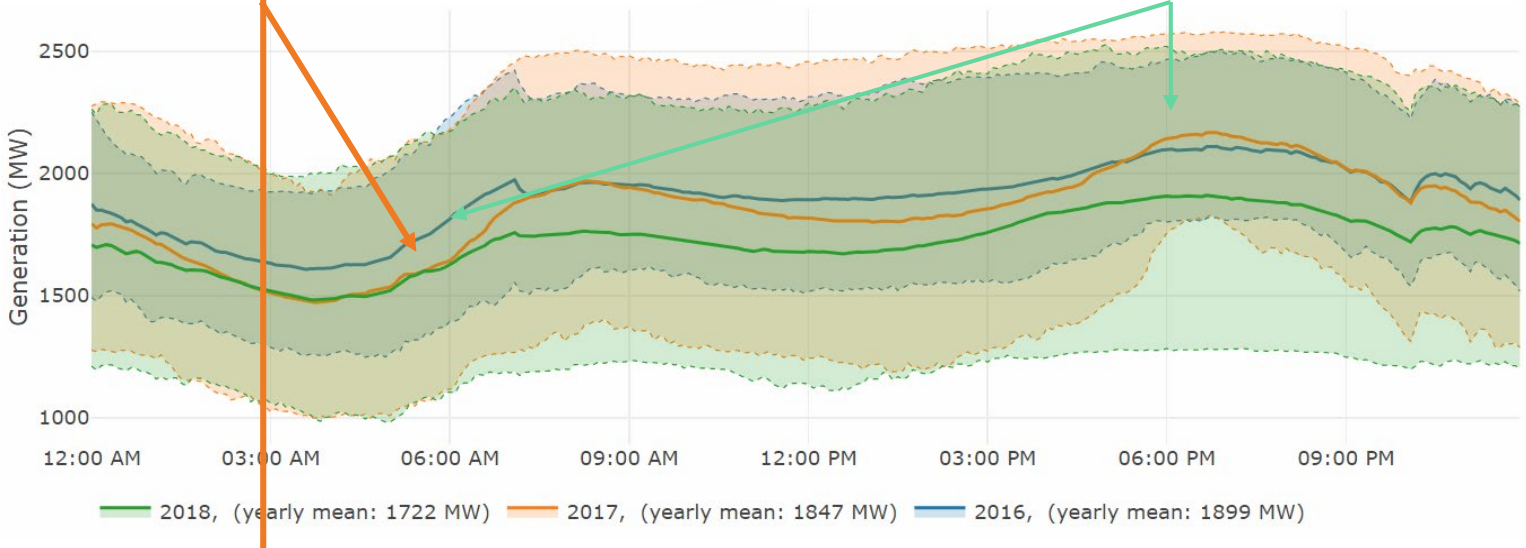


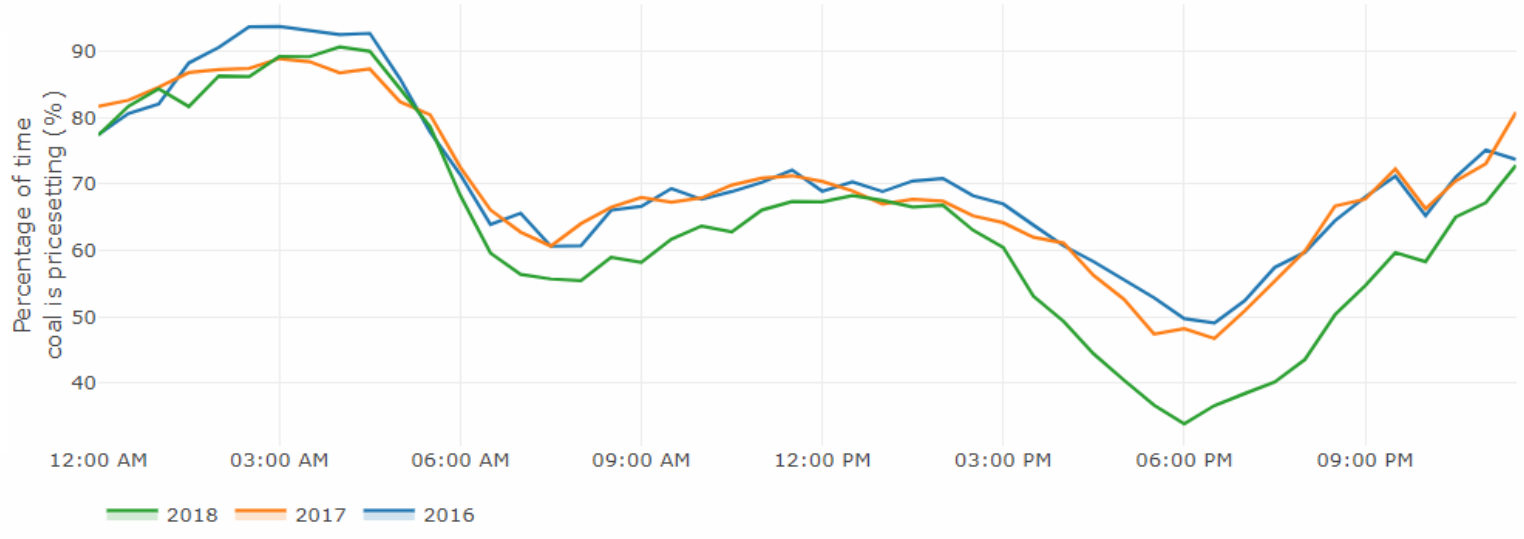
What did the average daily output of the AGL generators look like?

Reduced output after Hazelwood closed

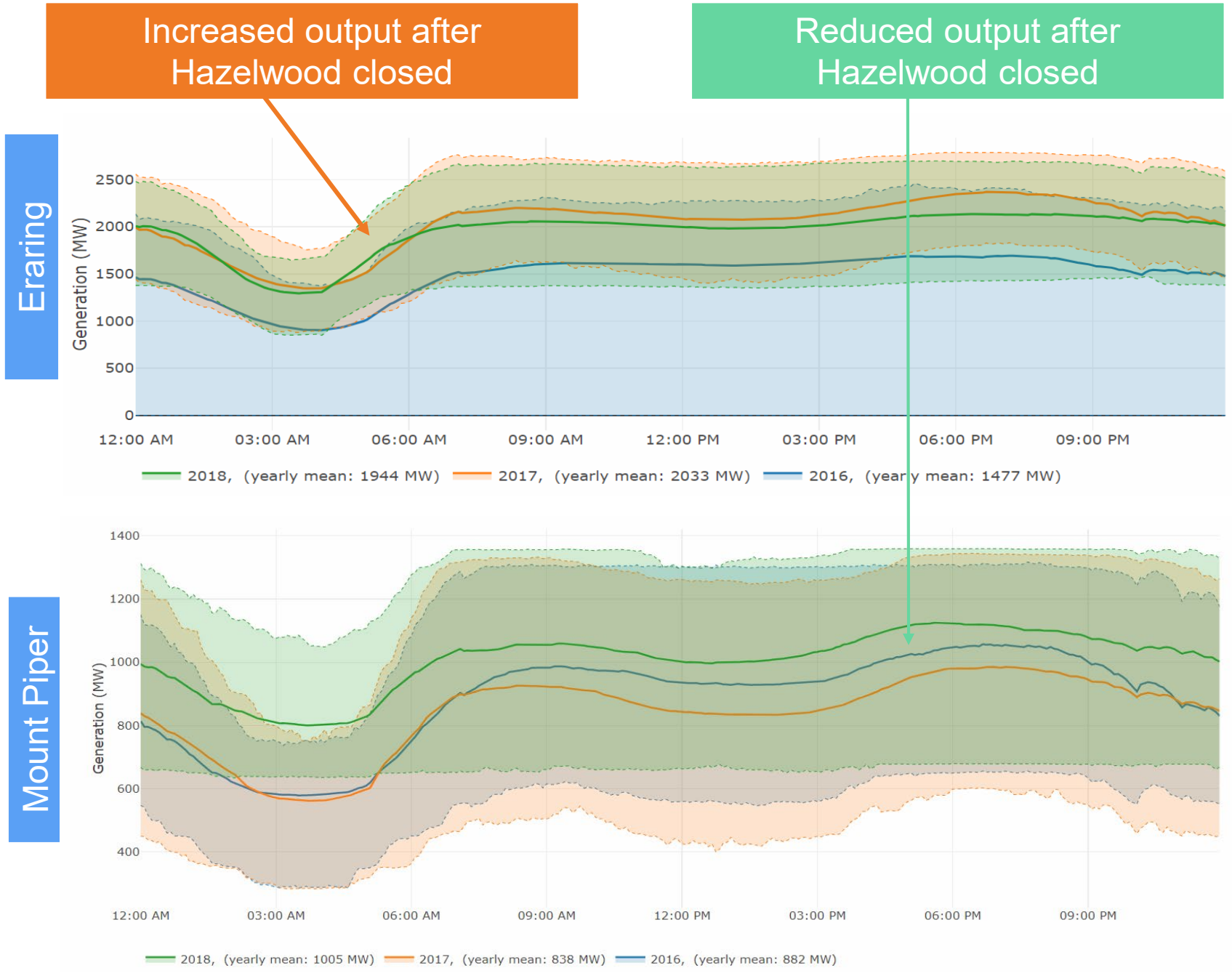
Consistent with optimal mark-up rule

Bayswater





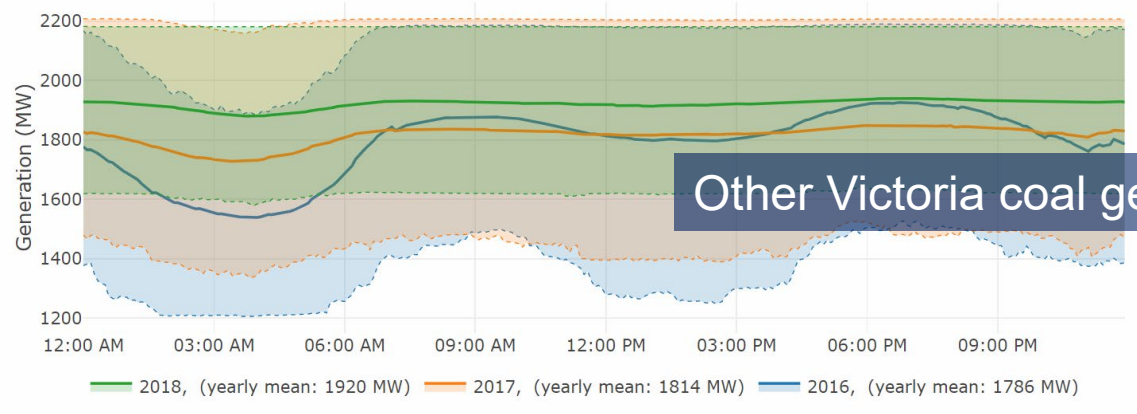
What did the daily output of the other NSW generators look like?



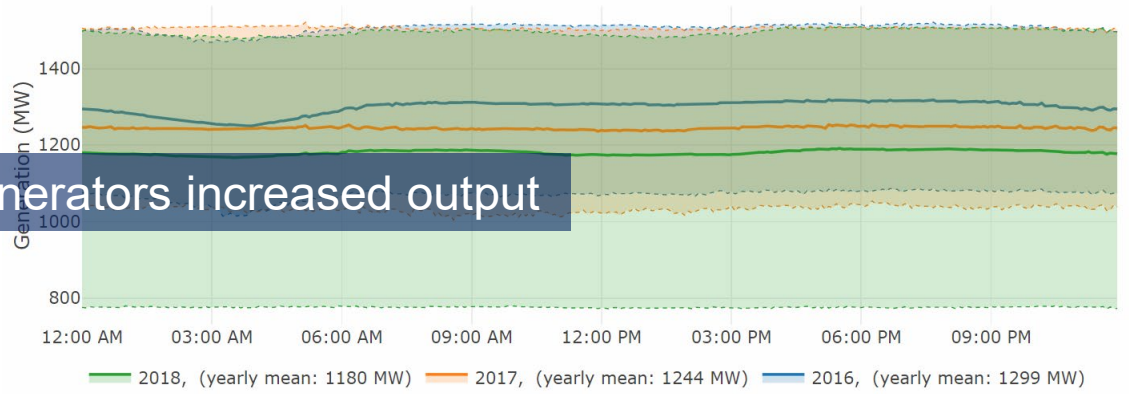
What about Victoria and Queensland?

Victoria

Loy Yang A - Increased



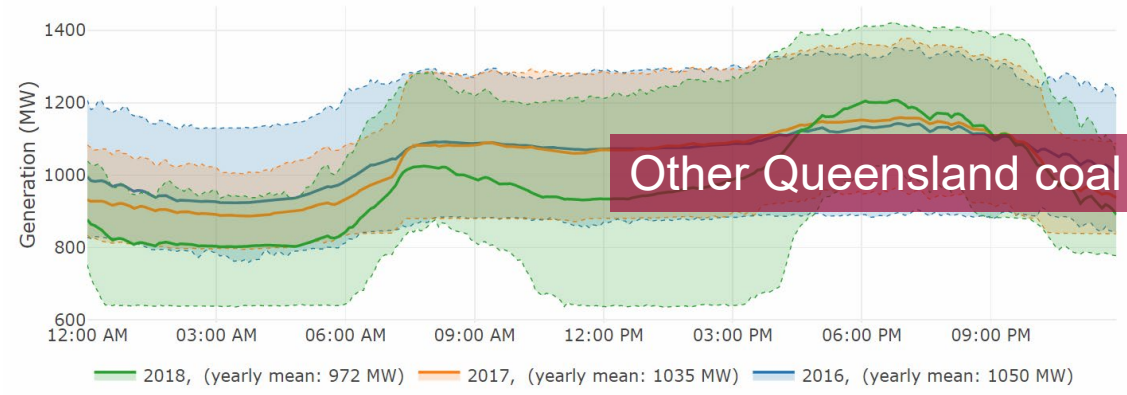
Yallourn 'W' - Reduced



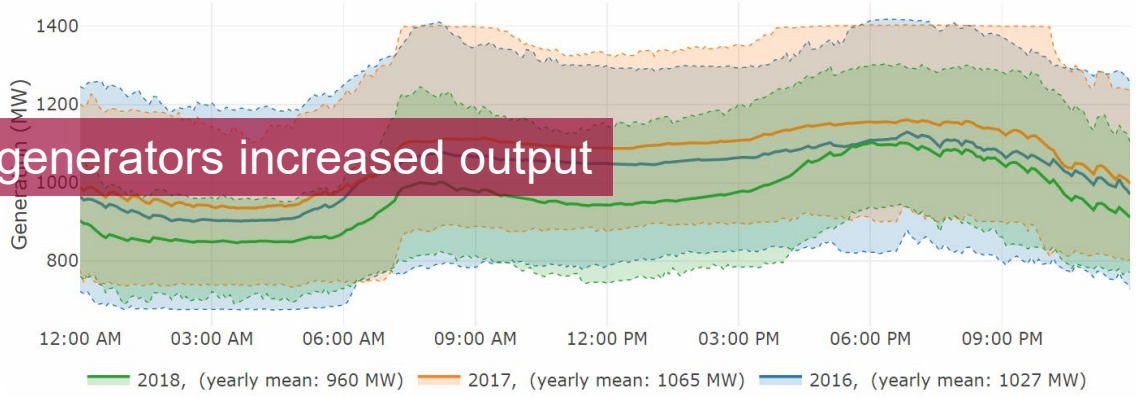
Other Victoria coal generators increased output

Queensland

Stanwell Power Station – Approx. the same



Tarong – Increased in 2017 and reduced 2018



Other Queensland coal generators increased output

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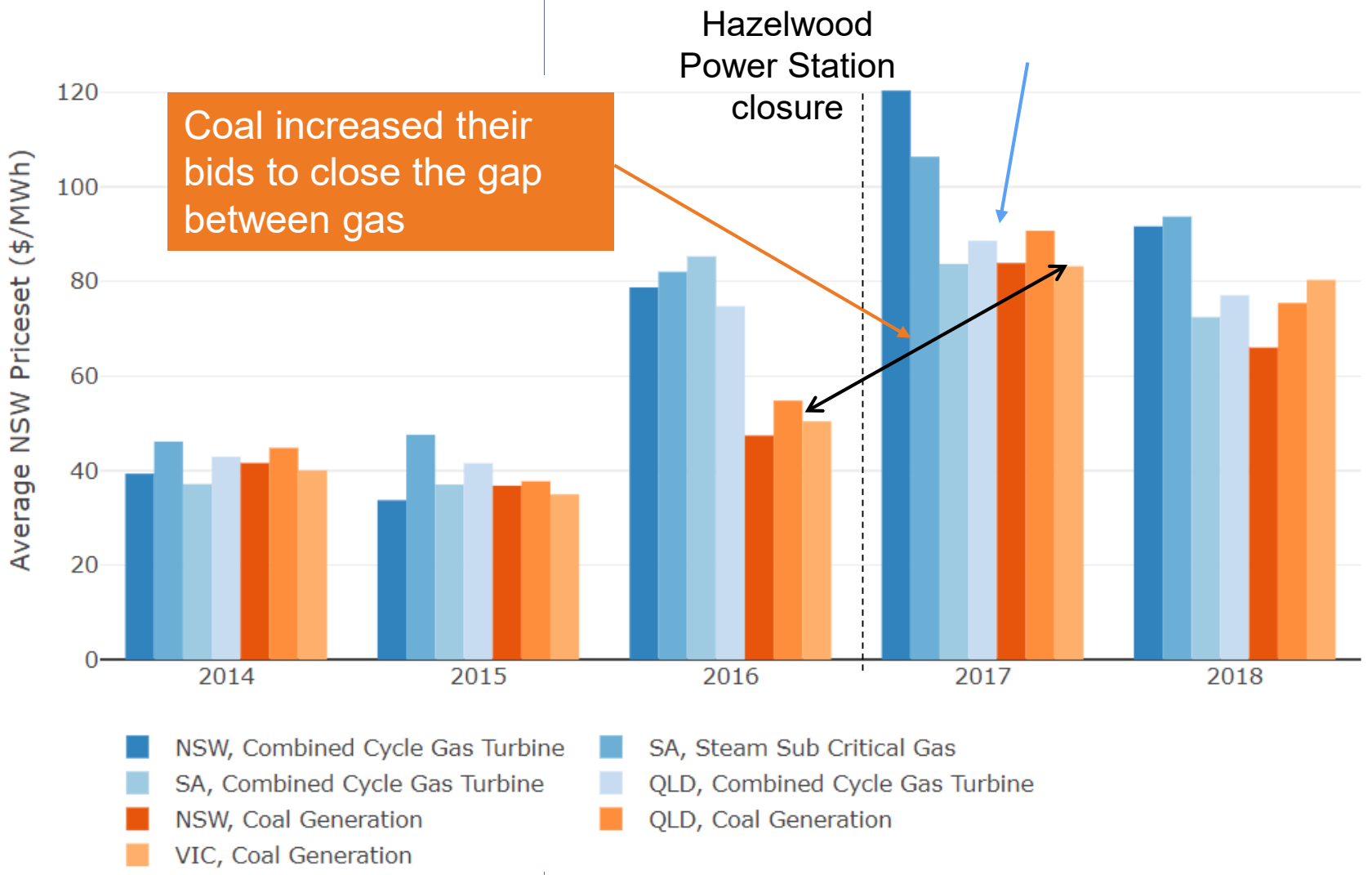
How have NSW spot prices changed when coal and gas generators set the price ?



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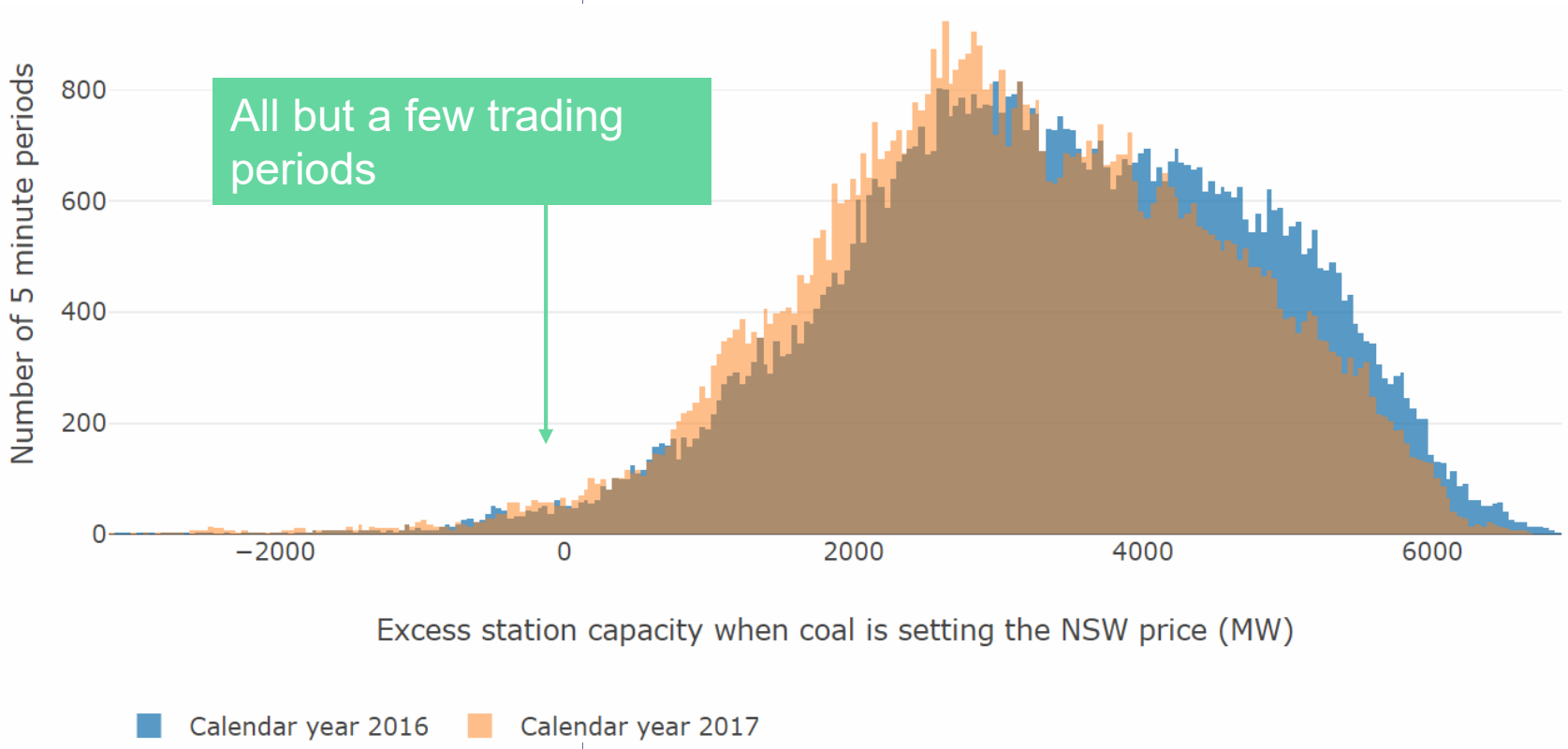
No shortage of production capacity at most times when coal setting prices



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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

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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).

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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).

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Lerner

Lerner Index = Price-Cost Mark-up$_{i,t}$

= (Price$_t$-Cost$_{i,t}$)/Price$_t$ for firm (i) and time (t)

"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.

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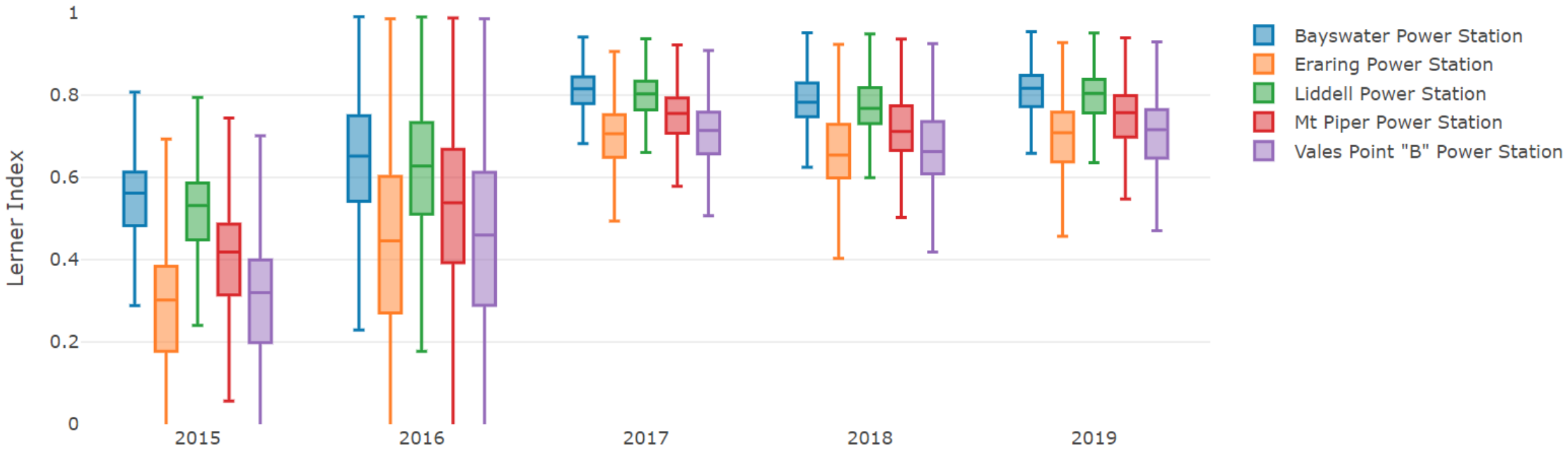
Lerner Index, NSW Coal Generators



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Residual Supply Index

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

$RSI_{i,t} = (\sum_{i=1 \text{ to } n} Production_{i,t} - Production_{i,t}) / \sum_{i=1 \text{ to } n} Production_{i,t}$ 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.

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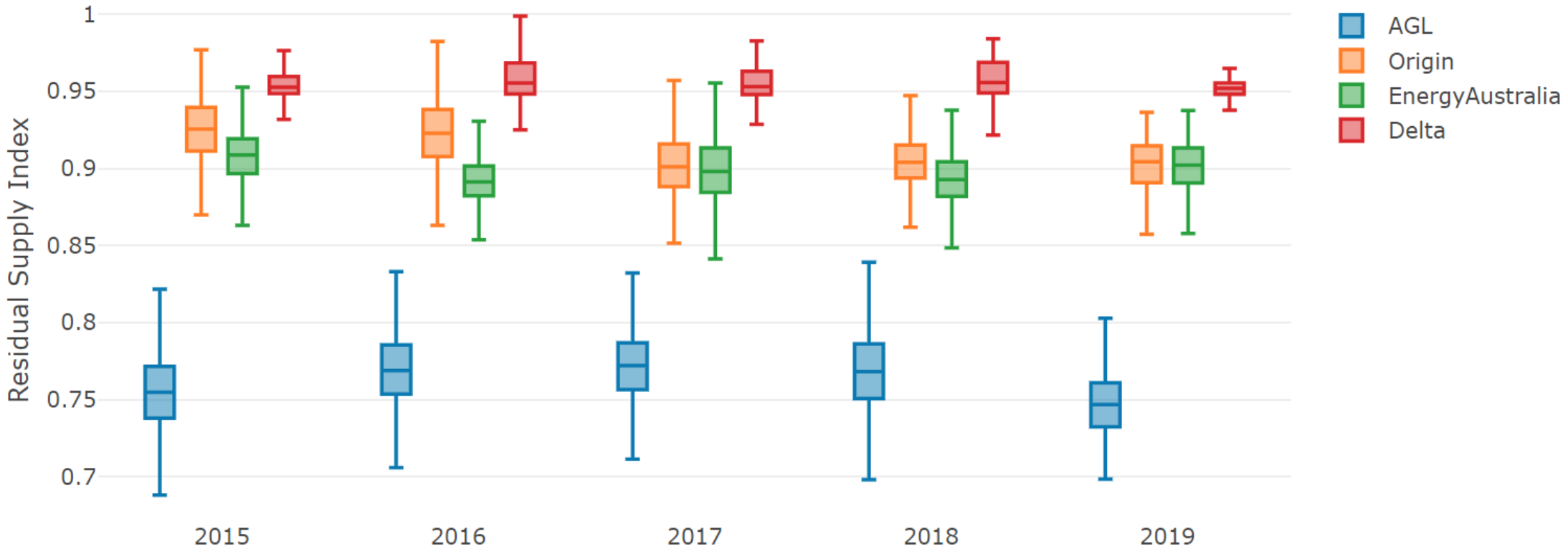
NEM wide when single NEM – Coal only



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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" ($\Delta P.(production_{i,t} - 1)$) to lost profit ($market\ price_t - avoidable\ production\ cost_{i,t}$) for firm (i) and trading interval (t).

$$RWC_{i,t} = \Delta P.(production_{i,t} - 1) / (market\ price_t - avoidable\ production\ cost_{i,t})$$

Where:

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

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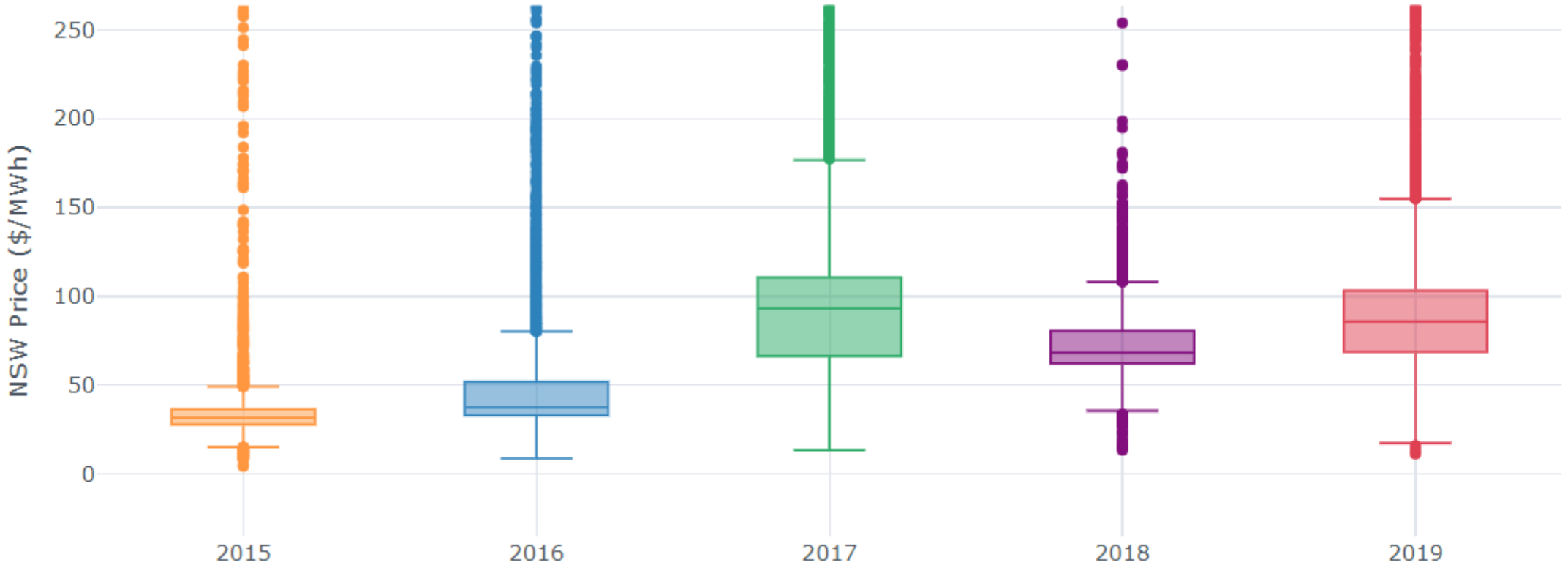
NSW Price



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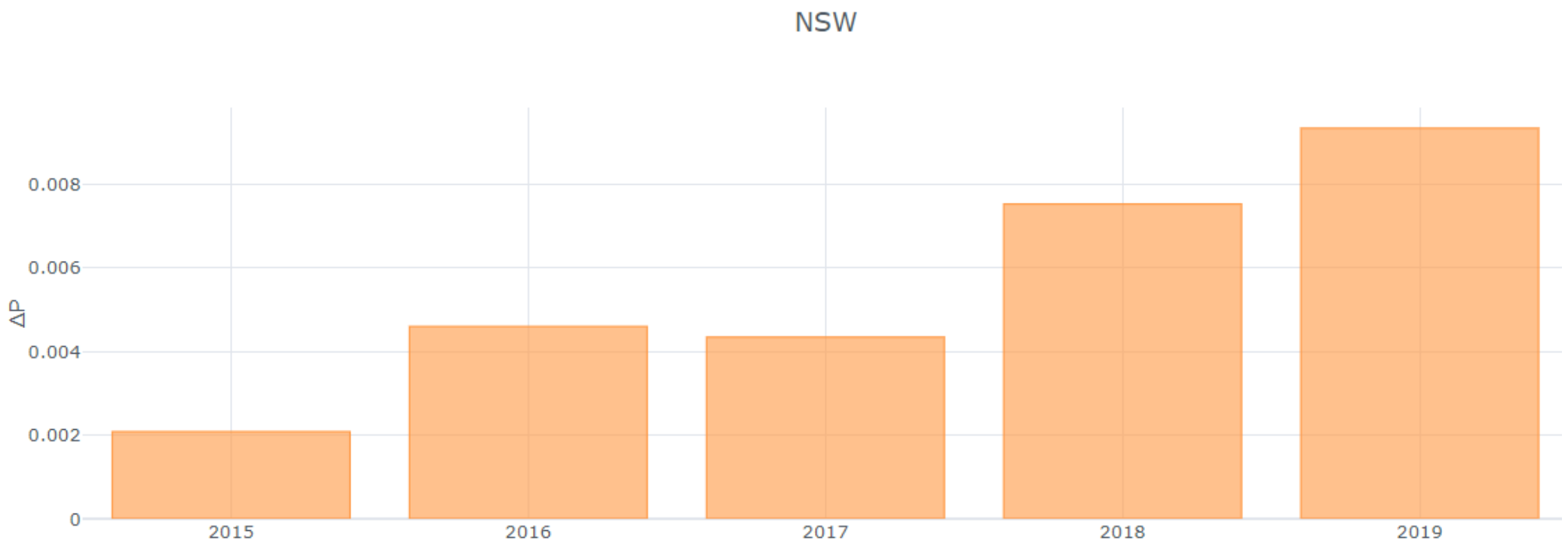
DeltaP: NSW, all dispatch intervals, controlling for gas price



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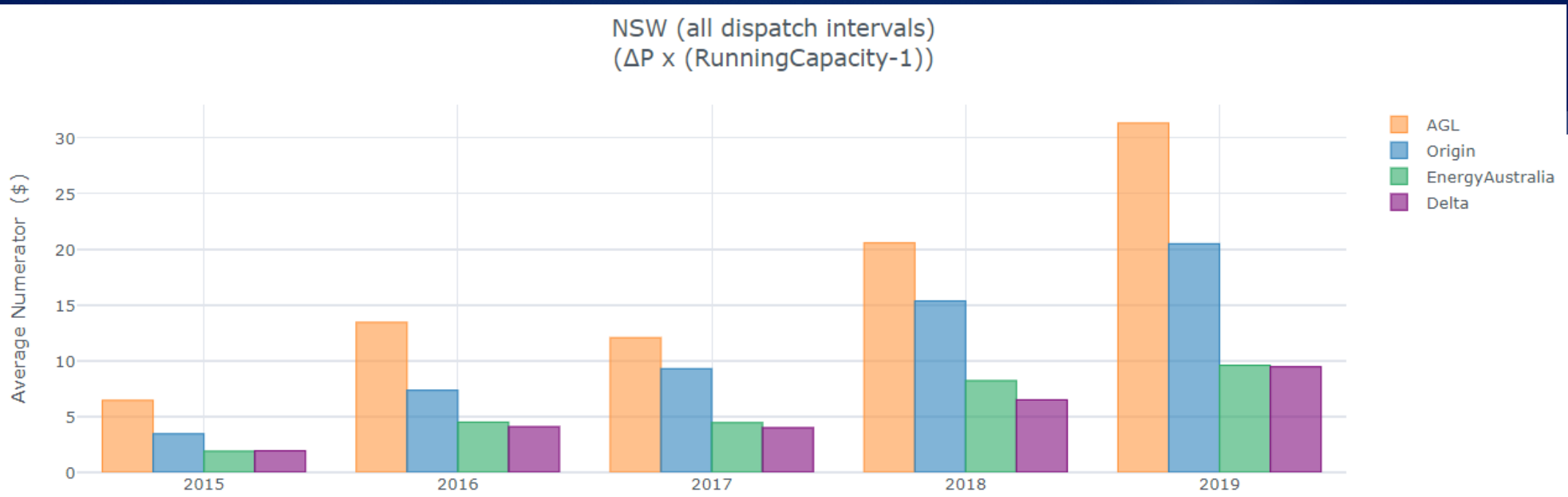
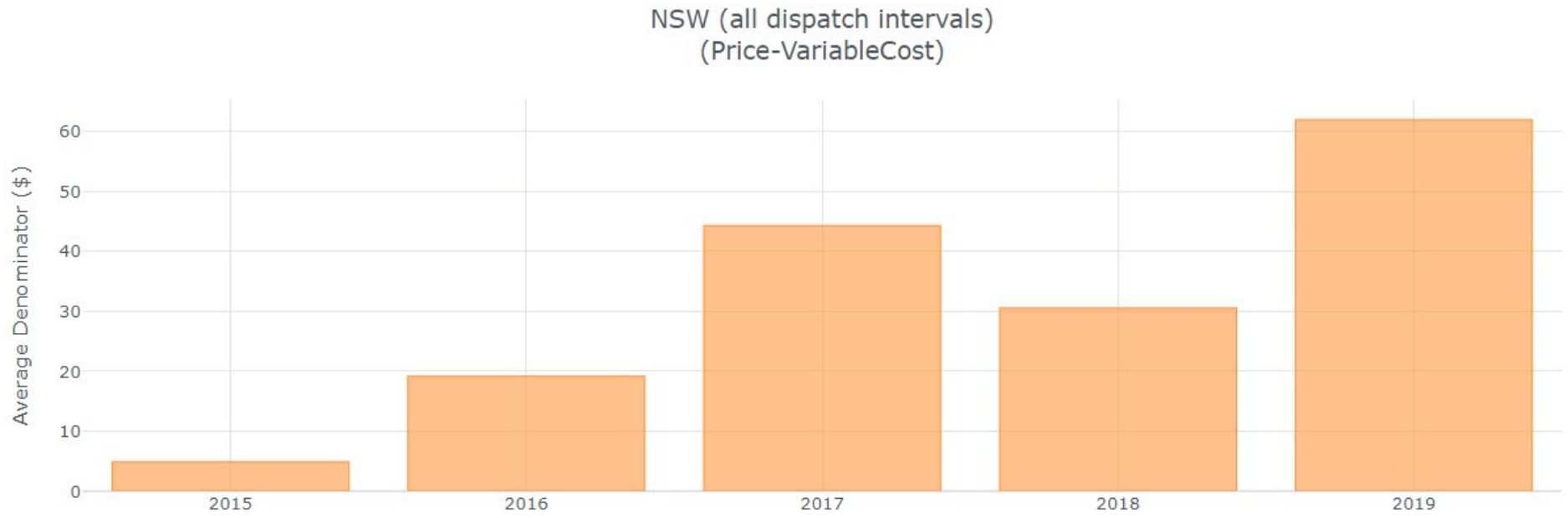

NSW (all dispatch intervals)
(ΔP x (RunningCapacity-1))
Average Numerator ($)
0
5
10
15
20
25
30
2015
2016
2017
2018
2019
AGL
Origin
EnergyAustralia
Delta


NSW (all dispatch intervals)
(Price-VariableCost)
Average Denominator ($)
0
10
20
30
40
50
60
2015
2016
2017
2018
2019

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