Electricity spot prices *above $5000/MWh*

10 August 2010
New South Wales

AUSTRALIAN ENERGY REGULATOR

Introduction

The AER is required to publish a report whenever the electricity spot price exceeds $5000/MWh.[1] The report:

- describes the significant factors contributing to the spot price exceeding $5000/MWh, including withdrawal of generation capacity and network availability;
- assesses whether rebidding contributed to the spot price exceeding $5000/MWh;
- identifies the marginal scheduled generating units; and
- identifies all units with offers for the trading interval equal to or greater than $5000/MWh and compares these dispatch offers to relevant dispatch offers in previous trading intervals.

Summary

On Tuesday 10 August 2010, the spot price in New South Wales reached $6267/MWh at 8.30 am and $5739/MWh at 9 am. These prices were significantly higher than forecast largely as a result of unforecast network congestion. This is the same congestion that has led to spot prices above $5000/MWh in New South Wales on four previous occasions since December 2009. During this time, as a result of significant changes in flows across QNI, the spot price in Queensland fell to $-488/MWh at 8.30 am and $-327/MWh at 9 am.

Over a number of rebids, Delta Electricity delayed the return to service of the Wallerawang unit seven from midnight on 9 August to 8.35 am on 10 August. The other Wallerawang unit (unit eight) was also offline. However, the return of unit seven required a network reconfiguration that caused a reduction in the rating of the Mt Piper to Wallerawang lines. The reduced capability across the Mt Piper to Wallerawang lines reduced the dispatch of low-priced generation and forced flows out of New South Wales into Victoria and Queensland. This caused the New South Wales price to reach the price cap for five dispatch intervals from 8.20 am.

In response to the high prices there appeared to be a demand side response leading to a 300 MW reduction in New South Wales demand from around 8.25 am.

Actual and forecast demand

Figure 1 compares the actual demand, available capacity and spot price in New South Wales with that forecast by AEMO 4 and 12 hours ahead of dispatch. The spot prices at 8.30 am and 9 am were significantly higher than forecast. Demand was up to 265 MW less than forecast four hours ahead (as a result of an apparent demand side response) and available capacity was up to 190 MW less than forecast four hours ahead.

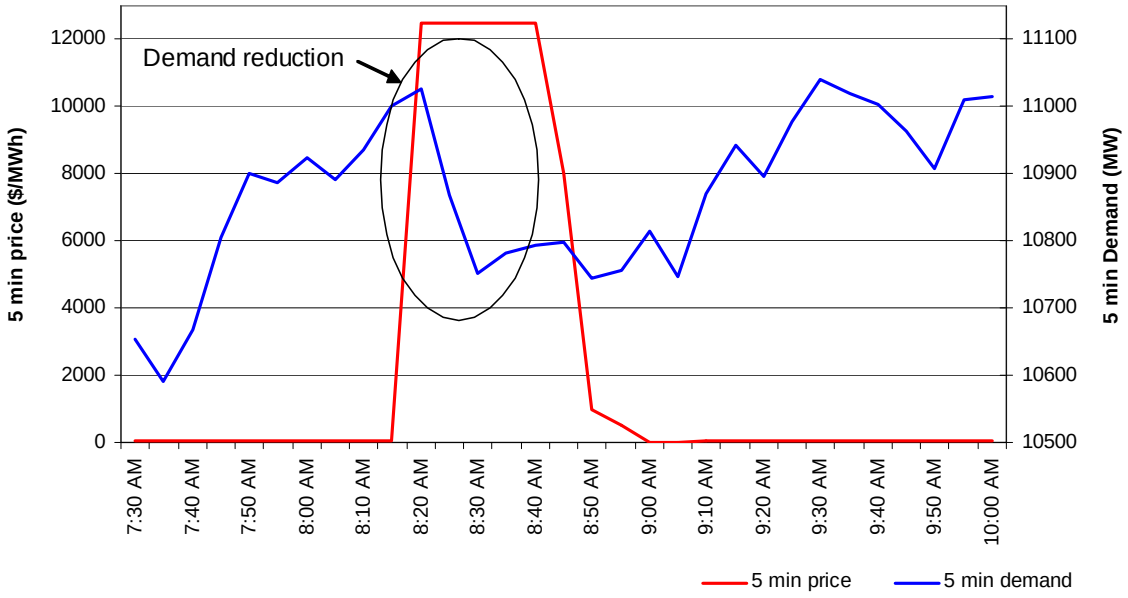
[1] This requirement is set out in clause 3.13.7 (d) of the National Electricity Rules.

Figure 1: Actual and forecast demand, spot price and available capacity

Tuesday 8.30 am	**Actual**	**4 hr forecast**	**12 hr forecast**
Demand (MW)	10 912	11 115	11 130
Spot Price ($MW/h)	6267	51	53
Available capacity (MW)	13 666	13 856	13 856
Tuesday 9.00 am	**Actual**	**4 hr forecast**	**12 hr forecast**
Demand (MW)	10 782	11 047	11 069
Spot Price ($MW/h)	5739	34	33
Available capacity (MW)	13 810	13 856	13 856

Figure 2 shows price and demand graphically on a five-minute resolution, and highlights the apparent demand side response.

Figure 2: Five-minute price and demand



The 5-minute price reached $12 500/MWh at 8.20 am and remained at that level until 8.40 am. The 5-minute price then fell to $8035/MWh at 8.45 am, $970/MWh at 8.50 am, $510/MWh at 8.55 am and to below $19/MWh at 9 am.

An apparent demand side response saw demand fall from 11 025 MW at 8.20 am to 10 750 MW at 8.30 am. Consequently, demand for the 8.30 am and 9 am trading intervals was lower than forecast four hours ahead.

Generator offers and rebidding

Both Wallerawang units were offline on the day. Wallerawang unit seven had been scheduled to return to service from a three day outage at midnight on 9 August. However, at 4.47 pm on 9 August, Delta Electricity delayed the return to service of Wallerawang unit seven to 6.30 am on 10 August. The ramp up rate was also decreased from 3 MW/min to as low as zero for the period up to 10 am. The reason given was "1646P Return to service – ET2.5 hours:: capacity limit & ROC change".[2]

[2] Note that Wallerawang unit eight was out of service on the day. Since December 2009 congestion on the Mt Piper to Wallerawang lines leading to spot prices above $5000/MWh has occurred on four other occasions – 7 and 17 December and 4 and 22 February. On each other occasion there was one Wallerawang unit in service and demand was considerably higher than on 10 August.

Over two further rebids, at 6.25 am and 8.14 am, Delta Electricity again delayed the return of Wallerawang unit seven to service until 8.35 am and reduced the unit's ramp up rate from 1 MW/min to zero for the 9.30 am to noon trading intervals. The reason given was "0625P Return to service:: Capacity limit/ROC change" and "0814P Delayed RTO – 0.5hrs:: capacity limit /ROC change".[3]

At 8.15 am, following the reduction in rating of the Mt Piper to Wallerawang line (discussed further in the "Transmission constraints" section) the 5-minute forecast price for the New South Wales region increased from less than $35/MWh to the price cap for the period from 8.20 am onwards. At 8.17 am, Snowy Hydro rebid 1382 MW across Tumut Three and Upper Tumut from prices above $285/MWh down to prices close to the floor price. The reason given was "08:15: prices higher than prev fcast NSW Voll". At 8.22 am, Snowy Hydro rebid the ramp down rate at Tumut Three and Upper Tumut from 200 MW/min and 130 MW/min, respectively, to the minimum allowable level of 3 MW/min. The reason given was "08:25:A:Voll prices unforecast prev fcast $33".

There was no other significant rebidding.

The generators involved in setting the price during the high-price period, and how that price was determined by the market systems is detailed in **Appendix A**.

The closing bids for all participants in New South Wales with capacity priced at or above $5000/MWh for the 12 pm trading interval are presented in **Appendix B**.

Transmission constraints

On the day there was a planned outage of the Mt Piper to Marulan line. The outage, which commenced four days earlier on 6 August was completed on 15 August. The constraint equation N>>N-MNMP_ONE_1 was invoked to managed the flows across the Mt Piper to Wallerawang lines as a result of the outage.

Also on the day Wallerawang unit seven was returning to service from a three day outage. This required a network reconfiguration that reduced the ratings of the Mt Piper to Wallerawang lines[4]. The lower capability took effect from 8.20 am, which caused a combined 7000 MW step change in the limit for flows across all New South Wales interconnectors, as shown in Figure 4. This resulted in the New South Wales region changing from importing to exporting electricity. The N>>N-MNMP_ONE _1 outage constraint and the N>>N-NIL_PRE36__S system normal constraint violated from 8.20 am to 8.35 am. The lower capability across the Mt Piper to Wallerawang lines also required reduced output from a number of low priced generators, which is discussed further below. The significant shock to dispatch caused the price to increase from $33/MWh at 8.15 am to the price cap at 8.20 am.

[3] Clause 3.8.3A (b) of the Electricity Rules states that Scheduled Generators must provide a 'ramp up rate' to AEMO of at least the lower of 3 MW per minute or three per cent of the full capacity of the Scheduled unit. The provisions require that, where a relevant participant submits a ramp rate this is less than the prescribed minimum, the participant must provide a ramp rate that is the maximum the relevant generating unit can safely attain at the time. Refer to the AER Rebidding and Technical Parameter Guideline for more information at www.aer.gov.au. This rebid is in line with the guidelines.

[4] From late February 2010, Transgrid has put in place special arrangements to increase the ratings of the Mt Piper to Wallerawang lines. This allows for the lines to operate at a higher rating of 1430 MVA, previously the rating was 1097 MVA. The return of Wallerawang unit 7 required the lower ratings to be reinstated.

Figure 3 compares combined (30 minute average) import limits into New South Wales across the Terranora, QNI and the Vic-NSW interconnectors with that forecast 4 and 12 hours ahead. It shows that the New South Wales region went from importing at 8 am, to exporting at 8.30 am and 9 am. Import capability was restored again from 9.30 am, with the increase in Mt Piper to Wallerawang network capability at 8.55 am, which is discussed further below.

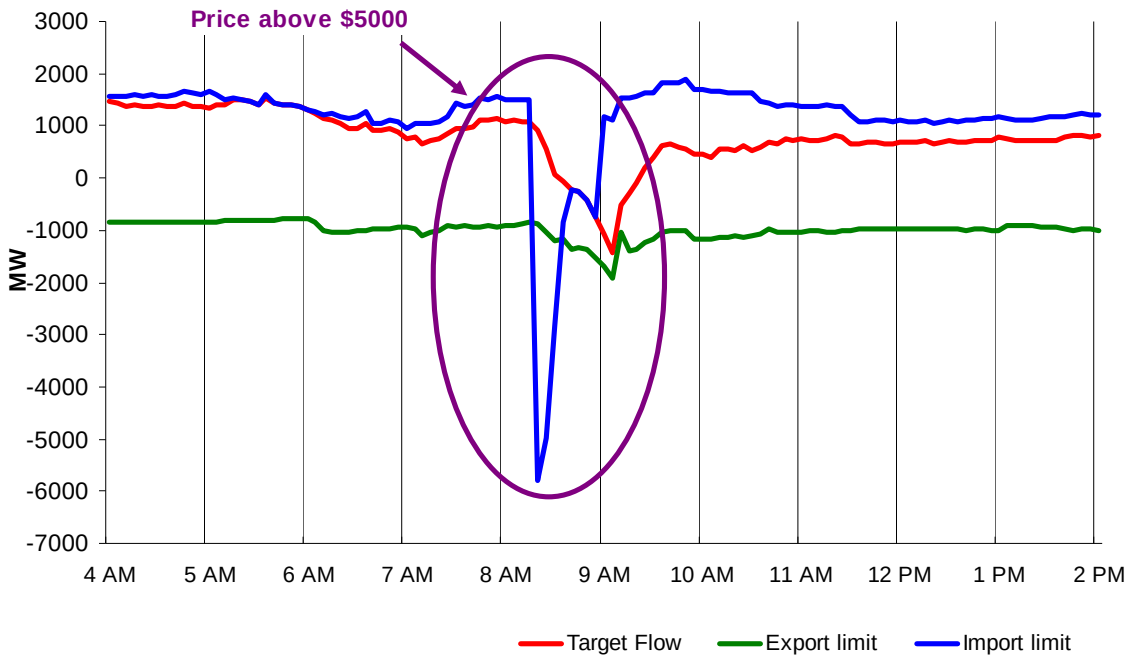
Figure 3: Combined actual and forecast import limits into New South Wales (MW)

Time	Actual	4 hr forecast	Difference	12 hr forecast	Difference
8 am	1481	1495	-14	1440	40
8.30 am	-1515	1556	-3071	1500	-3016
9 am	-217	1566	-1783	1580	-1797
9.30 am	1505	1569	-64	1591	-86

The congestion on the Mt Piper to Wallerawang lines led to prices at the price cap in New South Wales and forced exports into Queensland and Victoria counter-price. The forced exports into Queensland caused negative prices in Queensland (at the price floor of $-1000/MWh). Around $1 million of negative inter-regional settlement residues accrued across the New South Wales to Queensland interconnector and almost $90 000 across the Victoria to New South Wales interconnector.

Figure 4 illustrates the combined import, export limit and target flow into the New South Wales region across the Terranora, QNI and the Vic-NSW interconnectors on a 5-minute resolution, showing the import limit changing to forced exports out of New South Wales at the time of high prices.

Figure 4: Combined import, export limit and target flow into New South Wales



In optimising economic generation dispatch and interconnector flows, the National Electricity Market Dispatch Engine (NEMDE) takes into account the maximum network capability that applies at the time. These network limits are represented as constraint equations that describe the maximum capability of each network element and include generator and interconnector coefficients. The magnitude of a coefficient gives an indication of the significance of the generating unit or interconnector in managing the network limitation (the larger the coefficient the more significant the unit or interconnector). A positive coefficient means that a unit or interconnector is

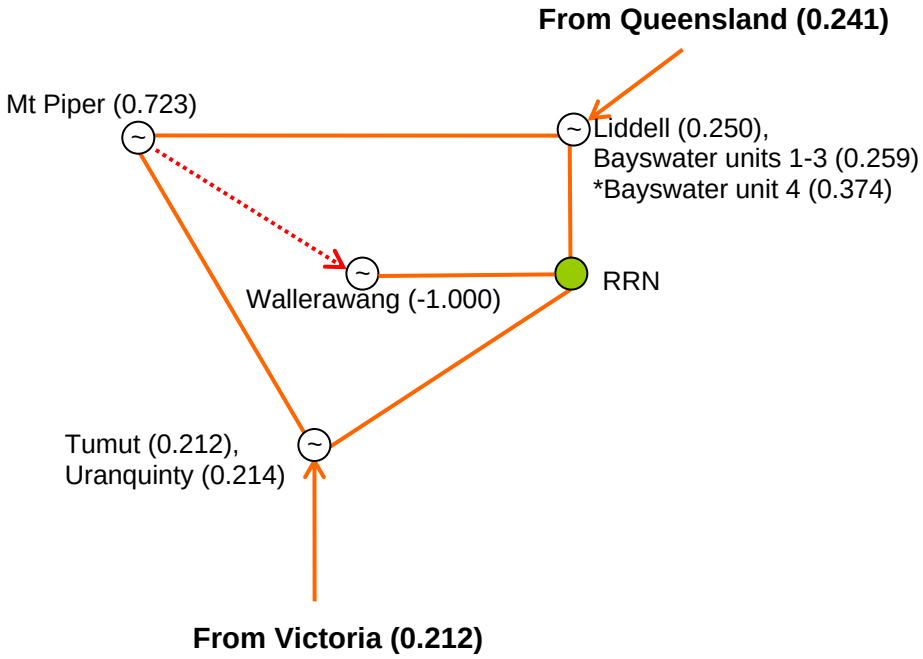
'constrained-off'[5] if the constraint is binding, where a negative coefficient means a generator is 'constrained-on'.

On 4 occasions since December 2009, the system normal constraint N>>N-NIL__S has led to prices above $5000/MWh. This constraint is designed to prevent the Mt Piper to Wallerawang lines from overloading. From late February 2010, Transgrid put in place arrangements to increase the capability of the Mt Piper to Wallerawang transmission lines as required, (through a temporary network configuration). This arrangement reduced the likelihood of congestion across these lines. However, the return to service of Wallerawang unit seven meant that this arrangement was not feasible. As a result network capability was reduced leading in turn to increased congestion.

From 4 August the N>>N-NIL__S [6] constraint was replaced with the N>>N-NIL_PRE36__S constraint to manage the augmentation of the 500 kV system around Bannaby. The two constraints are very similar.

Figure 5 is a simplified representation of the transmission network in New South Wales, highlighting the flow paths into the regional reference node (RRN) at Sydney West, the interconnectors to Queensland and Victoria and significant generation stations. Also shown are the relevant coefficients for the stations according to the N>>N-NIL_PRE36__S constraint.

Figure 5: Simplified transmission network in New South Wales



* Bayswater unit four is connected to the 500 kV network. All other Bayswater units are connected to the 330 kV network, which explains the different coefficients.

The N>>N-NIL_PRE36__S constraint is designed to prevent the Mt Piper to Wallerawang line (shown as a red dotted line) from overloading, which is consistent with Wallerawang and Mt Piper having the largest coefficients. In general, power flows from Mt Piper to Wallerawang. The direction of the power flow means that, to avoid

[5] Network constraints can cause generators to be dispatched at a price that is lower than its offer price (constrained-on) or generators to not be dispatched even though its offer price is lower than the regional price (constrained-off).

[6] Constraint equations are mathematical expressions used in the dispatch engine to describe the physical limitations of the power system. System normal constraints are used when the network is operating in its normal network configuration. The N>>N-NIL_PRE36__S constraint affects up to 11 700 MW of generation capacity (27 units) in New South Wales, and all three interconnectors into New South Wales.

overloading, it is necessary to increase or 'constrain-on' the Wallerawang units (with a -1.000 coefficient) and reduce or 'constrain-off' the Mt Piper units (with a 0.723 coefficient). Other generators can also influence flows across this line, but to a lesser extent (e.g. Bayswater unit four with a 0.374 coefficient is likely to be 'constrained-off' ahead of the other Bayswater units and the Liddell units with coefficients of 0.259 and 0.250 respectively, as it has a larger coefficient). The amount and rate at which a generator is 'constrained-on' or off is, however, limited by the availability and ramp rate offered by those generators. The interconnectors may also be 'constrained-off' in order to satisfy this constraint (with coefficients of 0.212 and 0.241), but unlike generators, there is no ramp rate restriction for interconnectors.

The Mt Piper and Wallerawang units' coefficients are much greater than those for other generators or interconnectors, given their proximity to the lines being managed. If the ability to 'constrain-on' or 'constraint-off' these units is limited (for example, due to low ramp rates), then other generators and interconnectors will need to be constrained, but by a larger amount (three to four times more) to manage flows on the network.

On this occasion there were no Wallerawang units online, with only the Wallerawang 7 unit attempting to return to service, and in any case with a ramp up rate of zero or one. This meant that all other generators and interconnectors were required to be constrained to a greater extent.

Following the return to service of Wallerawang unit seven at around 8.55 am, Transgrid was able to again reconfigure the network and increase the capability of the Mt Piper to Wallerawang lines from 1097 MVA to 1430 MVA. In response to the reduced congestion, prices reduced to below $30/MWh for the 9 am dispatch interval.

Australian Energy Regulator
September 2010

Appendix A – Price setters for 10 August 2010

The following table identifies the trading intervals in which the spot price exceeded $5000/MWh. Each five minute dispatch interval price and the generating units involved in setting the energy price. This information is published by AEMO[7]. Also shown is the energy offer price involved in determining the dispatch price together with the quantity of that service and the contribution to the total energy price. The 30-minute spot price is the average of the six dispatch interval prices.

New South Wales – 8.30 am

Time	Dispatch price	Participant	Unit	Service	Offer price	Marginal change	Contribution
08:05	$33.00	Macquarie Generation	BW01	Energy	$33.00	0.26	$8.69
		Macquarie Generation	BW02	Energy	$33.00	0.26	$8.69
		Eraring Energy	ER01	Energy	$33.00	0.16	$5.21
		Eraring Energy	ER03	Energy	$33.00	0.16	$5.21
		Eraring Energy	ER04	Energy	$33.00	0.16	$5.21
08:10	$33.00	Macquarie Generation	BW01	Energy	$33.00	0.26	$8.69
		Macquarie Generation	BW02	Energy	$33.00	0.26	$8.69
		Eraring Energy	ER01	Energy	$33.00	0.16	$5.21
		Eraring Energy	ER03	Energy	$33.00	0.16	$5.21
		Eraring Energy	ER04	Energy	$33.00	0.16	$5.21
08:15	$33.00	Macquarie Generation	BW01	Energy	$33.00	0.26	$8.69
		Macquarie Generation	BW02	Energy	$33.00	0.26	$8.69
		Eraring Energy	ER01	Energy	$33.00	0.16	$5.21
		Eraring Energy	ER03	Energy	$33.00	0.16	$5.21
		Eraring Energy	ER04	Energy	$33.00	0.16	$5.21
08:20	$32 532.60*	Snowy Hydro	TUMUT3	Energy	$284.09	175.72	$49 919.61
		Southern Hydro	MCKAY1	Energy	$97.86	-177.67	-$17 387.01
08:25	$86 009.69*	Southern Hydro	MCKAY1	Energy	$97.86	78.45	$7677.22
		Snowy Hydro	TUMUT3	Energy	-$1000.00	-54.09	$54 086.60
		Snowy Hydro	UPPTUMUT	Energy	-$1000.00	-24.25	$24 245.70
08:30	$83 598.34*	Southern Hydro	MCKAY1	Energy	$97.86	76.23	$7459.93
		Snowy Hydro	UPPTUMUT	Energy	-$1000.00	-76.14	$76 138.40
Spot price		**$6267/MWh**					

*Price capped to $12 500/MWh.

New South Wales – 9 am

Time	Dispatch price	Participant	Unit	Service	Offer price	Marginal change	Contribution
08:35	$12 400.01	Eraring Energy	SHGEN	Energy	$12 400.01	1.00	$12 400.01
08:40	$12 500.00	Delta Electricity	CG2	Energy	$12 500.00	1.00	$12 500.00
08:45	$8035.06	Delta Electricity	CG1	Energy	$8035.06	1.00	$8035.06
08:50	$969.76	TRUenergy (SA)	TORRB2	Energy	$35.77	1.71	$61.07
		Macquarie Generation	BW01	Energy	-$1000.00	-0.91	$908.70
08:55	$509.55	Snowy Hydro	MURRAY	Energy	$28.95	1.31	$37.96
		Macquarie Generation	BW03	Energy	-$1000.00	-0.24	$235.80
		Macquarie Generation	BW04	Energy	-$1000.00	-0.24	$235.80
09:00	$18.30	International Power	HWPS4	Energy	$22.39	0.82	$18.30
Spot price		**$5739/MWh**					

[7] Details on how the price is determined can be found at www.aemo.com.au

Appendix B – Closing bids

Figures B1 – B2 highlight the half hour closing bids for participants in New South Wales with capacity priced at or above $5000/MWh during the trading interval in which the spot price exceeded $5000/MWh. It also shows the generation output of that participant and the spot price.

Figure B1: Eraring Energy closing bid prices, dispatch and spot price

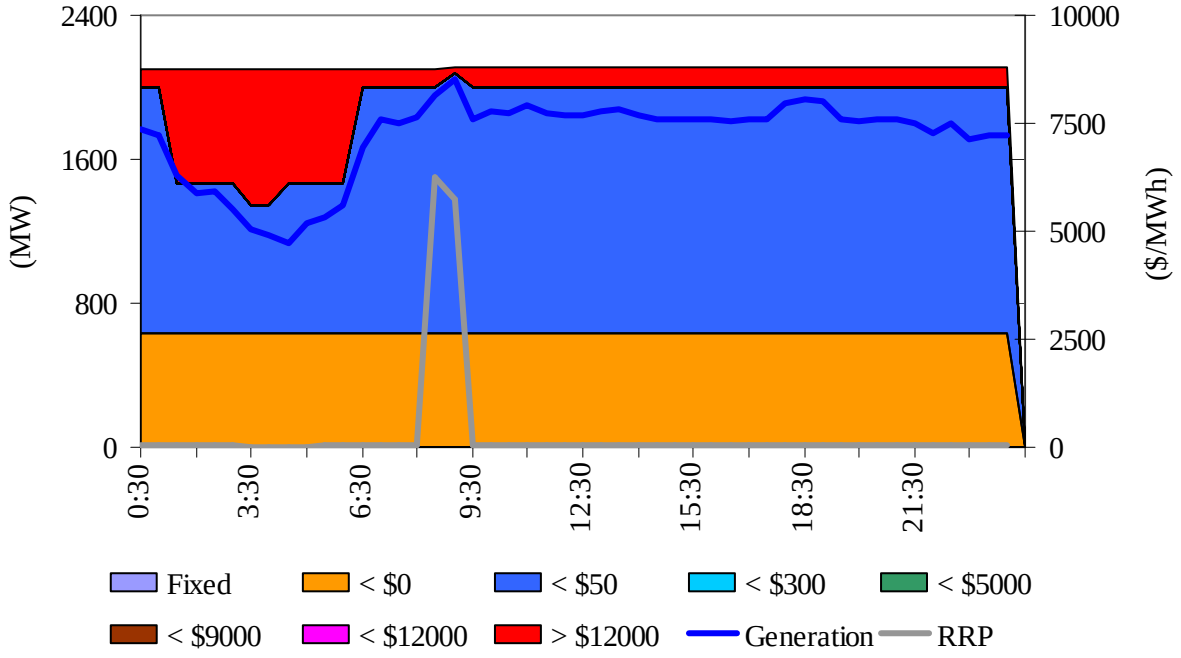


Figure B2: Delta (Colongra) closing bid prices, dispatch and spot price