Spot prices greater than $5000/MWh

AUSTRALIAN ENERGY REGULATOR

New South Wales 22 October 2007

Introduction

The AER is required to publish a report covering the circumstances in which the spot price exceeded $5000/MWh, pursuant to clause 3.13.7 (d) of the Rules. That report should:

- describe significant factors contributing to the spot price exceeding $5000/MWh, including withdrawal of generation capacity and network availability;
- assess whether rebidding pursuant to clause 3.8.22 contributed to the spot price exceeding $5000/MWh;
- identify the marginal scheduled generating units; and
- identify all units with offers for the trading interval equal to or greater than $5000/MWh and compare these dispatch offers to relevant dispatch offers in previous trading intervals.

This report examines the factors that can contribute to the spot price exceeding $5000/MWh including; changes in demand (compared to that forecast by NEMMCO); generator offers and rebidding (including changes to generation capacity); and changes to network availability.

Summary

On Monday 22 October, the spot price in New South Wales reached $7858/MWh. The price spike resulted from the inappropriate operation of network constraints.

A planned network outage in New South Wales led to other network constraints that are used to manage the normal operation of the network, to produce incorrect limits and security violations. As a result, imports from Queensland into New South Wales and generation at Macquarie Generation's Bayswater and Liddell power stations were significantly reduced.

There were, however, no actual security violations during this period.

The high price was also reflected across other regions. Turnover in the energy market for the 10 am trading interval was $46 million. This represented 60 per cent of the total for the day.

Actual and forecast demand

Demand at the time was 400 MW higher than forecast four and twelve hours ahead. Whilst this potentially contributed to the price being higher than forecast, it was not a significant contributing factor in the price exceeding $5000/MWh.

Figure 1 compares the actual demand in New South Wales with that forecast by NEMMCO four and twelve hours ahead of dispatch. A comparison of actual and forecast spot price is also included.

Figure 1: Actual and forecast demand and spot price in New South Wales

Monday 10:00 AM	Actual	4 hr forecast	12 hr forecast
Demand (MW)	10 069	9660	9655
Spot Price ($MW/h)	7858.07	60.00	44.91

Changes to network availability

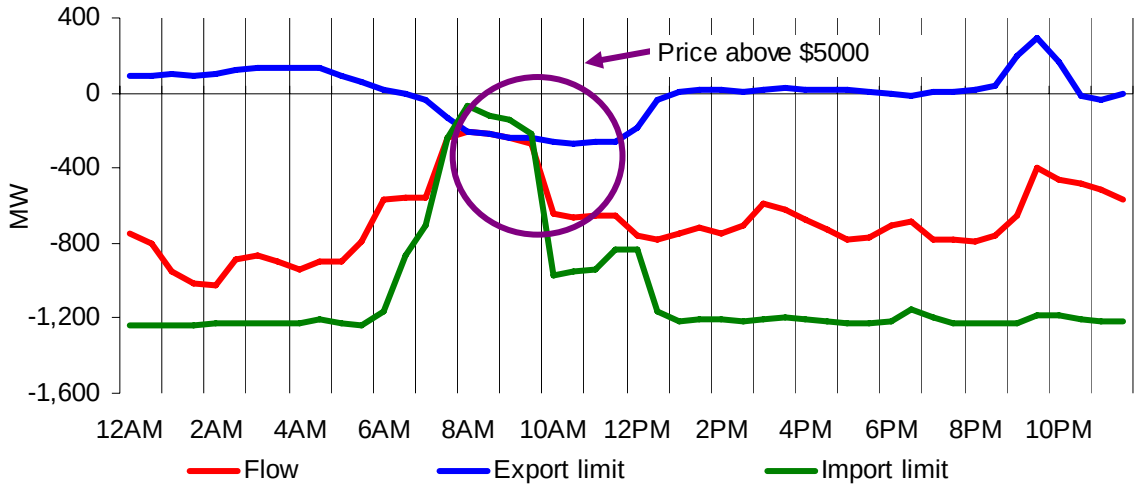
Network constraints had a significant impact on market outcomes during this period, limiting imports into New South Wales from Queensland across QNI and Terranora and constraining off generation in New South Wales. The constraint N>>N-NIL_DF_1, which had the most significant impact on dispatch, did not accurately represent the capability of the network, unnecessarily constraining operations.

The network constraint in question is designed to manage the overload of the Armidale to Kempsey (965) 132kV transmission line in northern New South Wales following the loss of the Coffs Harbour to Nambucca (9W3) 132kV line. These lines are parallel to QNI, which means that energy flows on these lines in proportion to southerly flows on QNI. The proximity of these lines to the Hunter Valley means that the output from generators in that area also affects the flows. The constraint is a system normal constraint and manages the network to within the nominal design capability. To achieve this, the constraint restricts flows south across QNI and Terranora and constrains off generation in the Hunter Valley.

On 22 October, this constraint reduced the limit into New South Wales across QNI to around 100 MW, almost 1000 MW lower than its nominal capability of 1078 MW. Terranora was also affected, forcing 30MW north into Queensland.

Figure 2 shows the combined half-hour flow and limits across QNI and Terranora for the day (southward flows are represented as a negative value). The blue trace shows that from 7 am the export limit from New South Wales went negative, forcing flows south. This was driven by a different system normal constraint (N^Q_NIL_B[1]). The green trace shows the New South Wales import limit, which started reducing from 6 am, driven by the N>>N-NIL_DF_1 constraint.

Figure 2: Actual flow and limits into New South Wales across QNI and Terranora

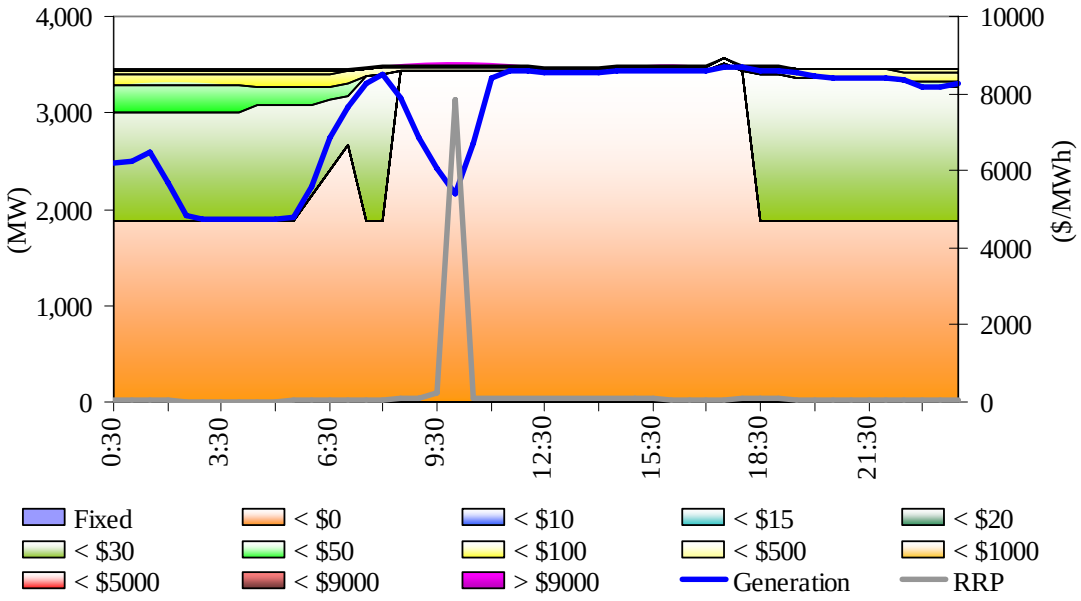


[1] N^Q_NIL_B sets the export limit, typically a maximum limit on flows north into Queensland across QNI and Terranora to avoid voltage collapse for the loss of the largest Queensland generator. On this day the largest generator was Kogan Creek which was operating at its maximum output of 750 MW. At this level of output the limit forces flow south into New South Wales. This constraint regularly causes forced flows south when Kogan Creek is generating at maximum output. The next largest generators in Queensland have a maximum output of around 450 MW, which does not normally force flows south.

The constraint also directly impacted on generation at Macquarie Generation in the Hunter Valley.

Figure 3 displays the half hour closing bids for Macquarie Generation in New South Wales for each trading interval of the day. The shaded orange area highlights the capacity priced at less than zero. The blue trace shows the generation output and the grey trace shows the spot price. This figure highlights the affects of the constraint on Macquarie Generation's output. At one point, as much as 1470 MW of capacity was constrained off with the majority of this capacity priced at less than zero.

Figure 3:Macquarie Generation closing bid prices, dispatch and spot price.



Combining the impacts of reduced imports and generation, this constraint removed almost 2500 MW of low priced supply from New South Wales, resulting in the price spike as alternate higher cost generation was dispatched. This constraint was violated between 8.05 am and 9.55 am.

At 8.15 am in accordance with its procedures, NEMMCO's control room advised off-line staff that this constraint equation appeared to be overconservative and requested a review. NEMMCO off-line staff reviewed and modified the constraint equation, and in accordance with its procedures this constraint equation was tested before being released. This work was completed by around 10 am and NEMMCO removed the system normal constraint from the market systems. This saw the five-minute dispatch price fall from $9408/MWh at 9.55 am to $336/MWh at 10 am. The corrected constraint was returned to the market systems by 10.15 am and had no impacts on dispatch for the remainder of the day. The constraint was modified to add a test for the topology of the network, effectively setting aside the constraint whenever the Armidale to Coffs Harbour 330 kV line is out of service. Despite the constraint violations, NEMMCO has confirmed that the network was never insecure. NEMMCO will soon be commissioning a new tool which will allow constraint equations due to thermal limits to be generated automatically. This is expected to significantly improve the response time for issues such as this.

Forecast results

At no time in the 30-minute predispatch forecasts was there any indication that New South Wales would be operating with reduced generation and import capabilities.

Forecasts indicated that flows south into New South Wales across both the QNI and Terranora interconnectors were consistently around the nominal design capability of the interconnectors.

At times, however, the forecast capability of the interconnector was misaligned with the actual capability of the interconnectors reported at the same time. At 9.30 am for example, the forecast was estimating a capability of 1019 MW across QNI for the 10 am trading interval. At the same time, the five minute dispatch limit was only 190 MW, a difference of more than 800 MW[2]. Discrepancies between forecast and actual conditions were also observed on the Terranora interconnector and for the dispatch of the Macquarie Generation plant.

Figure 4 compares the half hour average flow and limits to and from New South Wales across the QNI and Terranora interconnectors for the 10 am trading interval with those forecast four and twelve hours ahead of dispatch. Southward flows are represented as a negative value.

Figure 4: Combined actual and forecast flow and limits into New South Wales across QNI and Terranora

Monday 10:00 AM	Actual	4 hr forecast	12 hr forecast
Export limit	-240	19	54
Flows into NSW	-268	-703	-629
Import limit	-220	-1239	-1246

Network outage planning

Transgrid first notified NEMMCO of the planned outage of the 87 line on 13 September 2007. Under NEMMCO's outage assessment procedures, the request was assessed in four timeframes:

- "medium term likely-to-proceed" status was given on 13 and 14 September
- "short term likely-to-proceed" status was given on 18 October 2007;
- "predispatch likely-to-proceed" status was given on 21 October 2007.

NEMMCO gave "permission-to-proceed" at 4.54am on 22 October 2007 and the outage commenced on schedule at 5.05 am. The line was returned to service at 12.40 pm well ahead of the 5 pm expected completion time.

As part of its investigation, the AER wrote to NEMMCO seeking clarification of a number of issues. NEMMCO indicated that the erroneous behaviour of the system normal constraint (N>>N-NIL_DF_1) resulted from the planned outage of the 330kV line between Armidale and Coffs Harbour in New South Wales. With this line out of service, real-time measurements gave a false indication of a need to constrain operation.

NEMMCO stated that it does not usually assess the likely impacts of network outages on system normal constraints on the basis that the technical envelope for an outage is usually more restrictive than the system normal envelope. This is for practical reasons as it would require separate analysis for all relevant constraint and contingency combinations for each outage.

[2] These errors first appeared in the 6.30am predispatch forecast, increasing to an error of around 800 MW from 8 am.

Generator offers and rebidding

The registered capability of the installed generation in New South Wales is 12 190 MW. On 22 October, there was 3222 MW not presented to the market during the high priced period. Of this capacity, 1300 MW at Bayswater, Liddell and Redbank would have been restricted by the constraint N>>N-NIL_DF_1 and is unlikely to have made a difference to the outcomes on the day. The remaining 1872 MW of capacity not presented may have reduced the impact of the network constraint but was also not material to the event. Figure 5 details the significant generation capacity that was not presented on that day.

Figure 5: New South Wales generation capacity not presented

Participant	Capacity (MW)	Comment
Delta Electricity		
Munmorah Vales Point	900	Munmorah unit three (300 MW) and Vales Point unit six (660 MW) were both offline for the day. The remaining units offered 60 MW above their registered capacity.
Macquarie Generation		
Liddell Hunter Valley GT	1200	Liddell units one and four (both 500 MW) and Hunter Valley GT (50 MW) were offline for the day. Other units in the portfolio were operating a combined 150 MW below registered capacity.
Eraring Energy		
Eraring	911	Eraring unit two (660 MW) was offline from midnight with a forced outage. Other units were operating a combined 251 MW below registered capacity.
Others		
Sithe Snowy Redbank	211	Snowy's Blowering (70 MW) and Babcock and Brown's Redbank (150 MW) were offline for the day. Sithe was operating slightly above its registered capability.
Total	3222	

Figure 6 shows, for the 10 am trading interval the actual generating capacity presented and compares this with the amount of available capacity forecast four and twelve hours ahead of dispatch. The amount of capacity offered at prices less than the forecast price calculated four hours ahead of dispatch is also included and shows an increase in low priced capacity. Also shown is the effect of the network constraint on the availability of low priced capacity, with a reduction of almost 1000 MW compared to the four hour forecast and almost 1400 MW of actual capacity effectively removed from the supply curve.

Figure 6: Actual and forecast capacity and spot price for New South Wales

Monday 10:00 AM	Actual	4 hr forecast	12 hr forecast
Capacity (MW)			
available	8997	9278	9778
priced at less than $60.00	8555	8118	
Less constrained generation	7171	8118	
Spot price ($/MWh)	7858.07	60.00	

There were a number of rebids made close to dispatch.

Eraring Energy's unit four had been operating at 300 MW since around 8 am the previous day. The unit was forecast to return to full availability of 700 MW, during the 9.30 am trading interval. At 8.36 am, Eraring Energy delayed the return of this capacity until 10.30 am. Almost all of this capacity was priced at less than $100/MWh. The forecast price after this rebid were not significantly affected, therefore this rebid was not a material driver to the price exceeding $5000/MWh. A second rebid at 9.43 am, made this capacity available from 9.50 am. The reasons given were "P: Steam leak repairs" and "P: Available for full capacity".

A number of other rebids shifted capacity into lower prices, mostly by Macquarie Generation attempting to limit the impacts of the constraint (N>>N-NIL_DF_1) on its dispatch.

The generators involved in setting the spot price during the 10 am trading interval, and how that price was determined by the market systems are detailed in **Appendix A.**

The closing bids for Delta Electricity, Eraring Energy and Snowy Hydro, with capacity priced at or above $5000/MWh during this period are presented in **Appendix B**.

Assessment

The false indication of a need to constrain operation following the commencement of a planned network outage between Armidale and Coffs Harbour was the most significant factor in the price exceeding $5000/MWh on 22 October 2007. This reduced the capability for imports into New South Wales from Queensland by 1000 MW and Macquarie Generation's dispatch by almost 1500 MW.

NEMMCO has commenced a detailed investigation into this event and will publish a separate report when the investigation is complete.

Australian Energy Regulator

November 2007

The following table identifies the trading interval in which the spot price exceeded $5000/MWh. Each five-minute dispatch interval price and the generating units involved in setting the energy price, as published in the market systems are shown. This information is published by NEMMCO[3]. Also shown is the energy or ancillary service 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 time weighted average of the six dispatch interval prices.

Monday 22 October – New South Wales 10 am

Time	Price ($/MWh)	Participant	Unit	Service	Offer price	Marginal change	Contribution ($/MWh)
09:35	$9,049.14	Snowy Hydro	TUMUT3	Energy	$7,483.27	1.20	$9,012.48
		Snowy Hydro	MURRAY	Energy	$150.00	-0.02	-$3.47
		Snowy Hydro	TUMUT3	Raise 5 min	$0.00	-1.15	$0.00
		Snowy Hydro	UPPTUMUT	Raise 5 min	$35.00	1.15	$40.15
09:40	$9,700.00	Delta Electricity	MM4	Energy	$9,700.00	1.00	$9,700.00
09:45	$9,423.85	Snowy Hydro	MURRAY	Energy	$150.00	-0.02	-$3.41
		Snowy Hydro	TUMUT3	Energy	$7,483.27	1.22	$9,135.13
		Snowy Hydro	UPPTUMUT	Raise 5 min	$250.00	1.16	$290.65
		Snowy Hydro	TUMUT3	Raise 5 min	$0.00	-1.16	$0.00
		Macquarie Generation	BW02	Raise 6 sec	$4.80	0.81	$3.91
		Snowy Hydro	TUMUT3	Raise 6 sec	$3.00	-0.81	-$2.44
09:50	$9,230.73	Snowy Hydro	MURRAY	Energy	$150.00	-0.02	-$3.41
		Snowy Hydro	TUMUT3	Energy	$7,483.27	1.22	$9,131.83
		Macquarie Generation	BW03	Raise 5 min	$88.00	1.16	$102.27
		Snowy Hydro	TUMUT3	Raise 5 min	$0.00	-1.16	$0.00
09:55	$9,408.01	Snowy Hydro	MURRAY	Energy	$150.00	-0.02	-$3.41
		Snowy Hydro	TUMUT3	Energy	$7,483.27	1.22	$9,132.51
		Snowy Hydro	TUMUT3	Raise 5 min	$0.00	-1.16	$0.00
		Tarong	W/HOE#1	Raise 5 min	$240.00	1.16	$278.94
10:00	$336.70	Snowy Hydro	UPPTUMUT	Energy	$301.27	1.08	$325.10
		Snowy Hydro	MURRAY	Energy	$150.00	0.08	$11.60
Spot price	**$7858.07/MWh**						

[3] NEMMCO first published details on how the price is determined, for every dispatch interval, in June 2004. Documentation of this process can be found at http://www.nemmco.com.au/dispatchandpricing/140-0036.htm

Appendix B displays the half hour closing bids for Delta Electricity, Eraring Energy and Snowy Hydro with capacity priced at or above $5000/MWh during the trading intervals in which the spot price exceeded $5000/MWh, for each trading interval of the day. It also shows the generation output of that participant and the spot price exceeding $5000/MWh.

Figure B1:Delta Electricity bid prices, dispatch and region price.

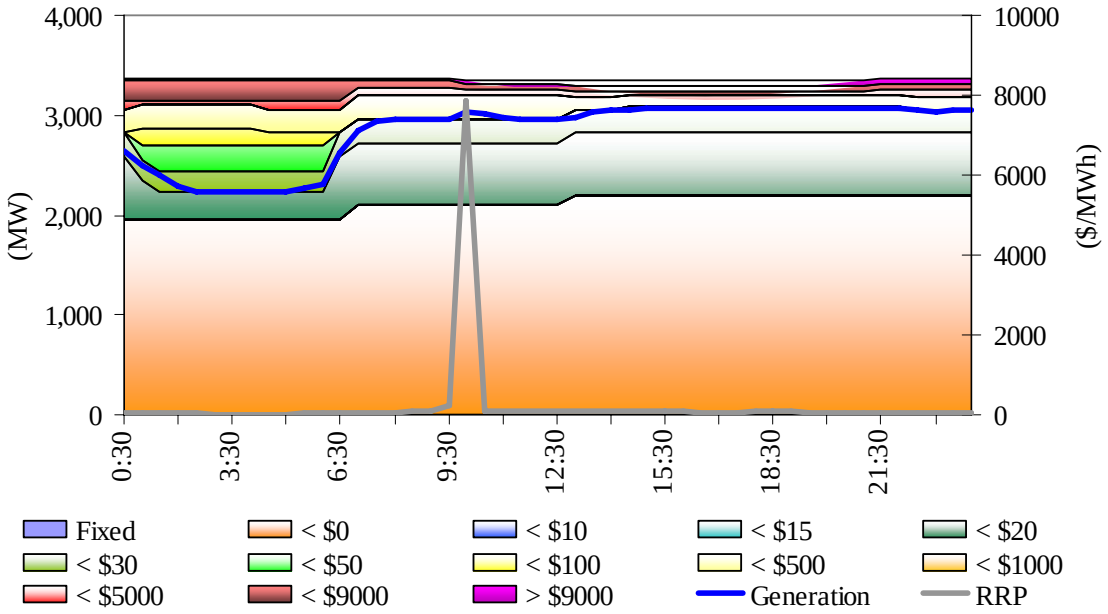


Figure B2:Eraring Energy closing bid prices, dispatch and spot price.

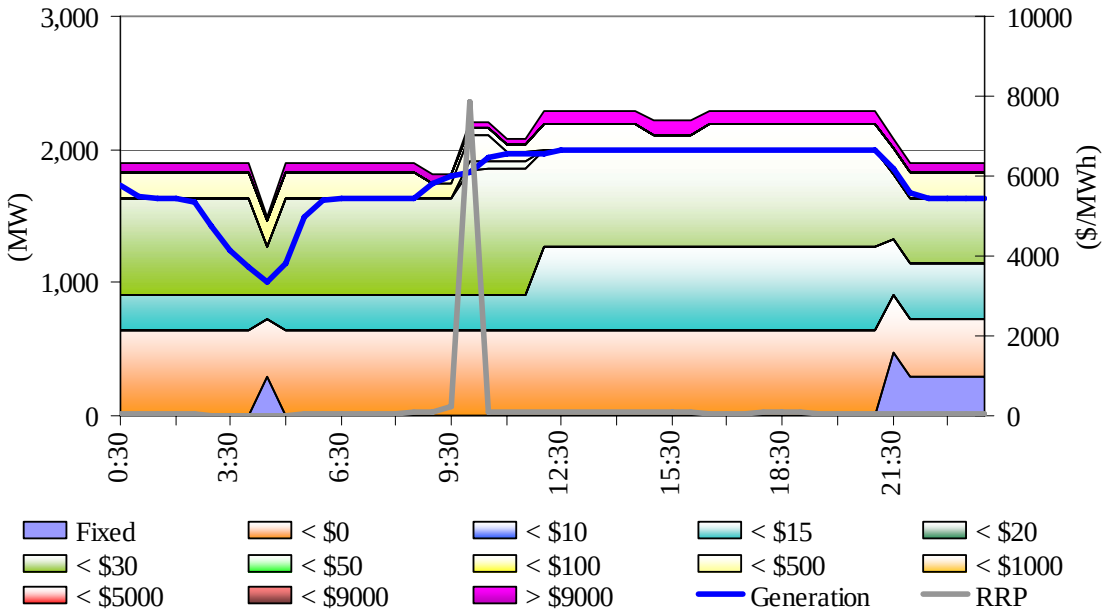


Figure B3:Snowy Hydro closing bid prices, dispatch and spot price.