Electricity spot prices above $5000/MWh

South Australia, 13 July 2016

11 October 2016

AUSTRALIAN ENERGY REGULATOR

Inquiries about this publication should be addressed to:

Australian Energy Regulator
GPO Box 520
MELBOURNE VIC 3001

Tel: (03) 9290 1444
Fax: (03) 9290 1457

Email: AERInquiry@aer.gov.au
AER Reference: 60456-D16/128184

Amendment Record

Version	Date	Pages
1 version for publication	11/10/2016	16

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1 Introduction

The AER is required to publish a report whenever the wholesale price for electricity in the National Electricity Market exceeds $5000/MWh.[1] The wholesale (or spot) price is the price that generators receive and retailers pay for electricity in the wholesale market and is one component that makes up the price ultimately seen by consumers. The wholesale price for electricity can vary between -$1000/MWh and $14 000/MWh. The National Electricity Rules require the AER to report whenever the spot price for electricity exceeds the $5000/MWh threshold. The report must examine the conditions in the wholesale market and:

- describe the significant factors contributing to the spot price exceeding $5000/MWh, including withdrawal of generation capacity and network availability;
- assess whether rebidding 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 compares these dispatch offers to relevant dispatch offers in previous trading intervals.

On 13 July 2016 at 6.30 am, the spot price for electricity reached $7068/MWh in South Australia. This report presents our analysis of the events in accordance with this obligation.

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

2 Summary

Forecasts for 13 July 2016 prepared by AEMO the day before, predicted the 30-minute spot price would be above $5000/MWh for six 30-minute trading intervals. However, on the day the spot price in South Australia exceeded $5000/MWh only once, reaching $7068/MWh during the 6.30 am trading interval. This price was not forecast.

The major contributing factor to the high price was wind forecast error. Semi-scheduled wind for the 6.30 am trading interval was forecast to be around 900 MW both four and 12 hours ahead and around 820 MW half an hour ahead. Actual semi-scheduled wind output was around 600 MW. Wind capacity is typically priced below $0/MWh. The wind forecast error had the effect of shifting the supply curve to the left. With all low priced generation either fully dispatched or restricted by plant limitations, the South Australian price reached $14 000/MWh from 6.20 am to 6.30 am.

Other relevant factors include:

- Planned network outages, at Tailem Bend to complete augmentation works on the Heywood Interconnector between Victoria and South Australia, materially reduced its capacity. While this major upgrade was flagged to the market in late 2015 its likely impact on Heywood's operating capability was not clear until the previous days forecast.
- Flows on Murraylink into South Australia partially compensated for the lower than forecast wind production.
- The supply curve in South Australia only had 225 MW of generation capacity priced between $125/MWh and $12 500/MWh. The majority of which was offered by peaking generators, which take longer than one dispatch interval to start.

Rebidding of capacity did not contribute to the price exceeding $5000/MWh. Demand was close to forecast, at similar levels to previous days and to average demand levels for the same time the previous winter.

3 Analysis

Table 1 shows the actual and forecast spot price, demand and availability for the 6.30 am trading interval.

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

	6.30 am trading interval			
	Actual	0.5 hr forecast	4 hr forecast	12 hr forecast
Price	7068	34	125	19
Demand	1191	1181	1180	1154
Availability	2429	2654	2706	2704

Table 1 shows the high price was not forecast and generator availability was materially lower than forecast for the 6.30 am trading interval. The difference between the actual and forecast generator availability is predominantly due to the lower than forecast wind output. Demand was close to forecast throughout the day.

3.1 Supply and Demand

This section discusses changes to the price and capacity offered by generators, and demand conditions relevant to the pricing event.

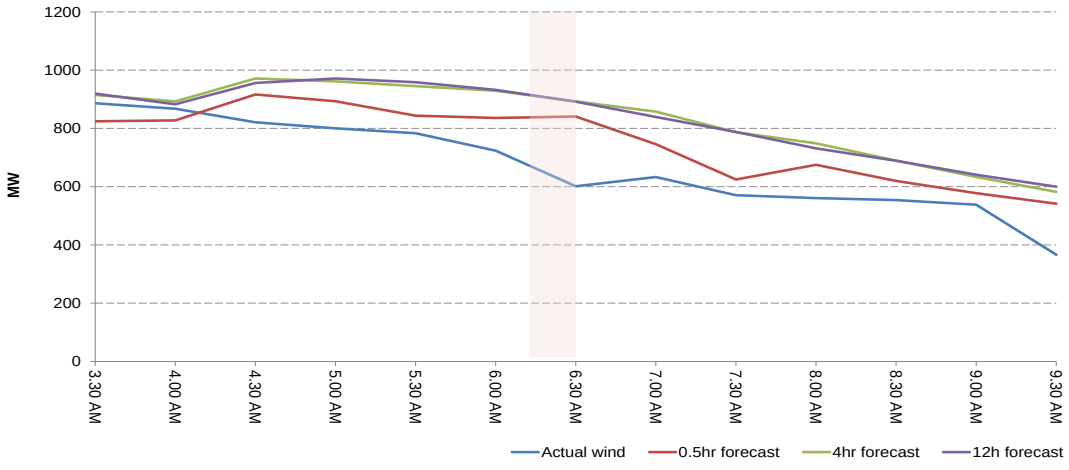
Following the shutdown of Northern Power Station (540 MW) in May, South Australia has an installed capacity of around 4200 MW, predominately fuelled by gas and wind generators. On the day, two gas generators were unavailable on planned outages, Pelican Point (480 MW) and Torrens Island B3 (200 MW).

Regional generator availability was lower than forecast because the contribution from wind generation was lower than forecast.

3.1.1 Wind

Figure 1 shows semi-scheduled actual and forecast wind output. The shaded area highlights the period where prices exceeded $5000/MWh.

Figure 1: Semi-scheduled wind generation actual and forecast



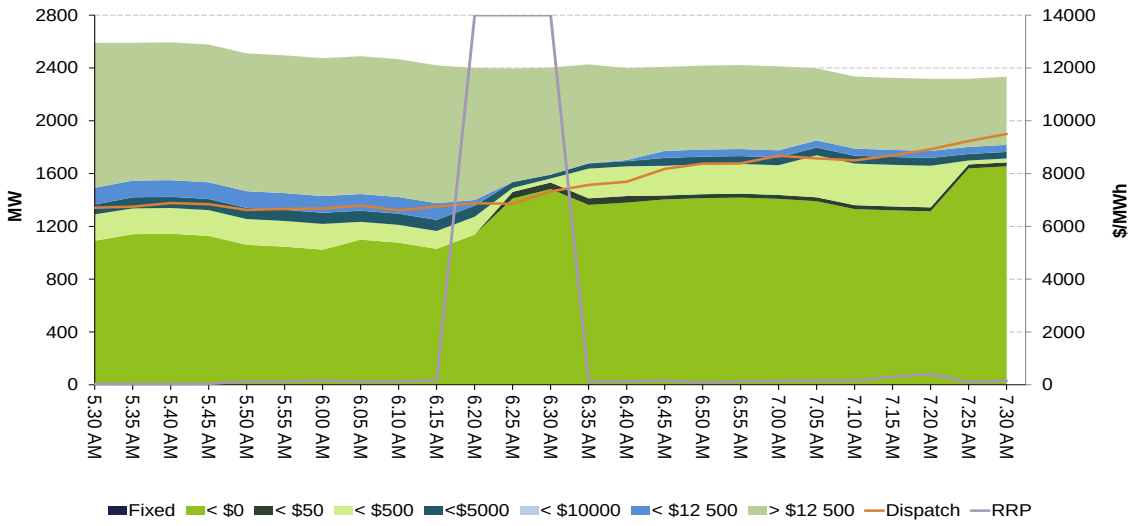
Semi-scheduled wind for the 6.30 am trading interval was forecast to be around 900 MW both four and 12 hours ahead and around 820 MW half an hour ahead. Actual semi-scheduled wind output was only around 600 MW, dropping around 150 MW over the 6.30 am trading interval.

3.1.2 Supply and generation

Initial offers from generators at 12.30 pm the previous day in South Australia showed there was around 1200 MW of capacity at prices less than $0/MWh, of which around 900 MW was wind. While high prices were forecast for 8.30 am, the 6.30 am high price was not.

Figure 2 shows the closing bids by dispatch interval for participants in South Australia as well as the dispatch price and total generation output in the region. At 6 am, there was materially less capacity available at less than $0/MWh (the lime green sections of the charts). This reduction is as a result of the reduced wind generation available against forecast.

Figure 2: South Australian generator closing bids, dispatch and spot price



At 6.20 am, South Australia had:

- 1200 MW offered at less than $125/MWh,
- 225 MW offered between $125/MWh and $12 500/MWh of which most of this was from peaking plant offers that take more than 5 minutes to start, and
- over 1000 MW priced above $12 500/MWh.

Effectively this meant that once local dispatch exceeded 1200 MW generation had to come from high priced capacity and/or peaking generators with delayed start times.

At 6.20 am, demand increased by 23 MW and semi-scheduled wind generation decreased by 17 MW. The outage at Tailem Bend, which commenced on 4 July prevented around 190 MW of generation from the South East being delivered to Adelaide, instead being exported to Victoria. MurrayLink was importing at its limit of around 220 MW. Given these network circumstances and with all low priced generation

either fully dispatched, ramp rate limited or limited by their Fast Start Inflexibility Profile (FSIP), taking more than five minutes to start, 18 MW of $14 000/MWh priced generation at Torrens Island was dispatched.[2] Torrens Island capacity continued to set the price until the end of the trading interval.

At 6.35 am, the start of the 7 am trading interval, the dispatch price dropped to around $120/MWh because:

- Around 80 MW more capacity was available at prices less than $1000/MWh. This was not as a result of rebidding but was set up more than four hours earlier.
- Demand decreased by 28 MW.
- Semi- scheduled wind increased by 23 MW.
- Committed peaking plant reached their minimum loads, had completed their FSIP's and were able to set price.

There was no significant rebidding of capacity from low to high prices that contributed to the high price outcomes.

Appendix B details the generators involved in setting the price during the high-price periods, and how that price was determined by the market systems.

The closing bids for all participants in South Australia with capacity priced at or above $5000/MWh for the high-price periods are set out in Appendix C.

3.2 Network Availability

This section examines the change in network capability approaching the event and its contribution to price outcomes.

While the outage on Heywood, which resulted in flows into Victoria was forecast, the outage itself did not result in forecast high prices. Flows into South Australia on Murraylink were significantly higher than forecast, compensating to a degree for lower than forecast wind production in South Australia.

Planned network constraints were invoked to manage a planned network outage on equipment at Tailem Bend in South Australia as part of the Heywood interconnector upgrade.[3] The planned outage reduced the network capability between the south east of South Australia and Adelaide. Consequently generation in the South East in excess of that network capability to Adelaide has to be constrained off or exported to Victoria. Appendix A provides a description of the constraint and network configuration. While this major upgrade was flagged to the market as early as November 2015, its likely impact on Heywood's operating capability was not entirely clear, until it was included in forecasts prepared the day before.

The Tailem Bend constraint was binding for the majority of the day, forcing flows of up to 290 MW into Victoria.

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2 Refer to Appendix D for more information on FSIP

3 At 7 am on 4 July, a planned network outage commenced on equipment at Tailem Bend in South Australia as part of the Heywood interconnector upgrade. This outage continued until the evening of 14 July.

Murraylink was limited to around 220 MW into South Australia.[4]

Table 2 shows actual and forecast flows and import limits into South Australia across Murraylink and Heywood for the 6.30 am trading interval.

Table 2: Interconnectors - Actual and forecast net network capability for 6.30 am

Inter-Connector	Flows into Victoria (MW)			Import limit (MW)		
	Actual	4 hr forecast	12 hr forecast	Actual	4 hr forecast	12 hr forecast
Heywood	190	182	171	218	182	171
Murraylink	-220	-6	-23	-200	-6	-23

For the 6.30 am trading interval, flows into Victoria across Heywood were as forecast. At the same time flows into South Australia across Murraylink were 214 MW higher than forecast four hours ahead, compensating for the reduced output from wind generation in South Australia.

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4 The nominal limit on Murraylink is 220 MW.

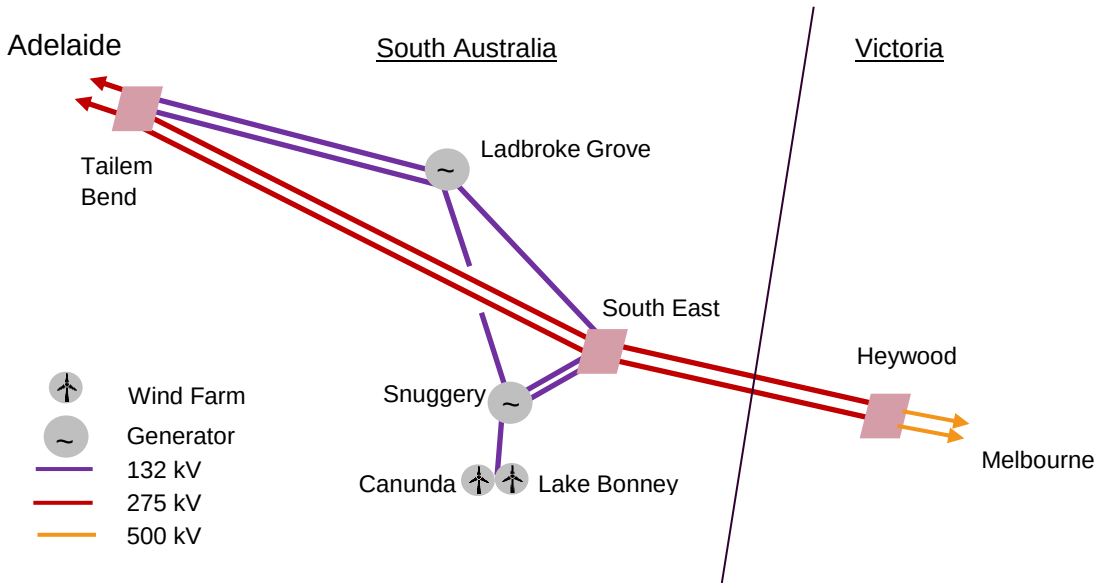
Appendix A: Network Diagram

In March 2014 the Heywood augmentation project to increase the capacity of the transmission system between South Australia and Victoria to 650 MW satisfied the Regulatory Investment Test (transmission). Until the completion of the augmentation, Heywood has a nominal capacity of 460 MW. While the Heywood interconnector is notionally only the lines between South East Substation and the Heywood Terminal Station it effectively comprised:

- four parallel circuits (two circuits operating at 275 kV and two circuits operating at 132 kV) between Tailem Bend (near Adelaide) and South East Substation (close to the border). These lines also deliver power to the load centres at Keith, Kincraig, Penola, Blanche and Mount Gambier; and
- two parallel 275 kV circuits between South East Substation to Heywood Terminal Station in south-west Victoria and two parallel 500 kV circuits from the Heywood Terminal Station to Moorabool Terminal Stations and on to the Sydenham Terminal Station 29 kms north west of Melbourne.

The upgrade works:

- reduce the number of parallel circuits in South Australia between Tailem Bend and South East Substation to three; and
- installs an additional transformer and associated switchgear at Heywood terminal station and compensation equipment along the transmission path.



The V::S_TB_275kV_W_B1 constraint was invoked to manage the outage of network equipment at Tailem Bend. The constraint contains six variables, all of which have a factor of one:

- Ladbroke units 1 and 2
- Lake Bonney units 2 and 3
- Snuggery unit 1 and,
- the Heywood interconnector.

This means that an increase in generation from these units or an increase in flow into South Australia across Heywood will reduce the headroom of the constraint, until it binds. Conversely reduced generation from the units or flows into Victoria increases the headroom. If the constraint is binding, flows on Heywood are optimised with local generation in the South East. For example a MW increase in generation in the South East must be balanced against either a MW reduction in flow into South Australia or a MW increase in flow into Victoria across Heywood.

Appendix B: Price setter

The following table identifies for 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. This information is published by AEMO.[5] The 30-minute spot price is the average of the six dispatch interval prices.

Table B1: Price setter for the 6.30am trading interval

DI	Dispatch Price	Participant	Unit	Service	Offer price	Marginal change	Contribution
06:05	$124.99	AGL (SA)	TORRB	Energy	$124.99	0.33	$41.25
		AGL (SA)	TORRB	Energy	$124.99	0.33	$41.25
		AGL (SA)	TORRB	Energy	$124.99	0.33	$41.25
06:10	$124.99	AGL (SA)	TORRB	Energy	$124.99	0.33	$41.25
		AGL (SA)	TORRB	Energy	$124.99	0.33	$41.25
		AGL (SA)	TORRB	Energy	$124.99	0.33	$41.25
06:15	$160.98	AGL (SA)	TORRB	Energy	$160.98	0.33	$53.12
		AGL (SA)	TORRB	Energy	$160.98	0.33	$53.12
		AGL (SA)	TORRB	Energy	$160.98	0.33	$53.12
06:20	$14 000.00	AGL (SA)	TORRB	Energy	$14 000.00	0.33	$4620.00
		AGL (SA)	TORRB	Energy	$14 000.00	0.33	$4620.00
		AGL (SA)	TORRB	Energy	$14 000.00	0.33	$4620.00
06:25	$14 000.00	AGL (SA)	TORRB	Energy	$14 000.00	0.33	$4620.00
		AGL (SA)	TORRB	Energy	$14 000.00	0.33	$4620.00
		AGL (SA)	TORRB	Energy	$14 000.00	0.33	$4620.00
06:30	$14 000.00	AGL (SA)	TORRB	Energy	$14 000.00	0.33	$4620.00
		AGL (SA)	TORRB	Energy	$14 000.00	0.33	$4620.00
		AGL (SA)	TORRB	Energy	$14 000.00	0.33	$4620.00
Spot Price		**$7068/MWh**					

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

Appendix C: Closing bids

Figures C1 to C5 highlight the half hour closing bids for participants in South Australia with significant capacity priced at or above $5000/MWh during the periods in which the spot price exceeded $5000/MWh. They also show generation output and the spot price.

Figure C1 - AGL (Torrens Island, The Bluff, Hallett Wind Farm, North Brown Hill) closing bid prices, dispatch and spot price

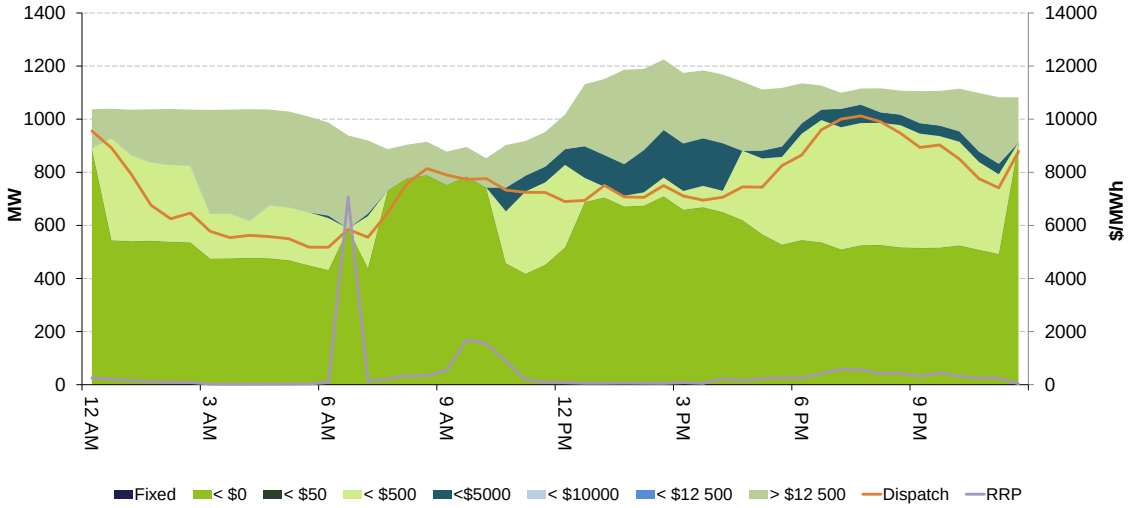


Figure C2 - EnergyAustralia (Hallett, Waterloo) closing bid prices, dispatch and spot price

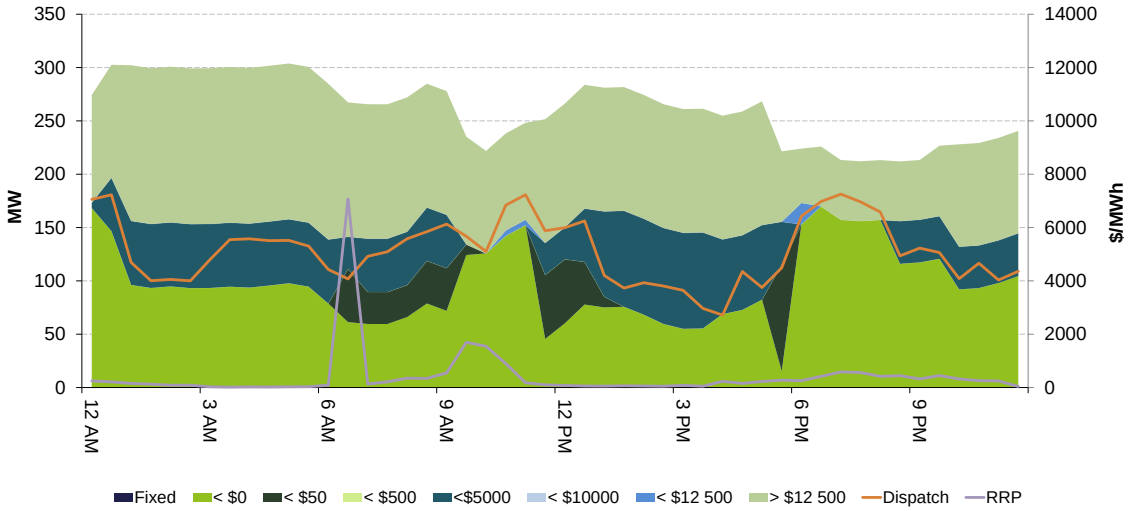


Figure C3 - Engie (Dry Creek, Mintaro, Port Lincoln, Snuggery) closing bid prices, dispatch and spot price

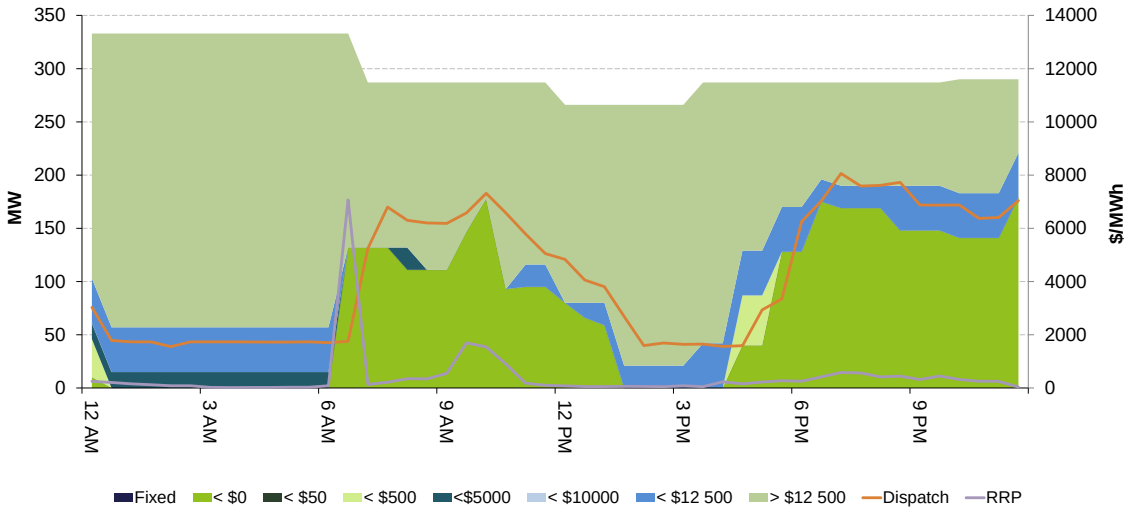


Figure C4 – Origin Energy (Ladbroke Grove, Osbourne, Quarantine)

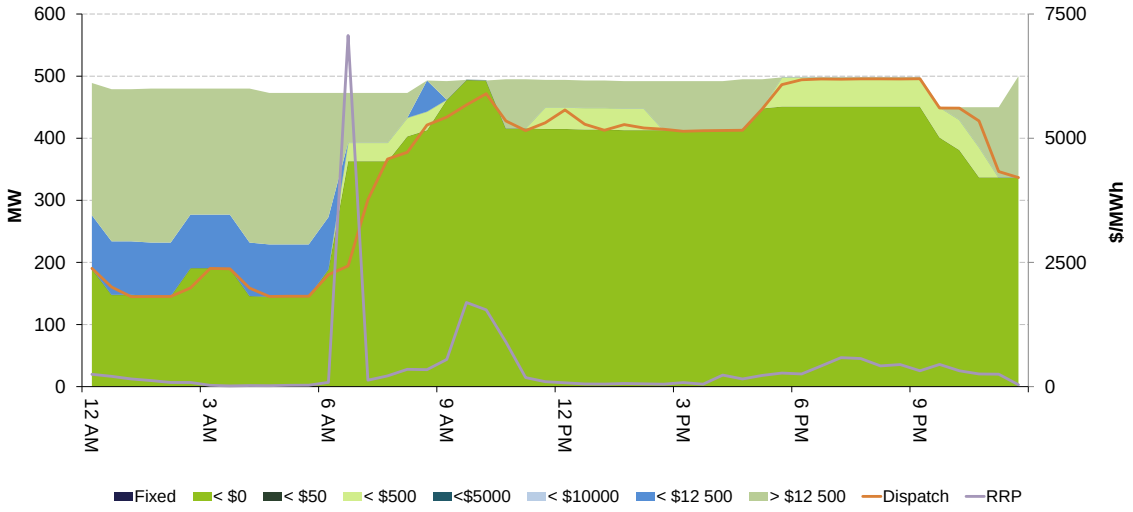
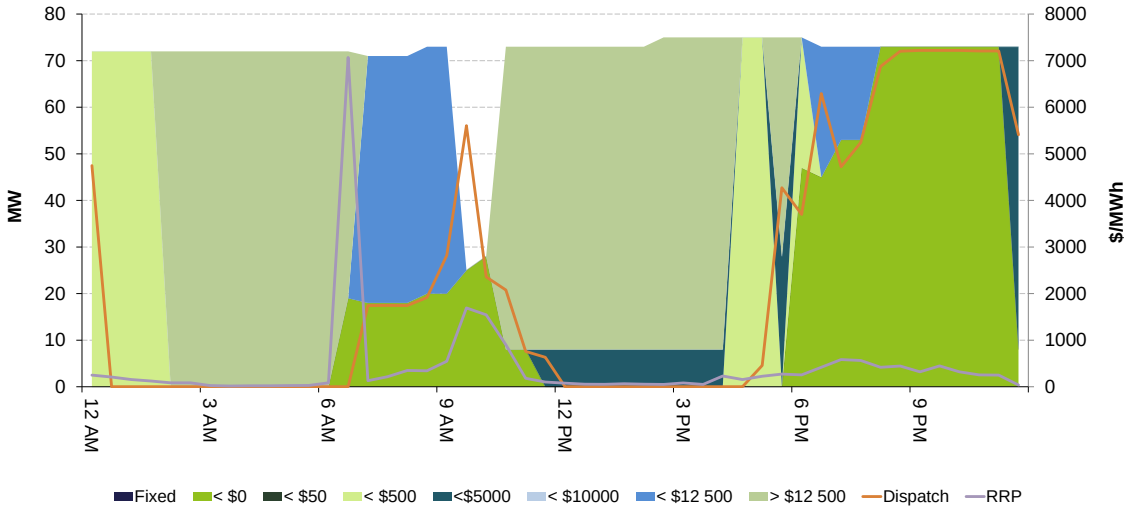


Figure C5 – Snowy Hydro (Angaston, Port Stanvac and Lonsdale)



Appendix D: Fast Start Inflexibility Profile

Generators which can start in less than half an hour can submit a fast start inflexibility profile (FSIP) that describes the time taken during start up and shut down, minimum run time and minimum output level after which the NEM dispatch engine can consider the unit free to operate.

The FSIP consists of five values, a minimum loading level (in MW) and four time periods (in minutes) as follows:

- T1 - the time required for the plant to synchronise its generator with the system, following a dispatch instruction to “start”.
- T2 - the time required for the plant to increase its output after synchronisation to reach its specified minimum loading level.
- T3 – the time required for the plant to operate at or above its minimum loading level before it can shut down.
- T4 - the time required to reduce from the minimum loading level to zero.

Figure D1 shows the FSIP times for three South Australian peaking plants that started and the times at which they received a start target during the 6.30 am trading interval.

Figure D1: FSIP profile for Ladbroke unit 1 and 2 and Snuggery

Unit	T1 (min)	T2 (min)	T3 (min)	T4 (min)	Min load (MW)	Received a start signal
Ladbroke unit 1	6	1	51	1	5	6.20 am
Ladbroke unit 2	6	1	51	1	5	6.20 am
Snuggery	6	1	15	5	6	6.25 am