NEMMCO

National Electricity Market Management Company Limited
ABN 94 072 010 327

Market Event Report:

High Temperatures and Bushfires 7 and 8 February 2009

Prepared by: Market Operations Performance

Final

1. Introduction

This report discusses the market outcomes when south east Australia, particularly Victoria, experienced severe weather conditions with high temperatures and bushfires on 7 and 8 February 2009. Two brief pricing reports, one covering the event for each calendar day, were published on NEMMCO's website following each event (http://www.nemmco.com.au/opreports/pricing_feb.html).

All NEM regions experienced price fluctuations on 7 and 8 February 2009. The peak energy price over the two days was experienced in New South Wales at $3,006.80/MWh on the afternoon of 8 February 2009. Tasmanian, Victorian and South Australian regions experienced negative energy prices for 24 trading intervals (TIs), 16 TIs and 9 TIs respectively over the two days. The Frequency Control Ancillary Services (FCAS) prices in Tasmania, Victoria and South Australia reached $10,000/MWh. FCAS prices in other regions were not materially affected.

The New South Wales and South Australian regions experienced extremely high temperatures on 7 February 2009. Victoria also experienced severe weather conditions with the combination of extremely high temperatures of above 45˚C, low humidity, very strong winds, lightning and bushfires. The following market outcomes were observed over the two days:

- Four price spikes of between $1500/MWh and $3000/MWh in various regions;
- Sustained negative price periods, particularly in the Tasmanian region;
- FCAS price spikes to $300/MW/h on the mainland and to $10,000/MW/h in Tasmania; and
- Approximately $1,618,000 of negative residues were accrued.

This report examines the market outcomes during this period.

Two power systems reports have been published (NEMMCO Communications No. 3255 and 3256) to detail the chronology of the power system event. A power system incident report covering the power system operational aspects of this event will be published in due course.

2. Energy pricing outcomes

Error! Reference source not found. Figure 1 shows the 30-minute trading interval energy prices in the NEM and Table 1 summarises the events when the energy prices were either above $300/MWh or below $0/MWh.

Figure 1 - Trading Interval Energy Prices in the NEM ($/MWh)

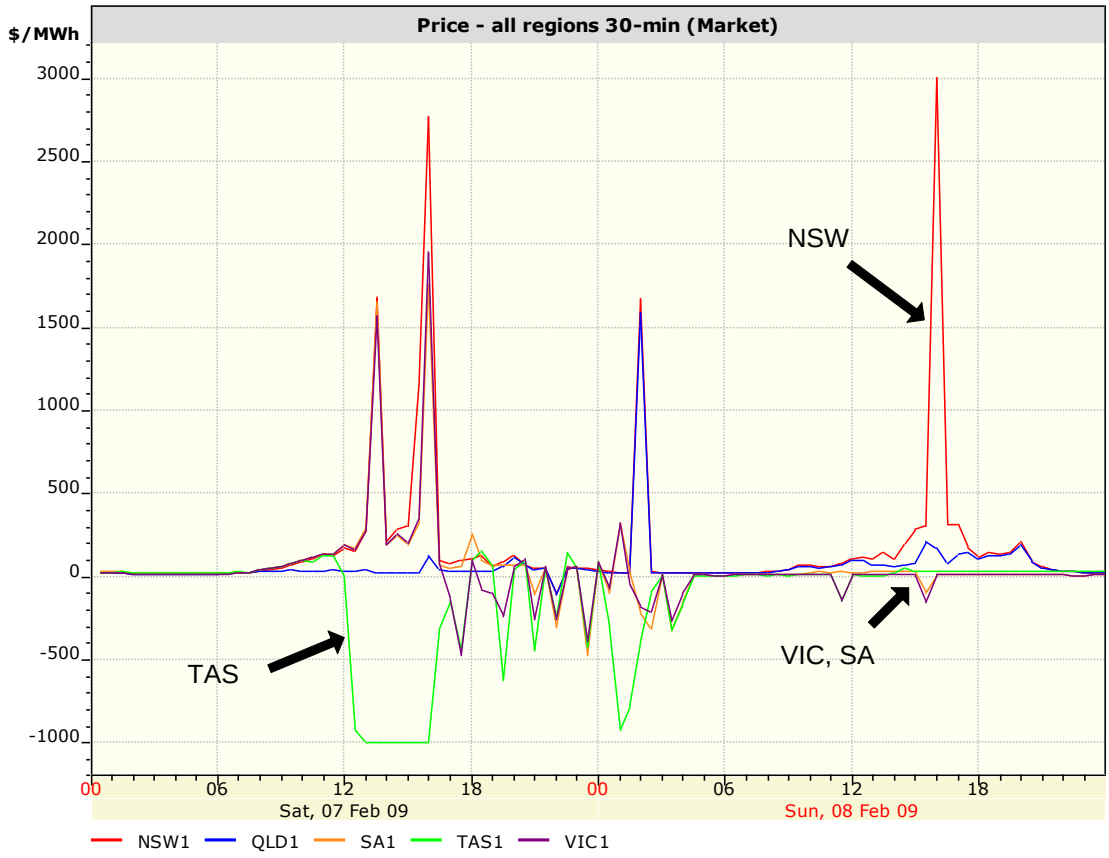


Table 1 - Trading Interval Energy Prices Above $300/MWh and Below $0/MWh

Date	Regions	Max Spot Price (Above $300/MWh)	Duration when Spot Prices > $300/MWh	Min Spot Price (Below $0/MWh)	Duration when Spot Prices < $0/MWh
7 February 2009	NSW	2772.67	2hrs	-106.15	0.5hrs
	QLD			-108.09	0.5hrs
	SA	1762.65	2hrs	-471.61	1.5hrs
	TAS			-999.71	8hrs
	VIC	1951.33	1.5hrs	-474.84	4hrs
8 February 2009	NSW	3006.8	2.5hrs		
	QLD	1593.85	0.5hrs		
	SA	319.76	0.5hrs	-324.2	3hrs
	TAS			-920.09	4hrs
	VIC	322.68	0.5hrs	-266.92	4hrs

2.1 Energy Price Fluctuations

The NEM regions all experienced significant price fluctuations between TI 12:00hrs on 7 February 2009 and TI 17:00hrs on 8 February 2009. During that period, the transmission system of the Victorian region was affected by bushfires and the maximum temperature recorded in Melbourne was above 45˚C on 7 February 2009. The temperatures in Adelaide (South Australia) and Bankstown (New South Wales) peaked above 41˚C and 39˚C respectively on the same day. As a result, the maximum demand in South Australia, Victoria and New South Wales reached very high levels of 2835MW, 9043MW and 12878MW respectively. The Administered Price Periods applying in the Victorian and South Australian regions since 29 January were terminated at 04:00 hrs on 6 and 7 February respectively, and did not affect the market outcomes in the period covered by this report. The cumulative energy prices for all regions fell away to less than 30% of the $150,000 threshold during this event. The remainder of this section presents a chronology of events that led to the energy price fluctuations.

The Tasmanian region saw negative prices from DI 12:00hrs to DI 17:30hrs on 7 February 2009 when local generators offered more than 70% of their generation capacity in the bands priced at less than $0/MWh. The average energy price for the region over the day was -$181.69/MWh.

The New South Wales, Victorian and South Australian regions saw a price spike (to $8800.84/MWh in NSW) at DI 13:25hrs on 7 February 2009 which coincided with the declaration of the loss of both Bayswater to Mt Piper (73) and Bayswater to Wallerawang (74) 330kV transmission lines as a credible contingency due to bushfire in the vicinity. A constraint equation was invoked from DI 13:20hrs to DI 15:45hrs to manage power system security under the reclassification. This resulted in a combined reduction in southerly flow on the QNI and Terranora interconnectors of approximately 540MW.

A Lack of Reserve (LOR) 2 condition was declared in Victoria from 15:00hrs on 7 February 2009 until 14:25hrs on 8 February 2009. This coincided with the classification of the trip of the Hazelwood to South Morang (No.1 and No.2) 500kV transmission lines as a credible contingency due to bushfires in the vicinity.

Each of the Hazelwood to South Morang No.1 and No.2 transmission lines independently tripped and reclosed at various times during the day due to bushfires (including 11:58hrs, 13:32hrs, 15:35hrs and 15:47hrs). Other transmission lines that were affected by bushfires include Dederang to South Morang No.1 and No.2 330kV, Eildon to Thomastown 220kV and Dederang to Glenrowan No.1 and No.3 220kV lines. A chronology of the power system events was distributed to market participants in NEMMCO Communication No. 3255 (Operations Report: Abnormal Conditions – Severe Weather Conditions and Bush Fires, Victoria region, 7 – 8 February 2009).

The New South Wales, Victoria and South Australia regions saw another price spike at DI 15:45hrs when the Basslink interconnector tripped from around 470MW of support into Victoria, due to excessive voltage rise following the trip of the Hazelwood to South Morang No.1 line at 15:35hrs. This resulted in over-frequency in the Tasmanian region, which required the tripping of several generator units including Reece 1, Reece 2, Tribute and Poatina. For DI 15:45hrs, the target flow on the interconnector was constrained to 0MW. The interconnector returned to service at DI 16:05hrs.

From the late afternoon on 7 February 2009 to early morning on 8 February 2009, the energy prices in Victoria, Tasmania and South Australia fluctuated between marginally above $0/MWh and near the market floor price of -$1000/MWh. Energy prices in South Australia started fluctuating at a later period from DI 20:45hrs on 7 February 2009. The price fluctuations followed the movement between binding/violating and non-binding states of a constraint equation managing the security of the western Victorian transmission system. This equation, when binding, constrained on some generators in north-eastern Victoria resulting in the need to back off some negatively priced generation in Latrobe Valley area.

On Sunday, 8 February 2009 at 00:16hrs, the Dederang to Shepparton 220kV line and the Buronga to Balranald 220kV line tripped due to bush fires and lightning in the vicinity. This resulted in the separation of the Victorian and New South Wales transmission systems. This separation did not occur at the regional boundary, and the north-eastern Victoria hydro generators (including Murray, West Kiewa, Eildon and McKay) supplied most of their generation capacity into New South Wales. During this separation event, Tasmania saw negative energy prices while the Victorian and South Australian energy prices fluctuated between negative and positive values.

After the power systems were resynchronised, the New South Wales and Queensland generation was increased at DI 02:00hrs when the target flow on the VIC-NSW interconnector reduced from 1344MW at DI 01:55hrs to 403MW at 02:00hrs (flowing in the Victoria to New South Wales direction). The step change on the interconnector target flow was due to the revocation of the constraint equation that manages the region separation and some generators shifting their generation capacity to different price bands (see section 5). This resulted in a large number of New South Wales and Queensland generators being fully dispatched and ramp rate constrained to balance the VIC-NSW interconnector reduction, leading to high prices in the New South Wales and Queensland regions.

The New South Wales region saw high prices for DIs 15:55 hrs and 16:00 hrs in the afternoon of 8 February 2009 after a local generator tripped from approximately 636MW at 15:00hrs. At the same time there was a 50MW increase in the flow from New South Wales into Victoria to support restoration of 60MW of load shed earlier from the Victorian outer 220kV grid, and a power system security constraint equation managing the flow on the 965 Armidale to Kempsey 132kV line in northern NSW bound for the two DIs. The flow on the 965 line is no longer managed by constraint equations as a variable phase-shifting transformer and local power control system has been commissioned at Armidale since this event.

2.2 Over-constrained dispatch (OCD)

A total of 22 automatic Over-Constrained Dispatch (OCD) re-runs were triggered on 7 and 8 February 2009. The OCD[1] re-runs are triggered when constraint equations violate and the original dispatch price is either above the market cap price or below the market floor price. The automatic OCD process relaxes the constraint equation by the violation amount, then re-running the NEMDE solver. A manual OCD process is required if, after the automatic process, an eligible constraint equation is violated and the calculated dispatch price is still either above the market cap price or below the market floor price. This manual process of determining and amending the dispatch and trading prices is carried out by the end of the next business day. The price solution from the manual OCD process (if it is performed) is used for the settlement calculation.

[1] See “Over-Constrained Dispatch Process Stage 1 Changes Business Specification” (http://www.nemmco.com.au/powersystemops/140-0075.pdf)

During the period in review, two dispatch intervals were subjected to manual OCD re-runs. One of these intervals required price adjustments, as listed in Table 2.

Table 2 - Manual OCD 7 February 2009 DI 20:45hrs

Dispatch Interval	Region ID	Market	Original Published Price	Final OCD Price
7 February 2009 DI 20:45hrs	NSW1	Energy	$ 5.08	$ 17.00
	QLD1	Energy	$ 4.83	$ 16.16

The prices were updated in all relevant NEMMCO records within the prescribed time limits.

2.3 Price Revisions

Prices for 59 DIs were triggered as "subject to review" due to a step change in regional energy prices and interconnector dispatch targets. The thresholds are available from NEMMCO's annual review[2] of price revision triggers. The prices for 58 of the 59 DIs were accepted as they were not affected by manifestly incorrect inputs (MIIs) and the prices for one DI were rejected.

On 8 February 2009, NEMMCO identified DIs 09:40hrs to 10:05hrs as being affected by an MII. *t* was found that incorrect constraint equations had been invoked during this period which firstly affected dispatch outcomes for the Terranora interconnector flow then affected the QNI interconnector flow.

The intervals between DIs ending 09:40hrs to 09:55hrs were not triggered as "subjected to review" (STR) as the change in prices and interconnector flows were not above the trigger threshold. The DI 10:00hrs and DI 10:05hrs were automatically triggered as STR in accordance with National Electricity Rule (NER) 3.9.2B. The prices at DI 10:00hrs were rejected and replaced with the corresponding prices for the preceding DI 09:55hrs.

In accordance with Rule 3.8.24(a)(3), a scheduling error occurs when NEMMCO determines that a dispatch interval contained a manifestly incorrect input. As incorrect constraint equations were invoked for dispatch intervals prior to that identified by the automatic process, NEMMCO determined[3], in accordance with Rule 3.8.24(a)(2) that a scheduling error occurred for the period 09:35hrs to 10:10hrs (i.e. from DI 09:40hrs to DI 10:10hrs).

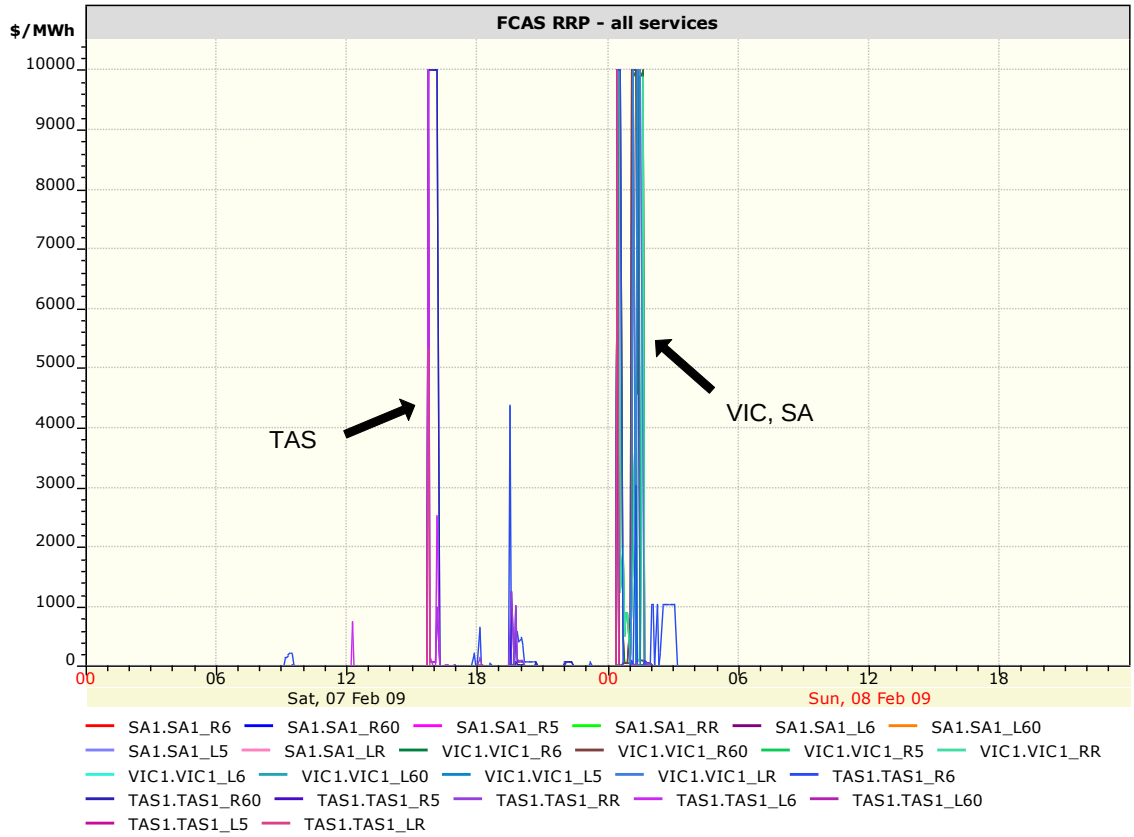
2.4 Frequency Control Ancillary Service (FCAS) prices

The FCAS prices in Tasmania increased to a peak of $10,000/MW/h on 7 February 2009 when the Basslink interconnector tripped, as shown in Figure 2. The Tasmanian, Victorian and South Australian regions saw FCAS prices reach $10,000/MW/h in the early morning of 8 February 2009 when the power system in Victoria was separated from New South Wales network.

The FCAS prices in other mainland NEM regions were not materially affected.

[2] See "Effectiveness of Procedures for Manifestly Incorrect Inputs" (http://www.nemmco.com.au/powersystemops/140-0104.html)
[3] Refer to the price revision report (http://www.nemmco.com.au/opreports/150-0082.pdf) for further information.

Figure 2 - 5-minute FCAS Prices for All FCAS Prices ($/MWh) in VIC, SA and TAS



2.5 Other Market Impacts

The amounts of negative residues accrued on various directional interconnectors on 7 and 8 February 2009 were:

- $7,941 – Victoria to South Australia
- $272,448 – South Australia to Victoria;
- $38,195 – Victoria to New South Wales; and
- $1,299,581 – New South Wales to Victoria.

The majority of the negative residues on the Victoria to South Australia directional interconnector was accumulated at TI 13:30hrs on 7 February 2009. During that period, the loss of both Bayswater to Mt Piper (73) and Bayswater to Wallerawang (74) 330kV transmission lines had been reclassified as a credible contingency event due to bushfire in the vicinity, as discussed in section 2.1.

The negative residues on the South Australia to Victoria directional interconnector were accumulated during the period TI 17:30hrs to TI 19:30hrs of the afternoon of 7 February 2009). Over this period NEMMCO applied a discretionary constraint equation[4] to force 250MW of South Australian supply into western Victoria to maintain power system security of that network. The energy prices in South Australia remained positive while those in Victoria fluctuated from marginally above $0/MWh to near the market floor price of -$1000/MWh due to fluctuations of the constraint equation RHS as discussed in section 3.

[4] See Market Notice 24908 (http://www.nemmco.com.au/data/market_notices/MARKETNOTICEINDEX.SHTM)

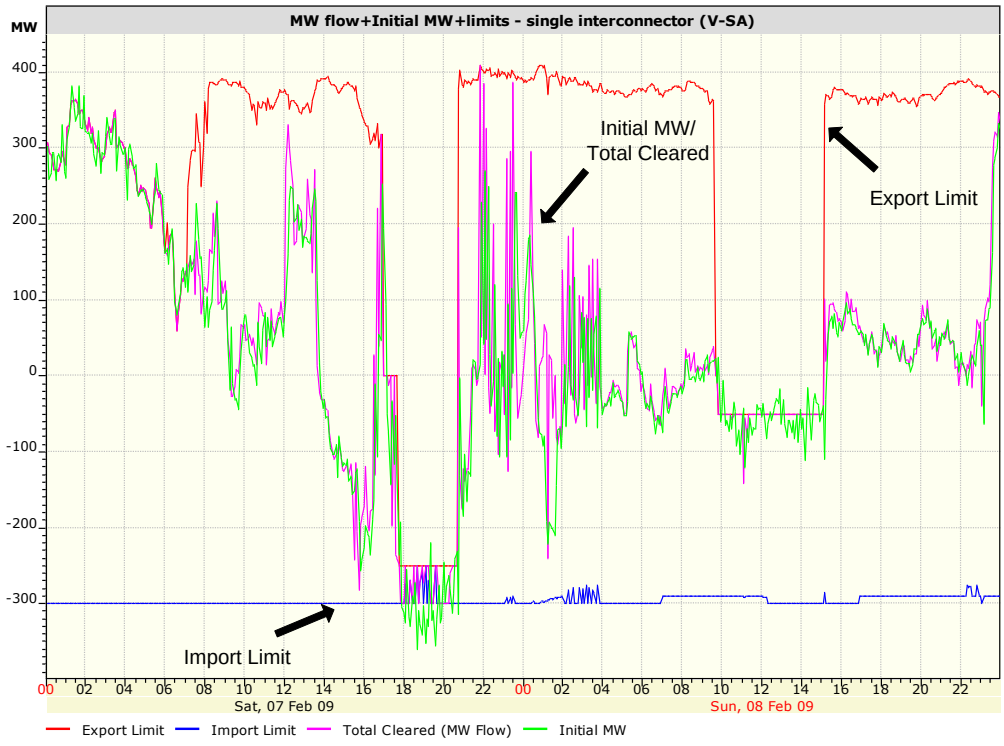
$38,195 of negative settlement residues was accumulated on the Victoria to New South Wales interconnector at TI 01:00hrs on 8 February 2009. During this period, the Victoria and New South Wales regions were separated. As the separation was not at the regional boundary, the economic dispatch of the north-east Victorian hydro generators based on their offers could not assist to reduce the price at the Victorian regional reference node. Counter-price flows of up to 600MW into NSW occurred in this TI. These negative settlement residues were insignificant compared to more than $1M of positive residues which accrued in TI 02:00, when the NSW energy price spiked to $10,000/MWh.
The majority of the negative residues on the New South Wales to Victoria directional interconnector were accumulated on the afternoon of 8 February 2009, with a spike to $563,000 at TI 16:00hrs accounting for about half of the total. The New South Wales energy price was $3,006.80/MWh for that TI.

3. Interconnectors

The following figures show the target flows and limits for Heywood, Basslink, VIC-NSW and Murraylink interconnectors on 7 and 8 February 2009. The interconnector limits are calculated for each interconnector in turn by assuming that all other variables remained unchanged. Therefore, the same constraint violation can be shown in the limits of multiple interconnectors.

On 7 February 2009, between DI 17:00hrs and DI 20:40hrs, a discretionary constraint equation was invoked to constrain the Heywood interconnector flow to ensure that the flow was from South Australia to Victoria, as discussed in section 2.5. The intention was to manage security in the Victorian power system that was weakened by the transmission line outages. The flow on the interconnector was constrained again on 8 February 2009 between DI 9:40hrs and DI 15:05hrs, for the same purpose. The interconnector flow and limits are shown in Figure 3. During the periods when the Heywood interconnector flow was constrained, both energy and FCAS prices in Victoria and South Australia were not materially affected.

Figure 3 - V-SA Target Flows and Limits (MW)



The Basslink interconnector flow was from Tasmania to Victoria on 7 February 2009, when local generators offered more than 70% of their generation capacity in the bands priced at less than $0/MWh. The interconnector tripped at DI 15:45hrs and returned to service by DI 16:00hrs on the same day due to excessive voltage rise following the trip of the Hazelwood to South Morang No.1 line at 15:35hrs. The market impact resulting from the reduction of 478MW of Basslink target flows is outlined in section 2.1.

Figure 4 - T-V-MNSP1 Target Flows and Limits (MW)

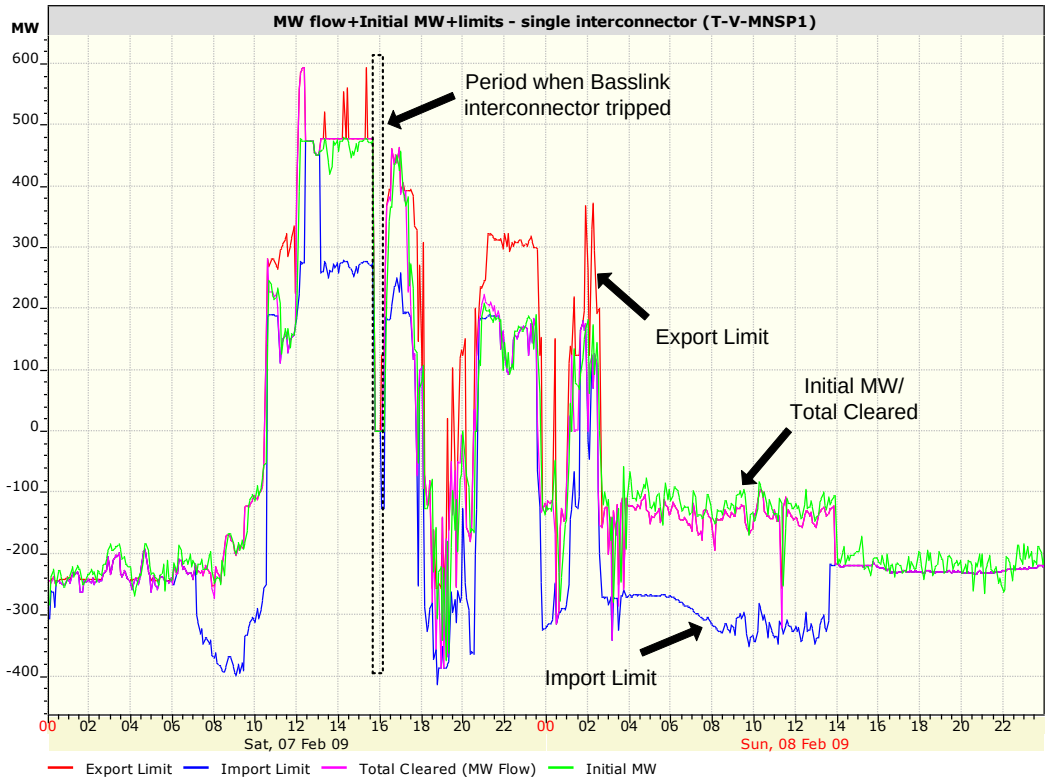
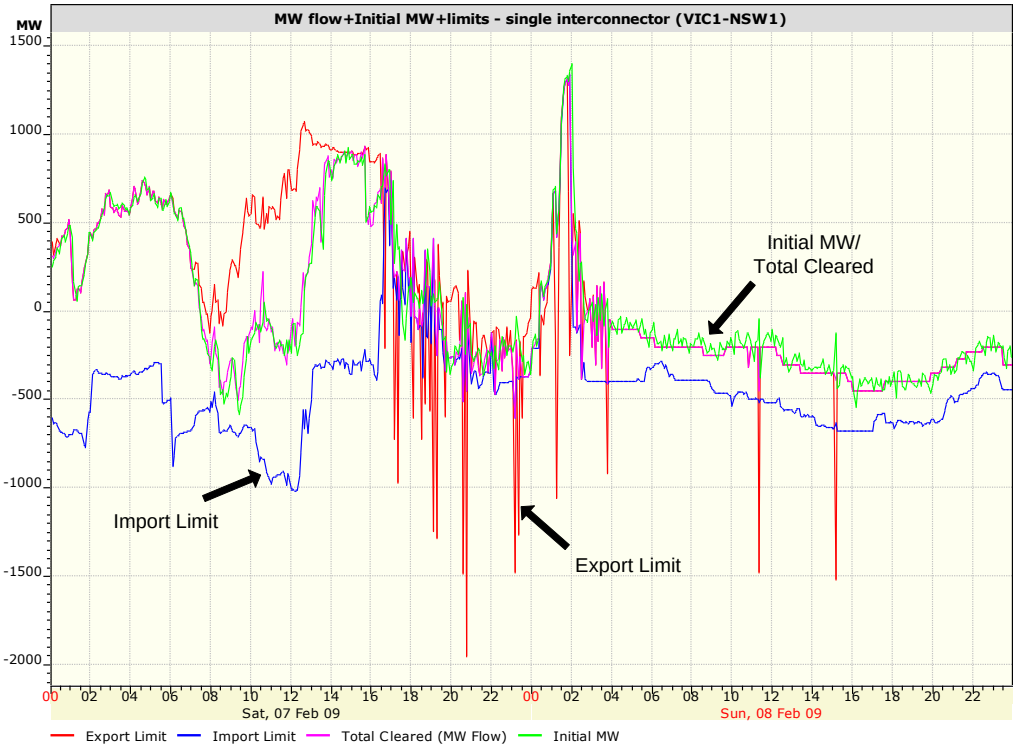


Figure 5 shows that the transfer capability on the VIC-NSW interconnector reduced from DI 16:25hrs on 7 February 2009. This was due to the unplanned outage of the Dederang to South Morang 330kV lines due to bushfires.

The constraint equation that sets the export limit of both the VIC-NSW and Murraylink interconnectors violated for several DIs on 7 and 8 February 2009, as shown in Figure 5 and Figure 6. The equation limits the Victorian generation and both interconnector flows to avoid overloading the Ballarat to Moorabool No.2 line after a trip of the No.1 line. During this period, the right hand side of the constraint equation fluctuated considerably. The SCADA data which inputs to the right hand side of this constraint equation include the MW output of several Victorian generating units and the power flow on the Ballarat to Moorabool transmission 220kV line. The fluctuation of the latter input contributed to the changes in the right hand side of the constraint equation. Offline analysis indicated that the constraint equation operation is consistent with the power system condition at that time.

From DI 03:40hrs on 8 February 2009, several hours after the separation event, the VIC-NSW interconnector flow was constrained in the New South Wales to Victoria direction to manage power system security in the Victorian outer 220kV grid. This resulted in the accumulation of negative residues across the New South Wales to Victoria directional interconnector as discussed in section 2.5 above.

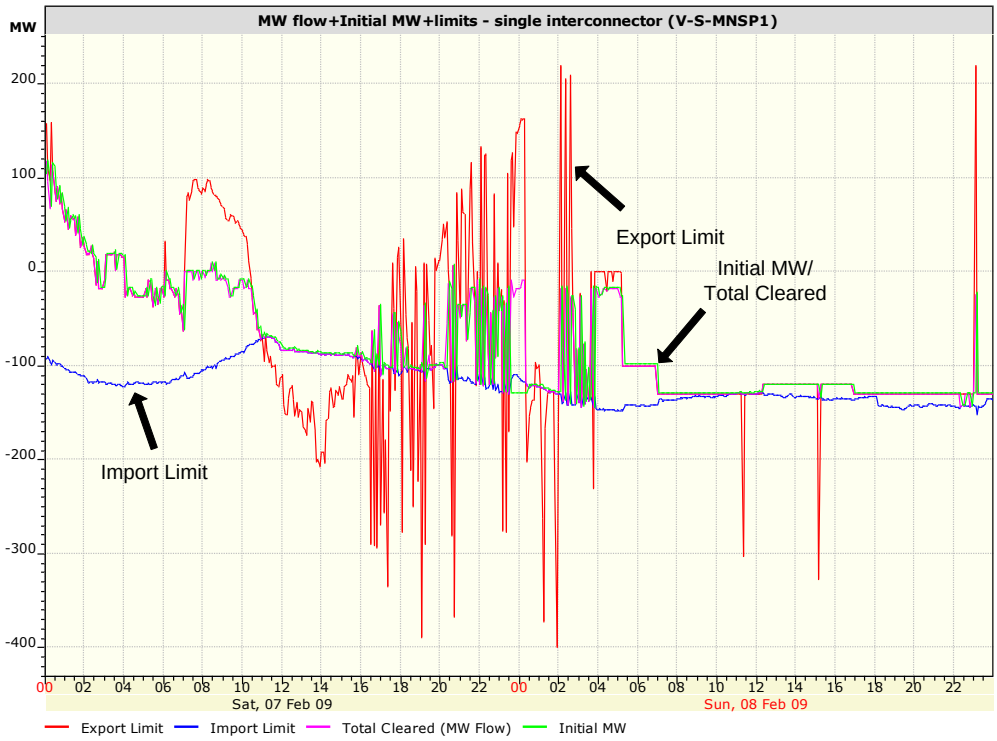
Figure 5 - VIC1-NSW1 Target Flows and Limits (MW)



Violation of constraints on interconnector flows is manifest for those DIs where the export limit (red trace) is less than the import limit (blue trace). During these DIs, the constraint equation that sets the import limit of the Murraylink interconnector has a higher constraint violation penalty[5] (CVP) factor. This means that it cost more to violate this constraint equation. With the severe weather conditions affecting the power system, the constraint equation that sets the export limit of the interconnector had to be violated. The reason behind the fluctuation of this export limit constraint equation (that manages the Ballarat to Moorabool lines) was discussed above. Although the occurrence of an interconnector export limit being less than the import limit is unusual, it can exist under extreme network conditions where constraint equations violate.

[5] See http://www.nemmco.com.au/powersystemops/140-0011.pdf

Figure 6 - V-S-MNSP1 (Murraylink) Target Flows and Limits (MW)

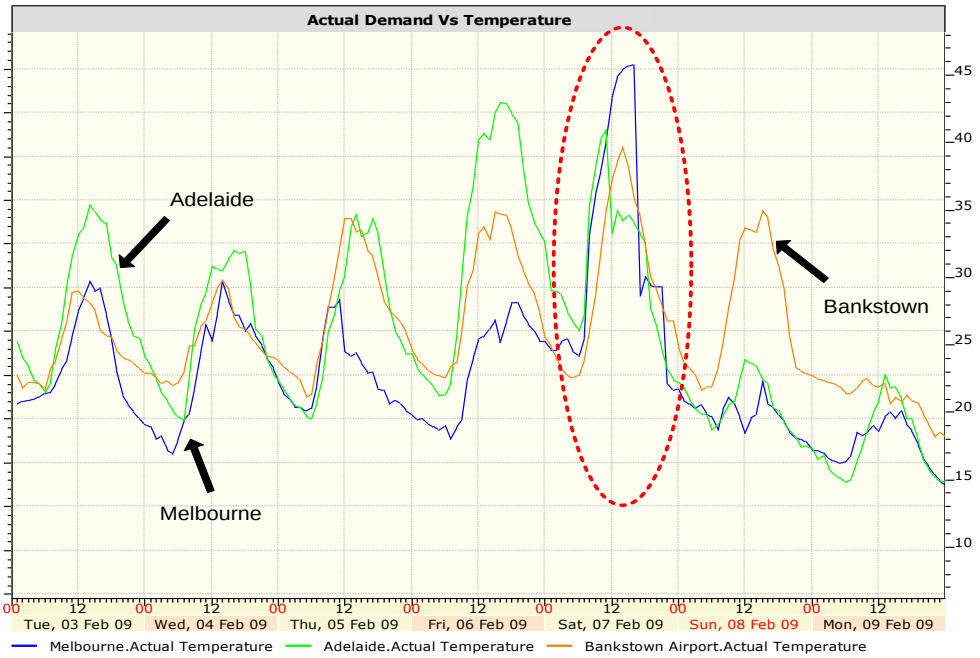


4. Temperature

The following figure shows the temperatures in Melbourne (Victoria), Adelaide (South Australia) and Bankstown (New South Wales) for the week 2009 were in excess of 45˚C, 41˚C and 39˚C respectively. These peak temperatures were ending 9 February 2009. The peak temperatures in each of the areas on Saturday, 7 February were unusually high for this time of the year. The peak demand in each of the regions on the day was 9043MW, 2835MW and 12,878MW respectively, which are below the summer 10% POE[6] for each of the regions.

[6] Probability of Exceedance

Figure 7 - Temperatures in Melbourne, Adelaide and Bankstown (in ˚C)



5. Generating Plant Offers

Figure 8 shows the 5-minute bid stack of the Tasmanian generators on 7 and 8 February 2009. The energy prices in the Tasmanian region dropped to near market floor price from DI 12:00hrs to DI 17:30hrs on 7 February 2009 when local generators offered more than 70% of their generation capacity in the bands priced at less than $0/MWh.

Figure 9 shows the 5-minute bid stack of the north-eastern Victorian hydro generators during the network separation period of Victoria and New South Wales region. Some of the generation capacity offered by these generating units was shifted to the lower priced bands during the separation period. The impact of this on settlement residues was discussed above in section 2.5.

Apart from this aspect, generating plant offers were typical during the period of this event.

Figure 8 - 5-minute Bid Stack of Tasmanian Generators

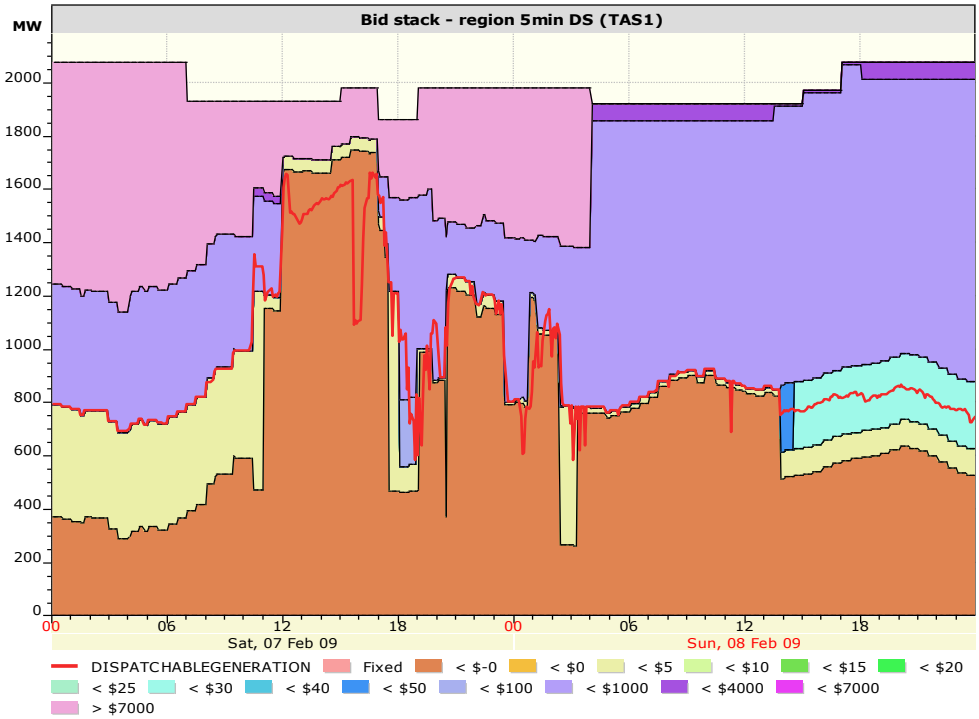
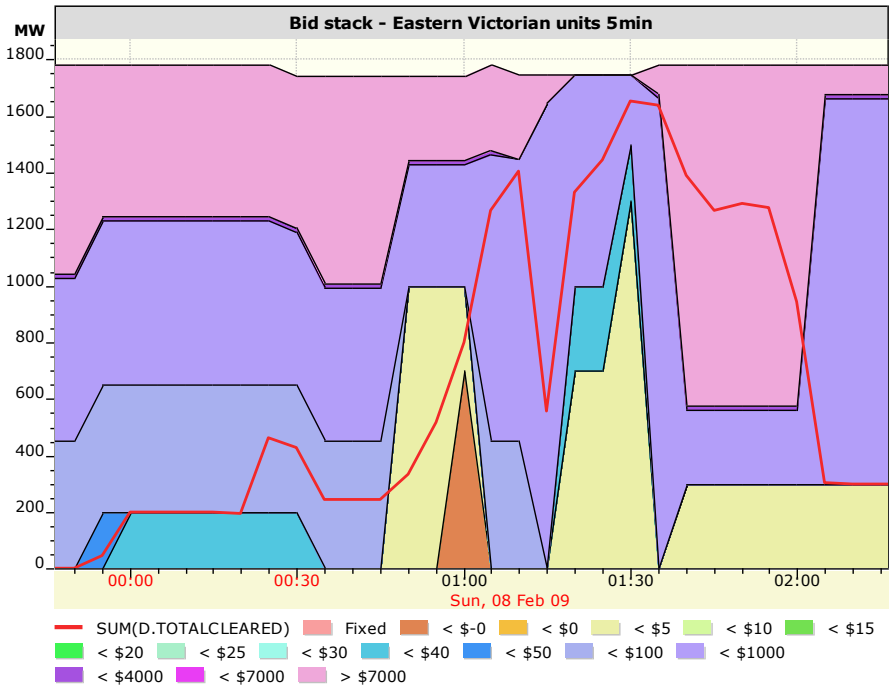


Figure 9 - 5-minute Bid Stack of North-Eastern Victorian Hydro Generating Units



6. Conclusions

The NEM regions saw significant energy and FCAS price fluctuations on 7 and 8 February 2009. The principal features of the event were:

- Reduced transmission network capability in Victoria due to bushfires affecting the Hazelwood to South Morang, Dederang to South Morang and Eildon to Thomastown lines;
- Basslink interconnector tripped at DI 15:45hrs and returned to service by DI 16:00hrs on 7 February 2009;
- Network separation between the Victorian and New South Wales grids in the early morning of 8 February 2009;
- A Lack Of Reserve (LOR) 2 condition was declared in Victoria from 15:00hrs on 7 February 2009 until 14:25hrs on 8 February 2009; and
- Approximately $1,618,000 of negative residues were accrued.

Dispatch and pricing outcomes appear to be consistent with the dispatch offers and power system conditions during this event. NEMMCO declared a scheduling error occurred for the period 09:35hrs to 10:10hrs (i.e. from DI 09:40hrs to DI 10:10hrs) on 8 February 2009 when incorrect constraint equations were invoked.

Appendix A – Glossary of Abbreviations

Abbreviation	Meaning
APP	Administered Price Period
DI	Dispatch Interval
DS	Dispatch
FCAS	Frequency Control Ancillary Services
L6	Lower 6 second FCAS service
L60	Lower 60 second FCAS service
L5	Lower 5 minute FCAS service
LHS	Left Hand Side
LOR	Lack Of Reserve
LReg	Lower regulation FCAS service
NEM	National Electricity Market
NEMDE	National Electricity Market Dispatch Engine
NEMMCO	National Electricity Market Management Company
OCD	Over Constrained Dispatch
PD	Pre-dispatch
R6	Raise 6 second FCAS service
R60	Raise 60 second FCAS service
R5	Raise 5 minute FCAS service
RHS	Right Hand Side
RReg	Raise regulation FCAS service
RRP	Regional Reference Price
TI	Trading Interval