

# **Indicators of the market impact of transmission congestion**

Report for 2006–07

November 2007

# Contents

<b>Contents .....</b>	<b>i</b>
<b>Summary.....</b>	<b>2</b>
Total cost of constraints .....	3
Outage cost of constraints .....	5
Marginal cost of constraints.....	5
Qualitative assessment .....	6
<b>1 Total cost of constraints.....</b>	<b>7</b>
1.1 TCC results .....	7
<b>2 Outage cost of constraints .....</b>	<b>10</b>
2.1 OCC results.....	10
<b>3 Marginal cost of constraints.....</b>	<b>12</b>
3.1 MCC results .....	12
3.2 Qualitative assessment .....	16
<b>Appendices.....</b>	<b>21</b>

## Summary

On 13 June 2006 the Australian Energy Regulator released its decision to publish indicators of the impact that transmission networks can have on the rest of the electricity market.<sup>1</sup> The AER aims to improve the current service standards regime by moving towards a regime that is directly linked to market outcomes.

The first stage in developing the new service standards incentive scheme was the publication of annual reports covering the market impacts of transmission congestion for the financial years 2003-04, 2004-05 and 2005-06. As a second stage, the AER has published its draft decision on a service standards regime aimed at reducing the cost of transmission congestion<sup>2</sup>.

This report covers the market impacts of transmission congestion for the 2006-07 financial year. The aim of this report is to:

- identify the market impact and causal elements of constraints
- provide information to participants that will be used as a tool for guiding behavioural decisions, therefore promoting efficient market participant behaviour

The AER has developed three measures of the impact of congestion on the cost of electricity. The measures relate to the cost of using more expensive plant than would be used in the absence of congestion. Two measures (TCC and OCC) focus on the overall impact of constraints on electricity market outcomes, while the third measure (MCC) identifies which particular constraints have the greatest impact.

The measures aim to show how congestion raises the cost of producing electricity, taking account of the costs of each individual generator. Under the model, if the bidding of generators reflects their true cost position, the new measures will be an accurate measure of the economic cost of congestion and makes an appropriate basis to develop incentives to mitigate this cost. However, if market power allows a generator to bid above its true cost structure, then the measures will reflect a mix of economic costs and monopoly rents.

This report, for the period 2006-07, includes:

- the total cost of constraints (TCC)
- the outage cost of constraints (OCC)
- the marginal cost of constraints (MCC) together with a qualitative assessment of those constraints with high market impacts.

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<sup>1</sup> *Indicators of the Market Impact of Transmission Congestion—Decision*, AER, 9 June 2006.

<sup>2</sup> *Service Target Performance Incentive Scheme - Draft Decision* AER, 19 November 2007

The TCC and MCC indicators are complementary. The TCC aims to estimate the cost of all transmission constraints. It does this by measuring the reduction in dispatch cost of generation that would occur if all transmission constraints were removed. It does not, however, identify the cause of these market impacts. The MCC examines the marginal value of individual constraint equations over time to identify the particular network elements that contribute to these market impacts. The TCC is an indicator of the quantum of the total market impact of transmission congestion, while the MCC indicates the underlying cause at the margin. The indicators in this report include the congestion within the Tasmanian transmission network and exclude the congestion on Basslink<sup>3</sup>.

In its qualitative assessment, this report focuses on the constraints identified as those having had a major impact during 2006–07 and explains the circumstances that led to these impacts.

## **Total cost of constraints**

The TCC is an indicator designed to estimate the cost of all transmission constraints. Simply, the TCC is the answer to the question:

If all transmission network limits were removed, how much would the total cost of generating sufficient electricity to meet demand be reduced?

The TCC, like the OCC and MCC measures, values the cost of producing electricity using the prices at which each generator offers its output to the market.

During 2006–07 the TCC was \$107 million with two thirds of this accumulating on 16 days. This represents a significant increase compared to \$66 million in 2005–06, \$45 million in 2004–05 and \$36 million in 2003–04. The TCC has continued to exhibit a high volatility.

Two significant market events during the year were reflected in the TCC:

- On 16 January a bushfire in northern Victoria caused the loss of both Dederang to South Morang lines, which led to the separation of the power system, into three electrical islands and the loss of supply to 2200MW of customer load in Victoria. Before the transmission lines failed a record demand was reached in Victoria. The TCC for the day totalled \$2.3 million. Two thirds of the TCC on this day accumulated before the power system incident.
- In June the TCC totalled to \$46 million. Around 40 per cent of this or \$18 million accrued in just eight hours over ten days during the evening peak period when the five minute dispatch price exceeded \$5000/MWh in the New South Wales, Queensland or Snowy regions.

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<sup>3</sup> Basslink is an unregulated interconnector. The TCC and OCC indicators were developed to estimate the market impacts of regulated transmission congestion. In the modelling, flows across Basslink are limited to the offers from that participant, just as for other market generators. All other interconnectors are able to flow above the nominal import and export limits.

The AER has reported separately on each of these events.

Table 1 lists the date, the associated TCC amount and locations identified to have a high impact on network congestion for those 16 days.

**Table 1 —High TCC events**

<b>Date</b>	<b>Locations</b>	<b>TCC</b>
17/08/2006	Outages around South Pine in Queensland	\$2.5m
18/08/2006	Outages around South Pine in Queensland	\$2.2m
21/08/2006	Outages around South Pine in Queensland	\$2.2m
22/08/2006	Outages around South Pine in Queensland	\$4.3m
23/08/2006	Outages around South Pine in Queensland	\$3.5m
24/08/2006	Outages around South Pine in Queensland	\$5.7m
10/10/2006	Outage around Gladstone in Queensland Outage of the Sheffield to Fisher line in Tasmania	\$3m
12/10/2006	Outages around South Pine in Queensland	\$3.3m
17/10/2006	Outages around South Pine in Queensland	\$1.8m
16/01/2007	Bushfires in northern Victoria – network separation	\$2.3m
13/06/2007	June market events Partial outage of Directlink Outage around Gladstone in Queensland	\$6.7m
14/06/2007	June market events Outage around Gladstone in Queensland Constraints around Oakey (System normal)	\$4m
20/06/2007	June market events Outage around Gladstone in Queensland Constraints around Oakey (System normal) Outage of Blackwall SVC in Queensland	\$6.7m
26/06/2007	June market events Outage of Blackwall SVC in Queensland Constraints around Oakey (System normal)	\$2.7m
27/06/2007	June market events Constraints around Oakey (System normal)	\$8.1m
28/06/2007	June market events Outage around Gladstone in Queensland	\$10.5m

## Outage cost of constraints

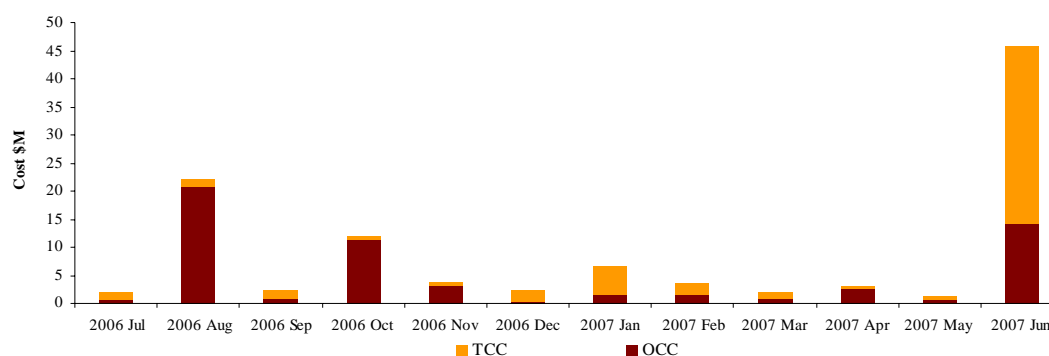
The OCC measure is designed to estimate the cost of transmission constraints that can be directly attributed to network outages (whether planned or unplanned). The OCC is closely related to the TCC. The OCC (as for the definition of the TCC above) is roughly the answer to the question:

‘How much lower would be the total cost of producing sufficient electricity to meet demand if all the limitations on the transmission network *due to outages* were removed?’

That is, the OCC is calculated by comparing the dispatch cost of the existing network (including any network outages or reductions in capability) with the network in its system normal state. The OCC for 2006–07 is \$58 million. This compares to \$27 million in 2005–06, \$16 million in 2004–05 and \$9 million in 2003–04. The proportion of the OCC to the TCC has steadily increased, from 25 per cent in 2003-04 to over half in 2006-07.

Figure 1 shows monthly breakdown of the TCC with the proportion attributed each month to the OCC. The ten highest days, accounted around half the total OCC and accumulated over the months of August and October 2006 and June 2007.

**Figure 1 – TCC and OCC by month**



## Marginal cost of constraints

The MCC is an indicator designed to identify the individual constraints that have significantly affected market outcomes. The MCC is derived by summing up the marginal constraint values reported with every constraint for every five minute dispatch interval over the year to obtain a Cumulative Marginal Value (CMV). When the full set of constraints that bound over the year is compared the relative severity of network congestion is revealed.

The MCC also indicates an increase in congestion in 2006 – 07 with:

- 40 network constraints that significantly affected interconnectors (compared to 32 in 2005-06, 15 in 2004-05 and five in 2003-04). All interconnectors were affected

- 14 network constraints that significantly affected market outcomes within regions on the mainland (compared to nine in 2005-06, nine in 2004-05 and seven in 2003-04)
- 4 network constraints that significantly affected market outcomes in Tasmania (compared to 13 in 2005-06).

## **Qualitative assessment**

Inter-regional congestion occurred at significant levels between all regions during 2006-07:

- Flows into New South Wales across QNI were constrained for around 1700 hours - a significant increase from the previous year. The majority of the congestion resulted from the inherent design of the network.
- The Terranora interconnector was constrained for around 1700 hours into New South Wales and 700 hours into Queensland. Around half of this congestion was due to outages.
- Flows into New South Wales from Snowy were constrained for 181 hours – double that of the previous year.
- The Victoria to Snowy interconnector was constrained for 865 hours, although in contrast to previous years there were no interventions by NEMMCO to manage negative residues.
- Flows into South Australia across the Heywood interconnector were limited for 740 hours – far less than in previous years.
- Network outages in neighbouring regions reduced the capability of Murraylink for 1100 hours in 2006-07 compared to around 340 hours in 2005-06. Outages of the Murraylink interconnector itself limited flows to zero for 800 hours.

For the second consecutive year, considerable congestion occurred between generation in central Queensland and the load centre around Brisbane. The duration of congestion increased from 170 hours in 2005-06 to 600 hours in 2006-07. The majority of this arose from a relatively small number of long term outages from July to November 2006 and March to June 2007. The inherent limits caused congestion for 80 hours, similar to the previous year.

# 1 Total cost of constraints

The TCC aims to estimate the cost of all transmission constraints. It does this by measuring the reduction in dispatch cost of generation that would occur if *all* transmission constraints were removed.

The TCC values the cost of generating electricity at the prices at which each generator offers its output to the market.<sup>4</sup>

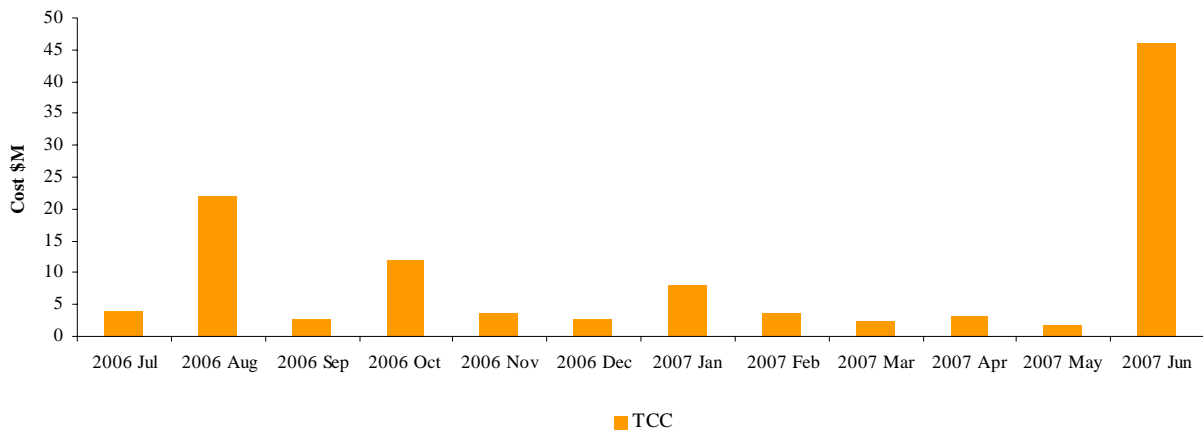
A detailed description of how the TCC is calculated is in the AER decision—Indicators of the market impact of transmission congestion<sup>5</sup>.

## 1.1 TCC results

The TCC has increased in each of the four reports to date, from \$36 million in 2003-04 to \$45 million in 2004-05, \$66 million in 2005-06 and \$107 million for 2006-07.

Figure 2 shows the TCC for each month. Two thirds of the total amount accumulated over 16 days, predominantly in August 2006, October 2006 and June 2007. Table 2 describes the circumstances for those 16 days.

**Figure 2 —TCC by month**



<sup>4</sup> Some generators contract with TNSPs to provide grid support services, for example in North Queensland. Their output is determined in these situations by the TNSP and the generators may not have an incentive to offer their output at a price which reflects their costs. To prevent distortions to the TCC, the impact of generators operating under a grid support agreement is excluded from the indicator.

<sup>5</sup> *Indicators of the Market Impact of Transmission Congestion—Decision: Appendices A & B.* AER, 9 June 2006



**Table 2—Significant TCC events**

<b>Date</b>	<b>TCC</b>	<b>Description</b>
August 2006	\$22.2 million	<p><b><i>Outage - Palmwoods to South Pine line in Queensland</i></b></p> <p>A planned network outage of the Palmwoods to South Pine line commenced on 12 August 2006, for 26 days. Powerlink gave up to 16 days notice of the outage. The Q&gt;PWSP_1350 constraint was used to manage the outage. This constraint reduces flows from central to south Queensland to a maximum of 1350 MW and can directly affect around 5700MW of generation capacity in central and north Queensland.</p> <p>The constraint bound on 12 days during this period for a total of 144 hours. Six of these days had high TCC values. At times significant quantities of central and north Queensland generation was constrained off, some of which was offered at -\$1000/MWh.</p>
17/08/2006	\$2.5 million	Up to 500 MW of generation constrained off.
18/08/2006	\$2.2 million	Up to 500 MW of generation constrained off.
21/08/2006	\$2.2 million	Up to 500 MW of generation constrained off.
22/08/2006	\$4.3 million	Up to 550 MW of generation constrained off.
23/08/2006	\$3.5 million	Up to 550 MW of generation constrained off.
24/08/2006	\$5.7 million	Up to 550 MW of generation constrained off.
October 2006	<b>\$12 million</b>	<p><b><i>Outages – South Pine to Tarong line and South Pine transformer in Queensland</i></b></p> <p>A simultaneous outage of the South Pine to Tarong line and South Pine transformer commenced on 25 September and lasted for 16 days. The line was returned to service on 12 October, with the transformer remaining out of service until 25 October. Powerlink gave 26 days notice of the outage. The constraints ‘Q_CS_1450’ and ‘Q_CS_1550’ were used to manage these outages. These constraints limit central to south Queensland flows to 1450 MW and 1550 MW respectively and directly affect around 5700MW of generation in central and north Queensland.</p> <p>The outage constraints bound for 12 days for a total of 108 hours. Three of these days had high TCC values. At times significant quantities of central and north Queensland generation was constrained off, some of which was offered at -\$1000/MWh.</p>
10/10/2006	\$3.0 million	Up to 500 MW of generation constrained off.
12/10/2006	\$3.3 million	Up to 400 MW of generation constrained off.
17/10/2006	\$1.8 million	Up to 200 MW of generation constrained off.

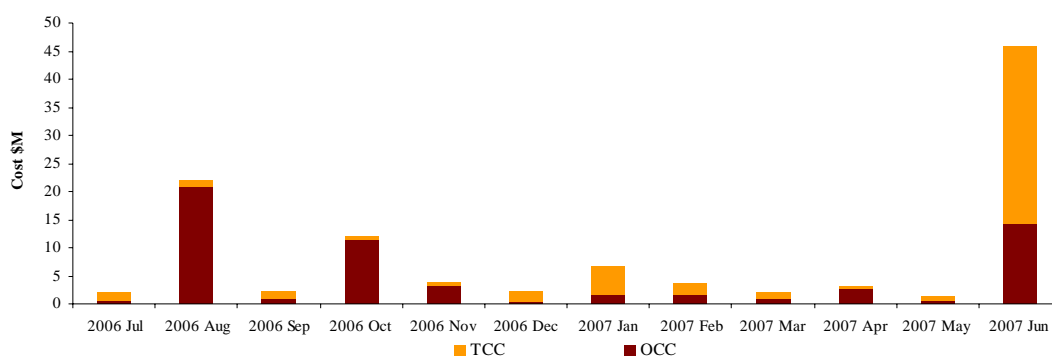
Date	TCC	Description
16 January 07	\$2.3 million	<p><b><i>Bushfires in northern Victoria – network separation</i></b></p> <p>At 3.02pm a bushfire in northern Victoria caused the loss of both Dederang to South Morang lines, leading to a separation of the power system, into three electrical islands. Prior to the separation a record demand was reached in Victoria. Two thirds of the TCC for the day accumulated before the power system incident.</p>
<p>June 2006</p> <p>13/06/2007</p> <p>14/06/2007</p> <p>20/06/2007</p> <p>26/06/2007</p> <p>27/06/2007</p> <p>28/06/2007</p>	<p><b>\$46 million</b></p> <p>\$6.7 million</p> <p>\$4.0 million</p> <p>\$6.7 million</p> <p>\$2.7 million</p> <p>\$8.1 million</p> <p>\$10.5 million</p>	<p><b><i>June market events – record prices and demand</i></b></p> <p>In June, a combination of high demand and generation outages led to a tight supply-demand balance. This resulted in the market spot price exceeding \$5000/MWh on 42 occasions.</p> <p><b><i>Outage – two of the three Directlink cables</i></b></p> <p>A planned network outage of two of three Directlink cables commenced on 2 June and was completed on 27 June. The N_MBTE3 constraint was invoked to manage the outage and limits flows across the interconnector to 120MW (compared to the nominal limit of 180 MW). The constraint bound for 44 hours during this outage.</p> <p><b><i>Outage – Gladstone to Gin Gin line in Queensland</i></b></p> <p>Three network outages of the Gladstone to Gin Gin line occurred in June for a total period of 16 days. The constraint Q_CS_1650 was invoked to manage the outage. This constraint limits central to south Queensland flows to 1650 MW and directly affects around 5700MW of generation in central and north Queensland and bound during peak hours for a total of 42 hours.</p> <p><b><i>System normal -Middle Ridge to Tangkam line - Queensland</i></b></p> <p>A new system normal constraint (Q_NIL_MRTA) was created on 14 June that limited the output from Oakey power station, to manage flows on the Middle Ridge to Tangkam lines. The constraint bound on the first day it was invoked and on 8 other occasions during the month, typically during peak hours, for a total of 15 hours.</p> <p><b><i>Outage – Blackwall SVC in Queensland</i></b></p> <p>A planned network outage of the Blackwall Static Var Compensator commenced on 13 June for two days. The Q:N_H36BK_VC constraint was used to manage the outage and bound for 8 hours. The constraint limited flows south from Queensland to 540 MW (nominal limit of 1078 MW) at times of extreme prices in New South Wales.</p>

## 2 Outage cost of constraints

### 2.1 OCC results

Fifty five per cent of the TCC, or \$58 million, is attributable to network outages (represented as the outage cost of constraints or OCC). Discretionary constraints invoked as a result of the outages are also included in the calculation. Figure 3 shows for each month during 2006-07, the TCC and the OCC.

**Figure 3 –TCC and OCC by month**



The OCC has increased over the four annual reports, from \$9 million (or 25 per cent of the TCC) in 2003–04 to \$16 million (33 per cent) in 2004–05, \$27 million (40 per cent) in 2005–06 and to \$58 million (54 per cent) in 2006–07.

Network outages at times had significant impacts on dispatch during the year, with only a few events over 10 days contributing to around half of the total OCC. Table 3 shows for those days the significant network outages and the OCC. The table is then followed by a detailed description of the significant outages.

**Table 3 —High OCC events**

Date	Locations	OCC
17/08/2006	Outage - Palmwoods to South Pine line in Queensland	\$2.4m
18/08/2006	Outage - Palmwoods to South Pine line in Queensland	\$2.2m
22/08/2006	Outage - Palmwoods to South Pine line in Queensland	\$4.1m
23/08/2006	Outage - Palmwoods to South Pine line in Queensland	\$3.3m
24/08/2006	Outage - Palmwoods to South Pine line in Queensland	\$5.4m
10/10/2006	Outage - South Pine to Tarong line in Queensland	\$3.0m
12/10/2006	Outage - South Pine to Tarong line in Queensland	\$3.2m
13/06/2007	Outage - Gladstone to Gin Gin line in Queensland	\$2.5m
20/06/2007	Outage -Gladstone to Gin Gin line in Queensland Outage - Blackwall SVC in Queensland	\$2.6m
28/06/2007	Outage - Gladstone to Gin Gin line in Queensland	\$5.1m

### **Outage of Palmwoods to South Pine 275kV line in Queensland**

In August, the OCC totalled \$21 million or 94 per cent of the TCC for the month. Most of this occurred during the outage of the Palmwoods to South Pine line which occurred over 26 days from 12 August.

The constraint used to manage the outage limited flows from central to south Queensland to 1350MW, with up to 550 MW of generation from north and central Queensland directly constrained off. Some of this capacity bid at -\$1000/MWh.

### **Outage of South Pine to Tarong line and South Pine transformer in Queensland**

In October, the OCC totalled \$11 million or 94 per cent of the TCC for the month. Most of this occurred during the simultaneous outages of the South Pine to Tarong line and South Pine transformer. The outage commenced on 25 September and continued for 17 days with the line returned to service on 12 October. The transformer remained out of service until 25 October.

The constraint used to manage the simultaneous outages limited flows from central to south Queensland to 1450 MW, with flows limited to 1550 MW when only the transformer was out of service. Generation from central and north Queensland was constrained off by up to 500 MW.

### **Outage of Gladstone to Gin Gin line in Queensland**

In June, the OCC totalled \$21 million or 31 per cent of the TCC for the month. Three network outages of the Gladstone to Gin Gin line occurred in June over a period of 16 days.

The constraint used to manage the outage limited flows from central to south Queensland to 1650MW. The constraint bound for 42 hours. Generation from central to south Queensland was constrained off by up to 250MW.

### 3 Marginal cost of constraints

The MCC is an indicator designed to estimate the market impact of individual constraint equations over time, to identify the network constraints (and associated network elements) that are causing significant market impacts.

Inter-regional constraints<sup>6</sup> with a cumulative marginal market impact over the year of more than \$30 000/MW are deemed as requiring further assessment. For the case of intra-regional constraints the threshold is set at those that bound for more than 10 hours.

A detailed description of how the MCC is calculated, including the different nature of the marginal values reported for inter and intra-regional constraints is contained in the AER decision— Indicators of the market impact of transmission congestion<sup>7</sup>.

On 12 January 2006, a Rule change came into effect that allows for a price to be revised when manifestly incorrect inputs<sup>8</sup> are supplied into the dispatch process. The first manifestly incorrect input was identified by NEMMCO on 20 June 2006 and a further 10 dispatch prices were revised in the 2006-07 period. NEMMCO does not, however, revise constraint marginal values under these circumstances. For each of the dispatch intervals affected by manifestly incorrect input(s) the AER has replaced the marginal constraint values with the corresponding values from the proceeding non affected interval. This approach mirrors the approach taken by NEMMCO when it revises prices.

#### 3.1 MCC results

During 2006–07 between 350 and 450 transmission constraints were generally in place at any one time. Most, however, did not affect market outcomes and therefore had a marginal value of zero. During 2006–07 there were around 740 constraints that affected the market at least once, with most related to inter-regional congestion. In assessing high impact constraints, those that related to the same network limitation were grouped where possible. The details of the constraints that materially affected market outcomes are provided in appendix H.

There were 40 inter-regional network limits or constraints with a cumulative marginal value (CMV) over the year of more than \$30 000/MW (this compares to 32 in 2005-06, 15 in 2004-05 and five in 2003-04). Those constraints are detailed in table 4 along with the CMV, the duration and a description of the constraint. The description includes the affected interconnector, the type of constraint - either system normal (reflecting the design or inherent limit) or outage (with details of the plant that was taken out of service).

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<sup>6</sup> Fully optimised or option 4 constraints are classified as inter-regional.

<sup>7</sup> *Indicators of the Market Impact of Transmission Congestion—Decision: Appendix C*, AER, 9 June 2006.

<sup>8</sup> A manifestly incorrect input is defined in 3.9.2B of the National Electricity rules.

**Table 4—High impact inter-regional constraints**

<b>Constraint</b>	<b>Duration (hours)</b>	<b>CMV (\$)<sup>9</sup></b>	<b>Type — description</b>
SVML_000, VSML_000	806	966 874	Outage — 0 MW limit on Murraylink (typically for outages on the interconnector)
S>V_NIL_NIL_RBNW	109	728814	System normal — limit flow across Murraylink (into SA)
V>>V_NIL_3B_R	163	537751	System normal — limit flow across VicSnowy (into Snowy), Basslink (into Vic) and Heywood (into Vic)
V>>SML_BAML	25	441 249	Outage — limit flow across Murraylink (into SA) (outage of line 1 or 2 between Ballarat to Moorabool)
HV_0250	2	233 657	Discretionary — 250 MW limit on VicSnowy (into Vic)
V>>SML_NIL_5A V>>SML_NIL_5B	1	223 021	System normal — limit flow across Murraylink (into SA) and VicSnowy (into Snowy) (loading on Geelong to Keilor line)
N>N-NIL_TE_E2	54	209 063	System normal — limit flow across Directlink (into Qld) (loading on Armidale to CoffsHarbour line)
V>>V_X_DDTX2_3_DBUSS	16	207 468	Outage — limit flow across VicSnowy (into Vic) (outage of Dederang No. 1 or No. 2 transformer)
Q^^TR_NIL-VE	1	195 243	Discretionary — limit flow across QNI (into Qld) (Manage negative inter-regional settlement residues on 24 January)
V>>H_NIL1A_R	3	187 373	System normal — limit flow across VicSnowy (into Snowy) and Murraylink (into SA)
N_MBTE2_B	44	176 557	Outage — limit flow across Directlink (into NSW) (Outage two of the three Directlink cables)
H>>V_NIL_1A	2	172 626	System normal — limit flow across VicSnowy (into Snowy) and Murraylink (into South Australia)
VS_460	184	167 597	System normal — limit flow across Heywood (into SA to 460MW limit)
Q:N_H36BK_VC	6	149 428	Outage — limit flow across QNI (into Qld) (outage Blackwall SVC)
Q:N_NIL_OSC	888	119 082	System normal — limit flow across QNI (into NSW), to avoid Oscillatory Instability
Q^BK_VC_GC	0.3	91 793	Outage — limit flow across Directlink (into Qld) (outage Blackwall SVC)
SV_300	94	88 213	System normal — limit flow across Heywood (into Vic), 300MW limit
Q:N_NIL_BCK2L-G	99	87 422	System normal — limit flow across QNI (into NSW)
V>SMLHORC1	11	84 223	Outage — limit flow across Murraylink (into SA) (outage Horsham to Red Cliffs line)

<sup>9</sup> A number of constraints had average marginal values close to, or even greater than the market cap of \$10 000/MWh. This can occur when the constraint is formulated such that a large change in the flow of an interconnector is required to meet the requirements of the constraint.

<b>Constraint</b>	<b>Duration (hours)</b>	<b>CMV (\$)'</b>	<b>Type — description</b>
V>>SML_NIL_1	2	83 541	System normal — limit flow across VicSnowy (into Snowy) and Murraylink (into SA)
N>>N-NIL_1U	0.3	79 695	System normal — limit flow across Snowy (into Snowy)
N>>N-NIL_DY_1	153	78 485	System normal — limit flow QNI (into Qld)
S>>V_NIL_DVBG_DVBR	50	73 443	System normal — limit flow across Murraylink (into SA)
S>>V_NIL_CGTX_ACMP3	30	69 015	Outage — limit flow across Heywood and Murraylink (into SA)
Q>>QTR_2900	1	66 544	Outage — limit flow across QNI (into Qld) (Outages around Tarong 23 and 24 January)
H>>H-NIL_A	15	62 452	System normal — limit flow across VicSnowy (into Vic) and across Snowy (into NSW)
V>>V_LTMS_1	43	53 027	Outage — limit flow across Snowy (into NSW) and across Murraylink (into SA) (outage Lower Tumut to Murray line)
#V-SA_I	1	49 157	Discretionary — limit flow to across Heywood (into SA)
#T-V-MNSP1_E	0.3	45 399	Discretionary — limit flow across Basslink (into Vic)
T_V_NIL_FCSPS	25	42 232	System normal — limit flow across Basslink (into Vic)
VSML_220	34	40 970	System normal — 220 MW limit on Murraylink (into SA)
Q>H4MU_TX_GC540	405	40 905	Outage — limit flow across Directlink (into Qld) (outage Mudgeeraba transformer)
S>>V_PATB_PATB_MOTB	150	39 728	Outage — limit flow across Heywood (into SA) (outage Para toTailem Bend line)
SA_HYSE1	0.7	39 555	Outage — 0 MW limit on Murraylink on 16 January (into SA)
N^N-X5_TRIP_A	11.3	38 874	Outage — limit flow across Murraylink (into SA) and across Snowy (into Vic) (outage of X5 tripping scheme in Victoria)
#NSW1-QLD1_E	3	37 087	Discretionary — limit flow across QNI (into Qld) (Management of negative inter-regional settlement residues 24 January)
Q>NIL_757+758_B	587	36 766	System normal — limit flow across Directlink (into NSW)
VS_120	6	35 720	Outage — 120 MW limit on Heywood (into SA)
N>>N-ERNC_H	15	32 021	Outage — limit flow across QNI and Directlink (into NSW), across Snowy (into NSW)
Q>N_NIL_8L_8M	251	32 389	System normal — limit flow across QNI (into NSW)

There were 14 intra-regional network constraints on the mainland that bound for more than 10 hours (compared to nine in 2005-06, nine in 2004-05 and seven in 2003-04). Those constraints are detailed in table 5 along with the duration and a description of the constraint. The description includes the type of constraint — either system normal (reflecting the design or inherent limit) or outage (with details of the plant that was taken out of service). Table 6 identifies the same information for the 4 intra-regional constraints (compared to 15 in 2005-06) that affected dispatch in Tasmania during the year.

**Table 5—High impact mainland intra-regional constraints**

<b>Constraint ID</b>	<b>Duration (hours)</b>	<b>Type — description (region)</b>
Q_CS_1900	82	System normal — limits flow from central to south Queensland to 1900 MW to maintain transient stability.
Q_CS_XXXX	344	Outages — limits flow from central to south Queensland at various levels for network outages: 1450 MW - Q_CS_1450 1550 MW - Q_CS_1550 1650 MW - Q_CS_1650 1700 MW - Q_CS_1700 1800 MW - Q_CS_1800
Q>PWSP_1350	157	Outage — limit flow from central to south Qld to 1350 MW for Palmwoods to South Pine outage (Queensland)
V>V_NIL_4	101	System normal — limit generation from Hazelwood units 3, 4 and 5 for loading on Hazelwood #1 transformer (Victoria)
S^NIL_SGBL_LB2MAX	73	System normal — constrains generation from Lake Bonney 2 and Snuggery to manage voltage stability on Snuggery fault. (South Australia)
Q>PRE855_871CAL, Q>PRE855_871GL_ST	21	System normal — Constrains Gladstone and Stanwell on and Callide B and C off to manage flows on 871 line. (Queensland)
Q^PWSP_C2CS	19	Outage — limit flow from central to south Queensland for Palmwoods to South Pine line (Queensland)
V>V_HWTS_TX3_PAR_3-5	16	Outage — limit Latrobe Valley generation for Hazelwood transformer outage (Victoria)
Q>MRTA	15	System normal — limit generation at Oakey to manage Middle Ridge to Tangkam rating (Queensland)
Q>TVAS7276_77_PRE	14	System normal — constrains Yabulu for Townsville to Alan Sherriff contingency (Queensland)
Q^NIL_1CS	12	System normal — limit flow from central to south Queensland to manage voltage stability (Queensland)
Q>GGGL_813_814	11	Outage — limit flow from central to south Queensland to 1650 MW for outages of Gladstone to Gin Gin (Queensland)
Q>TVAS7276_77_120PRE	11	Outage — constrains Yabulu for Townsville to Alan Sheriff contingency (Queensland)
Q:NIL_CN1	10	System normal — limits flow from central to south Queensland to maintain transient stability



**Table 6—High impact Tasmanian intra-regional constraints**

<b>Constraint ID</b>	<b>Duration (hours)</b>	<b>Type — description</b>
T>T_FASH_1_2_C1, T>T_FASH_1_2_B2, T>T_FASH_1_2_C3	45	Outage — Farrell to Sheffield lines
T_T_TU_BG_80	16	Outage — 80 MW limit on Tungatinah and Butlers Gorge generation for multiple equipment outages around Tungatinah
T>T_NIL_BL_110_19	14	System normal —avoid overloading Waddamana to Lake Each Tee line
T>T_HAPM_220_3B	12	Outage — Hadspen to Palmerston line

### 3.2 Qualitative assessment

This section provides further information on individual constraints highlighted in tables 4, 5 and 6 as having a high market impact. The assessment includes commentary on the following:

- The accuracy of forecast outage information (including the accuracy of timing of those planned outages).
- The impacts from unplanned outages (including short-notice outages).
- The accuracy of forecast network capability.
- The impacts of network constraints on the cost of frequency control ancillary services.

The analysis of inter-regional constraints with a CMV of more than \$75 000 and intra-regional constraints that bound for more than 10 hours is presented in Appendix A.

#### Locations of congestion within regions

This section describes the significant congestion locations as indicated by the MCC.

#### Queensland

The duration of congestion within Queensland has significantly increased from 375 hours in 2005-06 to 773 hours in 2006-07. Most of this congestion occurred on flows between central Queensland and the load centre around Brisbane. Around 80 hours of this congestion was as a result of the inherent design limits of the network. Long term outages of the Palmwoods to South Pine line and Gladstone to Gin Gin line accounted for the majority of the remainder. The constraints used to manage this congestion limited the dispatch of central and northern Queensland generators with a combined registered capacity of 5700 MW. At times this congestion restricted the output from these generators by as much as 550MW.

The Queensland to New South Wales interconnector (QNI) was constrained for around 1700 hours – almost all of this congestion occurred in the southerly direction. The constraints that had a high impact on market outcomes - those that are analysed qualitatively - affected flows for around 1350 hours. This is double that for the previous year. The majority of the congestion resulted from the inherent design of the network.

On 23 January a planned network outage at Tarong, combined with the loss of 120 MW of generation at Swanbank, resulted in flows between Tarong and Brisbane exceeding secure limits. NEMMCO managed the increased flows on the Tarong to Brisbane path by invoking constraints to limit flows into Tarong. The constraints restricted the dispatch of cheaper generation in South West and Central Queensland by around 1000 MW, significantly increasing the Queensland price. The constraints invoked by NEMMCO also reduced import capability from New South Wales by 425 MW.

Similar conditions occurred on the following day with the continuation of the outage. On both days the network constraints contributed to the spot price increasing above \$5000/MWh. The impacts of the outage were not actually forecast. The AER has reported separately on these events.

Outages of the Blackwall SVC limited flow across QNI into New South Wales for 33 hours during the year. The constraint had the most significant impact on 13 June. Powerlink typically gave one month notice of the outages.

### **New South Wales and Snowy**

Intra-regional congestion - which limits generation and not interconnectors - occurred for 3 hours during 2006-07 (down from 46 hours the previous year). In previous reports outages of network equipment on the western ring caused significant intra-regional congestion. Recent reformulation of constraints to the fully co-optimised form means that the constraints now limit generation and interconnectors simultaneously. As a result these constraints are no longer considered intra-regional and are reported as inter-regional congestion.

The duration of congestion on the Snowy to New South Wales interconnector has reduced from 410 hours in 2005-06 to 181 hours in 2006-07. Congestion through the Snowy region has also reduced significantly. An outage of the 66 line between Lower Tumut and Murray in the Snowy region resulted in reduced exports to New South Wales on 14 days for a total of 43 hours. On 11 January the constraint reduced flows to as little as 1600 MW whilst prices in New South Wales exceeded \$5000/MWh. Transgrid gave 13 days notice of the outage.

An outage of the Eraring to Newcastle line caused congestion on two days in March. The constraint limited NSW generation and inter-regional flows into NSW, with imports across QNI constrained to as little as 190MW, compared to the nominal limit of 1078MW. Transgrid gave 14 days notice of the outage.

## **Terranora**

The Terranora interconnector was constrained by high impact constraints for around 1300 hours. Around 40 per cent of this congestion was due to outages. The outage of two of the three of the Terranora<sup>10</sup> cables from 2 June to 27 June reduced the capability for flows across Terranora to 130 MW, down from the nominal limit of 180 MW. These outages impacted on 11 days in June, often coinciding with high market prices.

## **Victoria**

Congestion within Victoria has reduced to 129 hours, down from 162 hours the previous year.

At 3.02pm on 16 January 2007, bushfires in the north east of Victoria caused the fully loaded Dederang to South Morang 330kV transmission lines between Victoria and New South Wales to trip. The event also caused transmission lines between South Australia and Victoria to trip, resulting in the separation of the national power system into three electrical islands. A major imbalance between supply and demand followed, which led to the activation of the Victorian automatic under-frequency load shedding scheme. Around 2200MW of load was shed. The lines were restored at 11.23pm.

A system normal constraint which limits output from Hazelwood units 3, 4 and 5, to avoid overload of the Hazelwood transformer, bound on 22 days for 101 hours in 2006-07, compared 91 hours to the previous year. Outages of the Hazelwood transformers resulted in a further 26 hours of congestion.

The Victoria to Snowy interconnector was constrained for 865 hours during the year. The Victoria to Snowy interconnector was affected by high impact constraints for 240 hours. Exports to Snowy were constrained for over 200 hours mainly due to inherent limitations.

Limits on flows through the F2 transformer at South Morang caused 163 hours of congestion. This constraint affects exports from Victoria into Snowy, imports across Basslink into Victoria, constrains off Latrobe Valley generation, constrains on AGL's Southern Hydro generators and limits imports from South Australia. At times the constraint drove flows counter price into South Australia. This occurred frequently during the extreme price events in June and is the first time that significant counter price flows have occurred from Victoria to South Australia across the Heywood interconnector. The constraint that led to these outcomes was first invoked on 24 July 2006. This congestion is related to the inherent design capability or system normal limits of the network.

## **South Australia**

Congestion within South Australia occurred for 99 hours during the year, down from 155 hours the previous year. Lake Bonney wind farm, which is registered as a

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<sup>10</sup> The Directlink interconnector became a regulated interconnector on 21 March 2006. At that time its name was changed to the Terranora interconnector.

scheduled generator, was constrained off for 73 hours as a result of congestion in the south east of South Australia.

Congestion across the Heywood interconnector has changed significantly compared to previous reports. Flows into South Australia across Heywood were limited for 740 hours and by high impact constraints for 190 hours or 7 per cent of the time (compared to 1400 hours in 2005-06, 1000 hours in 2004-05 and 1300 hours in 2003-04). The 460 MW nominal limit into South Australia bound for 180 hours in 2006-07, compared to 1008 hours the previous year, whilst the 300 MW nominal limit on flows into Victoria bound for 94 hours, compared to 15 hours the previous year. Further, at times significant flows were forced into South Australia counter price as a result of congestion on the F2 transformer at South Morang in Victoria.

### **Murraylink**

There was an increase in the impact of network outages in neighbouring regions on Murraylink, with reductions in capability for 1100 hours in 2006-07 compared to around 336 hours in 2005-06. Outages of the Murraylink interconnector itself limited flows to zero in both directions for 800 hours

### **Tasmania**

The duration of congestion in Tasmania has decreased from 478 hours in 2005-06 to 161 hours in 2006-07. This accrued across 41 different constraints, with system normal limitations binding for 39 hours in total.

Outages of the Farrell to Sheffield lines in January and June led to congestion for 45 hours over four days. The constraints used to manage the outages can directly affect up to 460 MW of generation in Western Tasmania. On average, Transend gave three days notice of the outage.

### **Directions**

Ten directions were issued during the financial year with seven occurring during the separation event on 16 January in Victoria. A further direction was issued on 10 January due to lightning in northern Queensland. Two directions were issued on 20 May in northern Queensland. A total of \$1.8 million of compensation was paid for the directions given on 10 January and 16 January. The compensation payment for the remaining two directions given on 20 May totalled \$25 000. This compares to around \$1 million in compensation payments in 2005-06, \$4.2 million in 2004-05 and around \$5 million in 2003-04.

### **Inter-regional settlement residues**

The settlement residues totalled \$226 million for 2006-07 with the majority accruing for imports into New South Wales across the QNI and Snowy interconnectors. This compares to \$257 million in 2005-06, \$232 million in 2004-2005 and \$141 million in 2003-04.

Analysis shows that the capability of the Snowy to New South Wales interconnector was close to nominal limits on most occasions when large price differences occurred,

which means that in general the inter-regional settlement residues closely matched those that were anticipated through the SRA process for this interconnector.

Around 43 per cent or \$97 million of the 2006-07 settlement residues were accumulated in June. This was driven by the large price difference between NSW and its neighbouring regions combined with large imports across the Snowy interconnector.

### **Frequency control ancillary services**

Frequency control ancillary services cost \$40 million in 2006-07 across the market, with a quarter of this accruing in Tasmania.

On 16 January, following the market separating into three islands, additional frequency control ancillary services were sourced at a cost of \$18.5 million on the mainland and \$1.5 million in Tasmania. This represents half of the total cost of frequency control ancillary services for the year.

Planned network outages on the mainland, led to increased requirements for ancillary services for around 80 hours. These extra requirements added only \$27 000, compared to around \$3 million the previous year, when increased requirements were needed for around 1000 hours.

Interactions between the frequency markets and the limitations known as the no-go zone on the Basslink interconnector led to increases in the cost of local Tasmanian frequency control ancillary services. These interactions were also responsible for counter price energy flows at times across the Basslink interconnector.

# Appendices

<b>Appendix A</b>	<b>Qualitative analysis</b> .....	<b>22</b>
A.1	Inter-regional constraints .....	22
A.1.1	Queensland to New South Wales interconnector (QNI and Terranora) ....	22
A.1.2	Snowy to New South Wales Interconnector .....	24
A.1.3	Victoria to Snowy interconnector .....	25
A.1.4	Victoria to South Australia Heywood interconnector.....	26
A.1.5	Victoria to South Australia MurrayLink interconnector.....	26
A.2	Intra-regional constraints .....	28
A.2.1	Queensland.....	28
A.2.3	South Australia.....	31
<b>Appendix B</b>	<b>Inter-regional settlement residues</b> .....	<b>33</b>
<b>Appendix C</b>	<b>All network constraints</b> .....	<b>34</b>
<b>Appendix D</b>	<b>Frequency control ancillary services</b> .....	<b>35</b>
<b>Appendix E</b>	<b>Directions</b> .....	<b>36</b>
<b>Appendix F</b>	<b>Network related price variations</b> .....	<b>37</b>
<b>Appendix G</b>	<b>All significant network constraints</b> .....	<b>39</b>

## Appendix A Qualitative analysis

During the 2006-07 financial year, two events have been reflected into the metrics used to measure congestion in the NEM.

On 16 January at 3 pm (market time) bushfires in Victoria led to the loss of 1700 MW of imports from New South Wales. Immediately before the interconnector tripped, demand in Victoria reached a new record demand of 9012 MW. Following the loss of the lines, 2200 MW of load was disconnected. The impacts of the non-credible contingency on the market, particularly on days of record demand, are extreme and highly unpredictable. A number of network constraints subsequently bound with very high marginal values.

In June 2007, the impacts of the drought, flooding (particularly in NSW) and record demands across the NEM led to 42 spot market prices above \$5000/MWh across Snowy, New South Wales and Queensland. With such extreme price outcomes occurring, almost all congestion on the transmission network was recorded as having a large impact through the TCC. It should be noted, however, that congestion was not a significant factor in the outcomes.

### A.1 Inter-regional constraints

Historically, network constraints have been categorised as either inter-regional or intra-regional. These constraints generally only affected one interconnector or generation within one region. Since mid 2005, following a direction from the Ministerial Council on Energy, NEMMCO has been changing the formulation of a number of constraints to the fully co-optimised form. This form of constraint blurs the distinction between inter-regional and intra-regional, as the constraints can simultaneously restrict the flow across numerous interconnectors and generation in several regions.

A number of the constraints with significant market impacts over the period covered by this report are fully co-optimised and therefore difficult to assign to either one interconnector or one region. For the purposes of this report constraints of this type have been attributed to the interconnector most affected by the constraint.

#### A.1.1 Queensland to New South Wales interconnector (QNI and Terranora)

*Constraint: N>N-NIL\_TE\_E2 (23 and 24 Jan - system normal)*

This system normal constraint was first used on 9 November 2006. The constraint limits flow from New South Wales across the Terranora interconnector to manage loading on the 96C line between Armidale and Coffs Harbour.

The constraint bound over 20 days for 54 hours during the year. Its most significant market impact (as determined by the cumulative marginal value of the constraint or CMV) occurred over 10 hours on 23 and 24 January. On these days, prices in Queensland exceeded \$5000/MWh. Planned network outages led to unexpected network limitations on flows into the south east Queensland load centres; constraining off much of Queensland generation and restricting flows across QNI into Queensland. On this day, and at other times, this constraint has forced flow into New South Wales

counter to the prevailing market prices. These events caused high marginal values on this constraint as it bound on the Terranora interconnector, which is parallel to QNI. This limitation was not material to the market outcomes on these days.

***Constraint: Q^^TR\_NIL-VE (23 and 24 Jan - negative settlement residues)***

This co-optimised constraint limits central to south west Queensland generation and flows across QNI (into Queensland) for the management of inter-regional negative settlement residues.

On 23 and 24 January, a planned network outage led to unexpected network limitations on flows into the south east Queensland load centres; constraining off much of Queensland generation and forcing flows counter price across QNI into New South Wales. The above constraint was invoked from 2.55 pm to 3.20 pm on 23 January and from 10.25 am to 10.50 am the following day to prevent the further accumulation of negative settlement residues across the interconnector. The constraint bound for 1 hour over the two days.

***Constraint: N\_MBTE2\_B (June 2007 – outage of Terranora)***

The constraint was first created on 14 March 2007 to manage the outage of two of the three Terranora cables. The constraint limits flow across Terranora (into New South Wales) to 130MW, 90 MW below its nominal capability of 220 MW.

The constraint was invoked on 2 June for a 25 day outage. The constraint bound on 11 days, for a total of 44 hours. Five of the eleven binding days coincided with the high price events in June. This outage was not planned ahead of time.

***Constraint: Q:N\_H36BK\_VC (13 June – outage of Blackwall SVC)***

This constraint is used to manage the outage of the Blackwall Static Var Compensator (SVC) in south-east Queensland, limiting flow into New South Wales across QNI.

The constraint bound on 10 days during the year for a total of 33 hours. The most significant market impact was during the evening peak of 13 June when spot prices in New South Wales exceeded \$5000/MWh. The constraint bound for three hours, with the limit on flows south reduced by 538 MW from its nominal limit of 1078 MW during this outage.

For the 13 June outage, Powerlink gave 29 days notice to NEMMCO of the outage. NEMMCO entered the outage in the market forecast within 2 days of being notified.

***Constraint: Q^BK\_VC\_GC (13 June – outage of Blackwall SVC)***

This constraint is used to manage the outage of the Blackwall Static Var Compensator (SVC) in south-east Queensland, limiting flow into New South Wales across Terranora.

The constraint bound for 20 minutes during the evening peak of 13 June when spot prices exceeded \$5000/MWh in New South Wales.

For the 13 June outage, Powerlink gave 29 days notice to NEMMCO before the start of the outage and NEMMCO entered the outage in the market forecast within 2 days of being notified.



***Constraint: Q:N\_NIL\_OSC***

This system normal constraint restricts flows south across QNI to maintain oscillatory stability. The limit is set at either 950 MW or 1078 MW depending on the status of the Millmerran units. With both units online, the higher limit of 1078 MW applies.

The constraint bound on 192 days during the year for a total of 888 hours, compared to 484 hours the previous year. When the constraint bound, it typically restricted flows into New South Wales to around 1078 MW.

***Constraint: Q:N\_NIL\_BCK2L-G***

This system normal constraint restricts flows into New South Wales across QNI to avoid transient instability on a two phase to ground fault at Bulli Creek.

The constraint bound on 42 days during the year, for a total of 99 hours (59 hours the previous year), setting an average limit of around 1050 MW across the interconnector, close to its nominal limit.

Over half of the CMV accumulated on 19 July when the constraint bound for 12 hours. Prices in Queensland separated from the rest of the market which peaked at \$4070 in New South Wales. Flows south were restricted to 950 MW from the nominal limit of 1078 MW.

***Constraint: N>>N-NIL\_DY\_1***

This system normal constraint limits flows south across QNI and the Terranora interconnector and constrains around 4800 MW of generation in the Hunter Valley in New South Wales. This constraint manages loading on the Armidale to Kempsey line on a trip of the Coffs Harbour to Nambucca line.

The constraint bound for 153 hours over 58 days. The most significant market impact was on 3 March when the constraint bound for three hours and accumulated a MCC of \$21,000. Imports into New South Wales across the QNI interconnector were reduced by up to 400 MW. Generation was largely unaffected by this constraint on the day.

**A.1.2 Snowy to New South Wales Interconnector**

***Constraint: N>>N-NIL\_1U (15 Jun)***

This system normal constraint manages the loading on the Mt Piper 330 kV to 132 kV transformer for the loss of the Mt Piper to Wallerawang line. It directly affects about 2900 MW of generation in New South Wales.

The constraint was violated for 15 minutes on 15 June at a time when the spot price in New South Wales exceeded 5,000/MWh. Imports into New South Wales across the interconnector were reduced by up to 400 MW as a result of a . A short notice unplanned outage of the Mt Piper to Wellington 330 kV line was the cause in these violations.

### **A.1.3 Victoria to Snowy interconnector**

#### ***Constraint: H>>V\_NIL\_1A (16 Jan)***

This system normal fully co-optimised constraint restricts Victorian imports from Snowy and South Australia (across Murraylink) and generation in northern Victoria to manage flows across the Dederang to Murray line for the loss of the other Dederang to Murray line.

The constraint bound for 2 hours on 16 January prior to the islanding of Victoria. The Murraylink interconnector was out of service on the day with flows south across the Victoria to Snowy interconnector at around its nominal limit of 1700 MW.

#### ***Constraint: V>>H\_NIL\_1A\_R (16 Jan)***

This system normal fully co-optimised constraint simultaneously restricts Victorian exports and generation to avoid the overload of South Morang to Dederang line for the loss of the other South Morang to Dederang line. The constraint bound on 16 January for 3 hours following the islanding of Victoria.

The actions of this constraint unusual given that when the constraint bound the lines it was managing flow across were out of service at the time. The incorrect action of the constraint on this day has been identified and rectified by NEMMCO.

#### ***Constraint: HV\_0250 (9 Aug and 16 Jan)***

This discretionary constraint is used to limit flow across the Snowy to Victoria interconnector to 250MW. The constraint was used twice in the year: on 6 August and 16 January.

On 6 August, the constraint was used to reduce the rate of accumulation of negative settlement residues across the Snowy to Victoria interconnector. This occurred early in the morning, binding for only a single dispatch interval.

On 16 January, Victoria separated electrically from New South Wales in such a way as to see some parts of Victoria remain connected to the New South Wales region. This constraint was used to manage this condition.

#### ***Constraint: V>>V\_X\_DDTX2\_3\_DBUSS (15 March)***

This fully co-optimised constraint manages outages of the Dederang No 2 or No 3 transformer and the DBUSS transformer overload control scheme, by restricting flows south into Victoria across the Victoria to Snowy interconnector, constraining on generation in northern Victoria and constraining off generation in the Latrobe Valley.

The constraint bound for 5 days during the year for a total of 26 hours. The most significant market impact occurred on 15 March. Low reserves on the day saw prices in Victoria reach a high of \$2703/MWh with this constraint restricting flows into Victoria to 200 MW. The CMV of this constraint on the day was \$206 000/MW. The TCC on the day was \$329 000. On this occasion, SP AusNet gave 7 days notice of the outage.

More generally, when the constraint bound, an average of 5 days notice was given for the outages.

#### **A.1.4 Victoria to South Australia Heywood interconnector**

##### ***Constraint: VS\_460 (8 December)***

This system normal constraint limits flows into South Australia across the Heywood interconnector to 460MW.

The constraint bound on 86 days throughout the year for a total of 185 hours. This is a significant reduction from 1008 hours the previous year.

The most significant market impact occurred on 8 December 2006, with a CMV of \$78 326. On this day, the South Australian price rose to above \$4330/MWh, whilst the rest of the market remained below \$50/MWh. For much of the day, flows across the Victoria to South Australia (Heywood) interconnector were at the limit of 460MW.

##### ***Constraint: SV\_300 (16 January)***

This system normal constraint limits flow along the South Australia to Victoria (Heywood) interconnector to a maximum of 300 MW. The limit maintains transient stability in South Australia for a two phase to ground fault on the interconnector.

This constraint bound for 94 hours during the year over 69 days. The most significant market impact occurred on 16 January prior to the separation of the market into three islands.

This constraint bound for 15 hours the previous year.

#### **A.1.5 Victoria to South Australia MurrayLink interconnector**

##### ***Constraint: SVML\_000, VSML\_000***

These discretionary constraints limit flow across the Murraylink interconnector to zero. The constraints bound on 68 days for around 830 hours.

Murraylink was out of service for 68 days during the year including a month long outage between 6 January and 9 February. No notice was given ahead of time for this outage.

##### ***Constraint: S>V\_NIL\_NIL\_RBNW (15 March)***

This system normal constraint restricts flows into Victoria across Murraylink to avoid the overload of the North West Bend to Robertstown line. The constraint bound on 80 days during the year for a total of 161 hours. The most significant market impacts occurred on 15 March, when the constraint bound for four hours and was violated in two dispatch intervals. Flows on Murraylink were around 95MW at the time, 125 MW lower than its nominal limit of 220 MW.

***Constraint: V>>SML\_BAML (15 March)***

This constraint manages the outage of the Ballarat to Moorabool line. The constraint is formulated to limit flow into South Australia across Murraylink to manage the loading of the Moorabool to Terang line.

The constraint bound for 25 hours during the year over 12 days. On the days when the constraint bound, an average of 14 days notification of the outage was given by SP AusNet. The outages were approved by NEMMCO and progressed to LTP status on average three days after notification was first received.

The most significant market impact occurred on 15 March, where the constraint bound for 7 hours and was forcing flows into Victoria. On this occasion, 10 days notice of the outage was given by SP AusNet with NEMMCO progressing the outage to LTP status the next day.

***Constraint: V>>SML\_NIL\_5A and V>>SML\_NIL\_5B***

These system normal constraints limit imports into South Australia across Murraylink to manage loading on the Geelong to Keilor lines in the event that the Moorabool transformer is lost. Both constraints bound briefly during the 16 January bushfires in northern Victoria. In addition, constraint V>>SML\_NIL\_5A bound briefly on 16 and 17 February. Collectively, both constraints bound for less than two hours over three days.

***Constraint: V>>V\_NIL\_3B\_R***

This system normal co-optimised constraint is formulated to limit Victorian generation and interconnector flows to avoid the overload of the South Morang 500/330 kV transformer for the loss of the Rowville transformer.

This constraint affects exports from Victoria into Snowy, imports across Basslink into Victoria, constrains off Latrobe Valley generation, constrains on AGL's Southern Hydro generators and limits imports from South Australia. At times the constraint drove flows counter price into South Australia.

The constraint was first effective on 24 July 2006. Since its introduction, the constraint has bound on 34 days during the year for a total of 163 hours.

During the high price events of June in New South Wales, exports from Victoria were constrained to an average of 603 MW by this constraint, at the same time forcing counter price flows across the Victoria to South Australia interconnector.

This constraint has been relieved with the installation of the second 500/220 kV transformer at Rowville from 4 October 2007. This has reduced the impact of the South Morang 500/330 kV transformer limitation. VENCORP has identified a possible need to increase South Morang transformer capacity within 10 years which would further relieve network congestion. Commitment and timing of any augmentation is subject to further analysis.

***Constraint: V>SMLHORCI***

This constraint manages the outages of the Horsham to Red Cliffs 220kV line to avoid overloading Balranald to Darlington Point 220 kV line for the trip of the Bendigo to Kerang line. This constraint limits the flow across Murraylink from Victoria to South Australia.

This constraint bound for 5 days during the year for a total of 11 hours. The most significant market impact occurred on 8 December 2006 when an unplanned outage of the No1 and No2 Mount Beauty to Eildon 220 kV lines occurred as a result of bushfires. Murraylink was limited to an average of 2 MW at the time.

***Constraint: V>>SML\_NIL\_1***

This system normal constraint simultaneously limits Victorian exports and generators and exports to Snowy and across Murraylink to SA to avoid overloading one of the two Ballarat to Moorabool lines in the event that the other is lost. The constraint directly affects about 660 MW of generation in Victoria.

The constraint bound for two hours over four days during the year. The constraint bound for short periods during 11 January and 16 January, both days where prices in the market increased above \$5000/MWh. On 11 January, this constraint bound, forcing flow south into Victoria counter to the prevailing market conditions.

## **A.2 Intra-regional constraints**

### **A.2.1**

### **Queensland**

***Constraint: Q\_CS\_1900***

This system normal constraint limits flows from central Queensland to south Queensland to a maximum limit of 1900 MW to avoid transient instability.

This constraint directly affects around 5700 MW of generation in central and north Queensland or around 60 per cent of the total registered capacity for the region.

This constraint bound for 82 hours over 39 days during the year, similar to the previous year. In June, the constraint bound for 53 hours. The most significant market impact occurred on 27 June when it bound for 15 hours. On this day the spot prices exceeded \$5000/MWh and the TCC was \$8.1 million.

***Constraint: Q\_CS\_XXXX***

These outage constraints limit flows from central Queensland to south Queensland to a maximum limit of either 1450, 1550, 1650, 1700 or 1800 to manage transient stability.

From the period of July to November 2006 these constraints bound for a total of 212 hours over 62 days. From mid March through to the end of the financial year these constraints bound for a total of 135 hours over 51 days. Over the year, these constraints bound for 347 hours.

A large proportion of the time these constraints bound is attributable to Q\_CS\_1450 which bound for 141 hours over 18 days. The most significant market impact occurred on 10 October where it bound for 15 hours. The OCC on this day reached \$3 million, however prices in Queensland on the day averaged \$23/MWh, peaking at \$38/MWh over the evening. Beginning 25 September, this constraint managed the simultaneous 17 day outage of the South Pine to Tarong line and the South Pine transformer. At times this constraint constrained off up to 450MW of generation in central and north Queensland. On 12 October, the South Pine to Tarong line was returned to service whilst the South Pine transformer remained out of service. The constraint Q\_CS\_1550 managed this outage and bound for 56 hours over eight days. The South Pine transformer was returned to service on 20 October.

The constraint Q\_CS\_1700, which is used in conjunction with Q\_GLD34\_500 to manage outages of the Gladstone Bus Tie Transformer, contributed a further 83 hours over 28 days to the combined total number of binding hours. When the constraint bound, an average of 14 days notice was given by Powerlink through the NOS of the outage. NEMMCO progressed these outages to LTP status on average 11 days after notification was received. On 16 April the constraint bound for a total of 12 hours. The OCC on this day was \$1.1 million whilst prices in Queensland averaged \$99/MWh for the day and peaked at \$189/MWh over the evening. In excess of 350 MW of central Queensland generation was regularly constrained off during the outage.

The constraint Q\_CS\_1650 was used to manage outages of the Gladstone to Gin Gin line and bound for 42 hours over six days in June. The most significant market impact occurred on 28 June, a day when spot prices exceed \$5000/MWh. On this day it bound for 11 hours. The OCC on this day was \$10.5 million, its highest daily accumulation for the financial year.

The constraint Q\_CS\_1800 bound intermittently for 22 hours over 14 days from July to September and two days in November.

***Constraint: Q>PWSP\_1350 and Q^PWSP\_C2CS***

These constraints manage flows from central to south Queensland for an outage of the Palmwoods to South Pine line. The constraint directly affects around 5700MW of generation in central and north Queensland or around 60 per cent of the total registered capacity for the region.

Constraint Q>PWSP\_1350 was created on 10 August and limits flows to 1350 MW. Powerlink gave 16 days notice of the outage, which took place between 12 August and 6 September. This outage significantly contributed to the OCC during the month of August, with a total OCC of \$21 million for the month. Prices during the month of August were low in Queensland, averaging \$25/MWh. Circumstances during the binding period saw up to 800 MW of generation constrained off, with much of this generation offered at -\$1000/MWh. This bidding behaviour increased the OCC during the month. Over the length of the outage, the constraint bound for 144 hours over 12 days.

The constraint Q^PWSP\_C2CS, which manages voltage stability at Calvale during an outage of the Palmwoods to South Pine line, bound for 19 hours over 23 and 24 April.

When the constraint bound, 27 days notice was given through the NOS of the outage. NEMMCO progressed the outage to LTP status two days later.

***Constraint: Q>PRE855\_871CAL and Q>PRE855\_871GL\_ST***

These system normal constraints manage the overload of the 871 line between Calvale and Wurdong. The constraint Q>PRE855\_871CAL constrains off generation at Callide and the constraint Q>PRE855\_871GL\_ST constrains on generation at Stanwell and Gladstone.

Considered together, the constraints bound on 32 days for around 21 hours in total. The two constraints often bound at the same time. On 17 December, the constraints bound for a total of 8 hours. The constraints bound for a similar duration to the previous financial year.

***Constraint: Q\_NIL\_MRTA***

A new system normal constraint, Q\_NIL\_MRTA, was created on 14 June 2007 to constrain the 282 MW capacity Oakey power station for the continuous rating of Middle Ridge to Tangkam lines. The constraint bound on the first day it was invoked and on 8 other occasions during the month, typically during evening peaks. The constraint bound for a total of 15 hours.

This constraint was created to manage the impacts of a non-scheduled generator connected near Dalby.

***Constraint: Q>TVAS7276\_77\_PRE and Q>TVAS7276\_77\_120PRE***

These system normal constraints reduce output from the Yabulu power station. The binding of both constraints coincided with outages of the Townsville to Tulley line. This outage was managed by constraint Q^TVTU\_7134\_FNQ4 which binds to maintain voltage stability on loss of one of the lines from Chalumbin to Ross.

Constraint Q>TVAS7276\_77\_PRE bound for 14 hours over 9 days. The most significant market impact was on 23 October where the constraint bound for 7 hours. The TCC on this day was low at \$38 000. Constraint Q>TVAS7276\_77\_120PRE bound for 11 hours over only two days. On 16 August the constraint bound for 8 hours. The TCC on this day reached \$883 000.

***Constraint: Q^NIL\_1CS***

This system normal constraint manages voltage stability on lines connecting central and south Queensland. The constraint directly affects around 5700 MW of generation in central and north Queensland or around 60 per cent of the total registered capacity for the region. The constraint bound for 12 hours over eight days. The most significant market impact was on 14 June when the constraint bound for three hours. On this day the spot price exceeded \$5 000/MWh and the TCC was \$4 million.

***Constraint: Q>GGGL\_813\_814***

This constraint limits flows from central to south Queensland to 1650 MW to ensure thermal limits are observed. Around 5700 MW of generation in central and north

Queensland is directly affected or around 60 per cent of the total registered capacity for the region.

This constraint was used to manage outages of the Gladstone to Gin Gin line through April and May. The constraint bound for 11 hours over seven days. When the constraint bound, an average of 36 days notice was given through the NOS of the outage. NEMMCO typically progressed the outage to LTP status 7 days later.

***Constraint: Q:NIL\_CNI***

This system normal constraint manages transient stability between northern and central Queensland for the loss of one of the lines from Nebo to Strathmore. The limit is heavily dependent on the generation of gas turbines on the central coast. The constraint directly affects about 900 MW of generation in this area. The constraint bound for 10 hours over 53 days.

Powerlink has a number of network support agreements in place with generators in north Queensland to help manage these network limitations.

## **A.2.2 Victoria**

***Constraint: V>V\_NIL\_4***

This system normal constraint limits the total output from Hazelwood generating units 3, 4 and 5 to 640 MW. Since the fourth Latrobe Valley to Melbourne 500 kV line entered service at 500 kV in 2005, these Hazelwood units have been connected radially via the Hazelwood No1 500/220 kV transformer. The three units affected by this constraint have a combined maximum capacity of around 650MW. Anticipated works to improve the configuration of the Hazelwood switchyard will result in the elimination of this constraint.

The constraint bound for 100 hours over 22 days. On 1 July the constraint bound for 17 hours. The TCC on that day was \$81 000.

***Constraint: V>V\_HWTS\_TX3\_PAR\_3-5***

This constraint manages outages of the No 3 or No 4 500/220 kV transformers at Hazelwood to manage loading on multiple Rowville to Yallourn lines. About 2600 MW of capacity within the Latrobe Valley region is affected by this constraint.

The constraint bound for 16 hours over 31 October and 1 November. When the constraint bound, 18 days notice was given through the NOS of the outage. NEMMCO progressed the outage to LTP status 12 days later.

## **A.2.3 South Australia**

***Constraint: S^NIL\_SGBL\_LB2MAX***

This system normal constraint limits generation at Lake Bonney wind farm to maintain voltage stability on the Snuggery to Blanche line. The constraint also limits the generation at the normally off Snuggery plant.



The constraint bound for 73 hours over 16 days throughout June, it was first invoked on 1 June 2006. The constraint has since been modified 9 times. The most significant market impacts occurred on 7 June when the constraint bound for 20 hours.

#### **A.2.4 Tasmania**

***Constraint: T>T\_FASH\_1\_2\_B2, T>T\_FASH\_1\_2\_C3, T>T\_FASH\_1\_2\_C1***

These constraints are used to manage an outage of one of the Farrell to Sheffield lines by limiting west coast generation at Bastyan, John Butters, Mackintosh, Reece and Tribute.

Constraint T>T\_FASH\_1\_2\_B2 bound for a total of 15 hours on 8 January and 15 January. When the constraint bound on these days, 75 and 68 days notice was given respectively by Transend of the outage. On both occasions, NEMMCO progressed the outage to LTP status 11 days before the outage was scheduled to take place.

The T>T\_FASH\_1\_2\_C3 and T>T\_FASH\_1\_2\_C1 constraints bound on 8 June and 9 June for a combined total of 30 hours. The constraints typically bound simultaneously with dispatch impacted for a total of 16 hours. An average of three days notice was given of the outage with the progression of the outage to LTP status completed by NEMMCO the next day.

***Constraint: T\_T\_TU\_BG\_80***

This constraint limits generation at Tungatinah and Butlers Gorge for an outage of Tungatinah – Lake Echo – Waddamana 110 kV lines. The constraint bound for 16 hours over three days on 29 May, 30 May and 12 June.

When the constraint bound, an average of 27 days notice was given by Transend of the outage. NEMMCO progress the outages to LTP status 17 days later.

***Constraint: T>T\_NIL\_BL\_110\_19***

This system normal constraint manages the overload of the Waddamana to Lake Echo Tee No.1 line (flowing north) for the loss of the Tungatinah to Lake Echo Tee to Waddamana No.2 line, radialising the Bridgewater to Waddamana line from Bridgewater. It affects around 1000 MW of generation, constraining on 200 MW and constraining off 800 MW. The constraint bound for a total of 14 hours over 14 days between January and April.

***Constraint: T>T\_HAPM\_220\_3B***

This constraint manages the outage of the Hadspen to Palmerston line to manage loading on the other Hadspen to Palmerston line for the loss of Palmerston to Sheffield line. It affects about 1300 MW of Tasmanian generation capacity.

The constraint bound for 12 hours over two days on 3 and 4 April. When the constraint bound, 56 days notice was given by Transend through the NOS of the outage. The time taken by NEMMCO to progress the outage to LTP status was 20 days before the outage was planned to take place.

## Appendix B Inter-regional settlement residues

Inter-regional settlements residues (IRSR) arise when electricity is generated in a low priced region and transmitted to a higher priced region. These IRSR are effectively a pool of funds that eligible persons can access via the settlement residue auctions (SRA) process. The SRAs give participant's access to IRSR by enabling them to bid for units (shares in the total IRSR amount). The auction process is intended to encourage inter-regional trade by reducing the price difference risks and lead to a more efficient and competitive national electricity market. The firmness of this hedge is, however, affected by the capability of an interconnector—if its capability is reduced when prices diverge, then the benefit of the hedge is significantly discounted.

The settlement residues totalled around \$226 million for the 2006–07 financial year compared to \$257 million in 2005-06, \$232 million in 2004-05 and \$141 million in 2003-04. Almost half of the inter-regional settlement residues for the year accumulated on 10 days. The residues accruing for those days are presented in Table B1 along with the proportion of the total.

Around 40 per cent of the residues for the year accumulated on the Snowy to New South Wales interconnector with the majority of this accruing in June. Analysis shows that in general the interconnector capability was at near nominal limits, which means that the IRSR closely matched those that were anticipated through the SRA process on this interconnector.

On 16 January when bush fires in northern Victoria caused the separation of the power system into three electrical islands, the IRSR reached its highest daily accumulation for the 2006-07 financial year of \$27 million or 12 per cent of the total.

Around \$97 million or 43 per cent of the 2006-07 settlement residues accumulated during the June market events.

**Table B1: Top 10 days for accumulation of inter-regional settlement residues.**

Date	Settlement residues		TCC
19/07/2006	\$7 million	3%	\$ 343 454
11/01/2007	\$7 million	3%	\$ 366 098
12/01/2007	\$8 million	4%	\$ 605 727
16/01/2007	\$27 million	12%	\$2 349 368
13/06/2007	\$24 million	11%	\$6 680 368
14/06/2007	\$10 million	5%	\$4 005 062
15/06/2007	\$14 million	6%	\$1 613 533
19/06/2007	\$6 million	3%	\$ 468 592
27/06/2007	\$10 million	5%	\$8 104 287
28/06/2007	\$7 million	3%	\$10 508 626

## Appendix C All network constraints

Table C1 provides a summary of the notice given for all outages by TNSP's to NEMMCO through the NOS. The total number of outages has fluctuated from 4033 in 2003–04 to 3911 in 2004-05, 4487 in 2005-06 and the greatest number of 5031 in 2006-07. The broad statistic shows that almost one third of all planned outages are submitted with less than four days notice.

**Table C1—Transmission outages submitted to NEMMCO**

<b>Region</b>	<b>QLD</b>	<b>NSW<sup>1</sup></b>	<b>VIC</b>	<b>SA</b>	<b>TAS</b>	<b>Murray link</b>	<b>Terranora<sup>4</sup></b>	<b>Total</b>
<b>Total outages<sup>2</sup></b>	1039	1141	1402	984	397	13	55	5031
<b>Scheduled with less than four days notice</b>	26%	22%	33%	21%	22%	80%	58%	26%
<b>Forced outages<sup>3</sup></b>	7%	6%	11%	5%	6%	23%	22%	7%

### Notes

- <sup>1</sup> The NSW TNSP arranges Snowy outages.
- <sup>2</sup> Only primary plant outages (affecting load carrying capability) are included.
- <sup>3</sup> Outages not previously notified to NEMMCO, including failures and amendments by TNSPs in response to unforeseen extreme conditions.
- <sup>4</sup> Directlink became a regulated interconnector on 22 March 2006 at which time it became known as the Terranora interconnector.

## **Appendix D Frequency control ancillary services**

The TCC and the MCC indicators exclude the effects of transmission constraints on the Frequency Control Ancillary Service (FCAS) markets. Typically the cost of FCAS is less than one per cent of the cost of the energy market. This section provides an assessment of the impacts of transmission on the FCAS markets. The largest impacts on FCAS were as a result of unplanned network events.

The turnover in the FCAS market in 2006–07 was \$40 million (compared to \$30 million in 2005–06, \$26 million in 2004–05 and \$28 million in 2003–04). The FCAS markets in Tasmania accounted for 25 per cent of this cost or \$10 million.

The separation of the market into three islands on 16 January led to the requirement for local FCAS in Victoria, Tasmania and South Australia. FCAS costs on the mainland totalled \$18.5 million and \$1.5 million in Tasmania. This is equivalent to half of the total FCAS cost for the year.

Network outages on the mainland at times led to increased requirements for global lower services, however these costs remained small, totalling around \$27 000 for the year. In the previous year outages accounted for around \$3 million.

Interactions between the FCAS markets and the no-go zone on the Basslink interconnector led to increases in the cost of local Tasmanian services. These interactions at times led to counter price energy flows across the Basslink interconnector. The TCC and OCC do not include the effects of congestion across Basslink as it is not a regulated interconnector.

## Appendix E Directions

The TCC and the MCC values the cost of producing electricity using the offer prices of each generator. Generators which are 'constrained on' or 'constrained off', however, may not have an incentive to offer their output at a price which reflects their own costs. Instead, such generators will, on occasion, offer their output at the price ceiling (\$10 000/MWh) or the price floor (\$-1000/MWh) of the market. As a result, this can distort the calculation of the TCC or the MCC. This can occur when a generator is directed. To prevent distortions to the TCC in these situations, generator offers have been substituted with \$300/MWh. This is an approximation only and does not reflect the true cost of the directions.

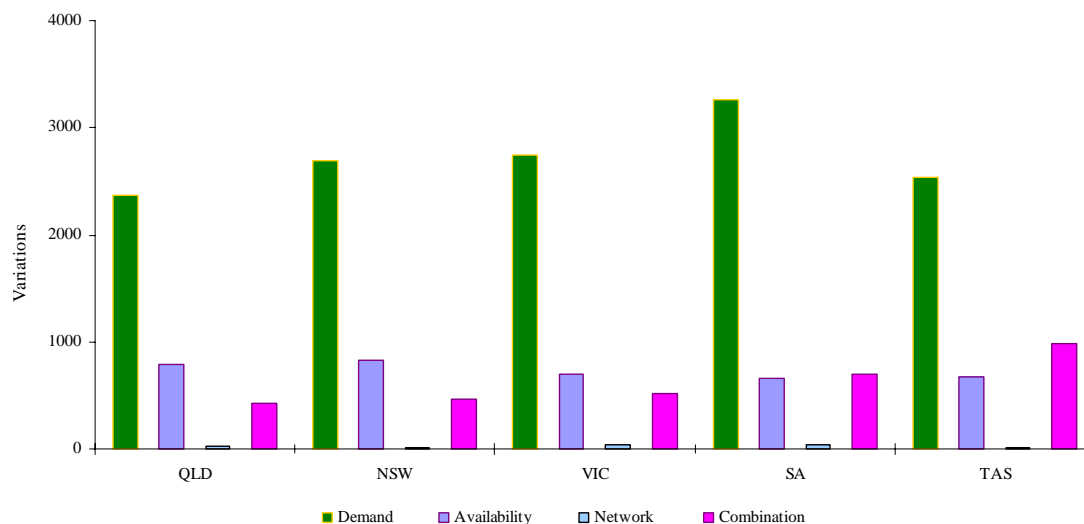
NEMMCO issued 10 directions throughout the year to manage local security issue (compared to 60 during 2005-06, 41 during 2004-05 and 10 in 2003-04). Of these, seven in Victoria and one in South Australia followed the loss of the Victoria to Snowy interconnector on 16 January.

The remaining three occasions occurred in Queensland. These events occurred on 10 January and twice on 20 May.

## Appendix F Network related price variations

Figure 1 shows the number and most probable reason for variations between actual prices and those forecast four hours ahead for the 2006-07 financial year.

*Figure F1: reasons for variations between forecast and actual prices*



The AER prepares a weekly report to help inform the market and interested parties about energy market trends and issues. These reports analyse all 30 minute trading prices which are greater than three times the weekly average price. Over the 2006-2007 financial year, the AER reported on 194 events covering 1033 trading intervals, compared to 1093 the previous year.

The table below identifies those 9 events (covering 36 trading intervals) where the spot price was greater than three times the weekly average, and the variation in price from forecast was driven to some extent by changes in the network.

Date	Region	Reason
03-Jul-06	TAS	Basslink's no go zone and the interaction of the frequency control and energy markets limited exports from Tasmania to 79 MW for the 9.05 pm dispatch interval. The dispatch price for Tasmania rose from \$36/MWh to \$7973/MWh and over 100 MW of generation was backed off in Tasmania. Simultaneously, a number of units were "trapped" in the ancillary service markets, further reducing the available capacity in the energy market. At 9.10 pm, an increase in the availability of ancillary services saw their prices fall, allowing the interconnector to reduce exports from Tasmania to 50 MW - the boundary of the no-go zone.
18-Aug-06	TAS	Two unplanned outages occurred during the day. At 8.04 am, Basslink tripped whilst exporting 100 MW into Victoria and remained out of service for one hour. At 11.56 am, the interconnection once again tripped, this time importing 300 MW into Tasmania. The loss of the interconnection whilst importing into Tasmania led to a requirement for locally sourced ancillary services. The price in Tasmania increased from \$30/MWh at 12pm to \$9000/MWh at 12.05 pm. This energy price was accompanied by a Tasmanian lower 6 second price of \$2242/MW. The Frequency Control System Protection Scheme operated as required, tripping around 200 MW of load in Tasmania. Basslink returned to service at 12.31 pm.

Date	Region	Reason
15-Jan-06	TAS	Conditions at the time saw demand and available capacity close to forecast. There was a 5 minute price of \$10 000/MWh at 9.25 am following a 355 MW step reduction in import capability into Tasmania across Basslink. This reduced import capability was driven by a telecommunication systems problem.
16-Jan-07	VIC/TAS	At 3.02pm, bushfire in northern Victoria tripped the two Dederang to South Morang lines, leading to a power system separation, into three electrical islands. There was a reduction of exports into Victoria for more than four hours.
23-Jan-07	QLD/ NSW /VIC	Conditions at the time saw demand less than that forecast four and 12 hours ahead, with prices generally aligned with those in New South Wales and Victoria. From 2.30 pm, constraints were invoked to manage a network outage near Tarong. These constraints drove counter price flows across the Queensland to New South Wales interconnector. Additional constraints, to restrict the accumulation of negative settlement residues, were invoked by NEMMCO from 3 pm.
24-Jan-07	QLD	Conditions at the time saw demand close to forecast, reaching a new record of almost 8340 MW by 3 pm. NEMMCO introduced constraints throughout the period to restrict the accumulation of negative settlements across the Queensland to New South Wales interconnector.
17-Feb-07	NSW/VIC/SA	From 1.15 pm a system normal network constraint led to see-sawing limits on the Snowy to Victoria interconnector. When the constraint bound, prices in New South Wales and Snowy increased to around \$450/MWh whilst prices in the southern regions fell, to as low as -\$1000/MWh in Victoria. Counter price flows between Snowy and Victoria were occurring at these times with flows forced south by as much as 730 MW. In response, NEMMCO intervened to limit the accumulation of negative inter-regional settlement residues from 2.20 pm, restricting flows from Snowy into Victoria to 200 MW.
22-Feb-07	TAS	A network limitation between western and northern Tasmania restricted the dispatch of lower priced generation from 9.05 am to 9.10 am. This resulted in no available capacity in Tasmania priced between \$60/MWh and \$8000/MWh, with 1 MW of capacity dispatched at \$8000/MWh setting the price for these two dispatch intervals. At 5.03 pm, lightning in the vicinity of northern Tasmania led to the tripping of two Farrell to Sheffield lines. This resulted in the loss of around 130 MW of load and 580 MW of generation. The reduction of exports across Basslink into Victoria increased the dispatch of locally sourced frequency control raise ancillary services. Both the raise 6 second service and energy prices rose significantly to around \$8000/MWh.
15-Mar-07	VIC	In north east Victoria, a planned network outage of equipment at Dederang limited the flow across the Snowy to Victoria interconnector to around 200 MW from 11 am to 12 pm. The constraint used to manage this outage restricted generation in the Latrobe Valley and constrained AGL Hydro generators. Simultaneously, a planned network outage between Ballarat and Moorabool forced flow into Victoria across Murraylink and Snowy to Victoria interconnectors, and constrained on the AGL Hydro generators.

## Appendix G All significant network constraints

The following tables present the most significant constraints for the year. The constraints are grouped according to interconnectors, region, frequency control, grid support and direction. Constraints applied to interconnectors are separated into the direction of flow and the network configuration they model (nominal or inherent capability, and those used to manage network outages).

- G1. New South Wales to Queensland (QNI)
- G2. Queensland to New South Wales (QNI)
- G3. New South Wales to Queensland (Terranora)
- G4. Queensland to New South Wales (Terranora)
- G5. Snowy to New South Wales
- G6. New South Wales to Snowy
- G7. Victoria to Snowy
- G8. Snowy to Victoria
- G9. Victoria to South Australia (Heywood)
- G10. South Australia to Victoria (Heywood)
- G11. Victoria to South Australia (Murraylink)
- G12. South Australia to Victoria (Murraylink)
- G13. Queensland intra-regional constraints
- G14. New South Wales intra-regional constraints
- G15. Snowy intra-regional constraints
- G16. Victoria intra-regional constraints
- G17. South Australia intra-regional constraints
- G18. Tasmania intra-regional constraints
- G19. Constraints used in grid support
- G20. Constraints used in power system directions



## G1. NEW SOUTH WALES TO QUEENSLAND (QNI) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
N>N-NIL_F7_15M	14	25,710	150	System normal - avoid overload (15 min rating) of Armidale to Tamworth (86) on trip of other Armidale to Tamworth (85) line, Feedback
N^Q_NIL_B	4	11,888	229	System normal - avoid Voltage Collapse on loss of largest Qld Generator
N:Q_NIL_B4	0.3	5,136	1,712	System normal - NSW to Qld Transient Stability Limit for Vic to Snowy flows of 0 to 500 MW, V-SA negative, 8 units in service at Bayswater and Liddell
N>Q+NIL_F7	0.3	522	174	System normal - limit QNI and Terranora to avoid overloading (15 min rating) of Armidale to Tamworth (86) 330kV line on loss of other Armidale to Tamworth (85) 330kV line, Feedback
N::Q_NIL_C_1A	2	364	18	System normal - NSW to Qld Transient Stability for a trip of Callide C3
N::Q_NIL_C_1B	1	166	21	System normal - NSW to Qld Transient Stability for a trip of a Callide C4
N>N-NIL__4_15M	0.4	137	27	System normal - avoid overload Muswellbrook to Tamworth (88) on trip of Liddell to Tamworth (84), Feedback
N:Q_NIL_B8	1	27	3	System normal - NSW to Qld Transient Stability Limit for: Vic to Snowy flows of 500 to 1000 MW, 7 or less units in service at Bayswater and Liddell
N:Q_NIL_B9	1	20	2	System normal - NSW to Qld Transient Stability Limit for: Vic to Snowy flows of 1000 to 1170 MW, 7 or less units in service at Bayswater and Liddell

## Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
Q^^TR_NIL-VE	1	195,243	19,524	Negative Residue application - Tarong Limit <= Dyn UV Limit Calculated for co-optimised. QNI and QGEN dispatch and pre-dispatch based on minimum limit criteria (CLTR, TRBK , MELL , WOPW) selection. LMT offset = EMS entered value with system normal =0.0.
Q>>QTR_2900	1	66,544	5,545	Multiple equipment outage. Tarong cutset discretionary thermal limit 2900MW
N^Q_AR_VCB	3	26,187	727	Outage of Armidale SVC, avoid Voltage Collapse on loss of largest Qld Generator
Q^^TCT_OFFSET_-200	1	25,778	4,296	Tarong Limit. Limit QNI and Queensland generation for under voltage conditions following trip of Calvale to Tarong,
Q>>BRTR_NTH-PRE	4	15,731	297	Outage of 275kV feeders between Braemar - Tarong 8814 or 8815. Precontingent transfer North across Braemar to Tarong for post contingent transfer on Millmerran to Middle Ridge 9908. Thermal limit 831 feeder and 726 feeder open.
Q>>QTR_3100	1	9,826	578	Multiple equipment outage. Tarong cutset discretionary thermal limit 3100MW
Q>>QTR_2950	1	8,944	994	Multiple equipment outage. Tarong cutset discretionary thermal limit 2950MW
NQ_100	0.3	3,117	779	NSW to Qld on QNI upper transfer limit of 100 MW
Q^^TCT_OFFSET_-60	0.1	2,872	2,872	Tarong Limit. Limit QNI and Queensland generation for under voltage conditions following trip of Calvale to Tarong,

## G2. QUEENSLAND TO NEW SOUTH WALES (QNI) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
Q:N_NIL_OSC	888	119,082	11	System normal - limit Qld to NSW on QNI to avoid Oscillatory Instability
Q:N_NIL_BCK2L-G	99	87,442	74	System normal - limit Qld to NSW on QNI to avoid transient instability on 2L-G fault at Bulli Creek.
N>>N-NIL_DY_1	153	78,485	43	System normal - avoid Armidale->Kempsey(965) OL(15m rat) on Coffs_Harbour-Nambucca(9W3) trip, Raleigh & Sawtell not ex Coffs_H, TG_spec
#NSW1-QLD1_E	3	37,088	1,196	Discretionary constraint. Force QNI to flow north above 130 MW
Q>N_NIL_8L_8M	251	32,389	11	System normal - limit QNI flow to avoid overloading 8L or 8M on trip of the other
Q>N-NIL_DY	39	9,219	20	System normal - limit Qld to NSW on QNI + Terranora to avoid O/L (conditional 15 min rating) Armidale to Kempsey (965) on trip of Coffs Harbour to Nambucca (9W3), Raleigh and Sawtell not fed from Coffs Harbour, Feedback
V::H_NILQF_BL_R	63	3,666	5	System normal - Basslink export to Tas, limit Vic interconnectors, NSW to Qld on QNI and Vic generation to avoid transient instability for fault and trip of a Hazelwood to South Morang 500kV line, radial mode at Hazelwood
N>>N-NIL_DX_1	8	2,944	30	System normal - avoid Armidale to Kempsey(965) overload (15m rat) on Coffs_Harbour to Nambucca(9W3) trip, one only of Raleigh, Sawtell loads supplied ex Coffs_H, TG_spec
V::H_NILQE_BL_R	55	1,925	3	System normal - Basslink export to Tas, limit Vic interconnectors, NSW to Qld on QNI and Vic generation to avoid transient instability for fault and trip of a Hazelwood to South Morang 500kV line, radial mode at Hazelwood
V::H_NILQC_BL_R	5	1,331	21	System normal - Basslink import from Tas, limit Vic interconnectors, NSW to Qld on QNI and Vic generation to avoid transient instability for fault and trip of a Hazelwood to South Morang 500kV line, radial mode at Hazelwood

## Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
Q:N_H36BK_VC	33	154,767	396	Outage of Blackwall SVC and with H22LL 50MVar Cap avail/not available ,Transient Stability (Boyne Island Pot Line Trip from 375MW) Limit,transfer from Qld to NSW.
N>>N-ERNC_H	18	33,480	154	Outage of Eraring to Newcastle (93), avoid overload of Liddell to Newcastle (81) on trip of Liddell to Tomago (82), Feedback
QNS_0050	0.1	5,553	5,553	Qld to NSW summated QNI + Terranora upper transfer limit of 50 MW
N>>N-81_1T	44	4,570	9	Outage of Liddell to Newcastle(81), avoid overload Liddell to Tomago(82)
N>>N-LDTM_15	8	3,816	42	Outage of Liddell-Tomago(82), avoid overload Liddell to Newcastle(81) on Bayswater-Regentville(32) trip
N>>N-ARKK_B	10	3,013	24	Outage of Armidale to Koolkhan(966), avoid overload Armidale to Kempsey(965) on Armidale to Coffs Harbour (96C) trip; Port Macquarie_Load=50
Q:N_ARDM_B	14	2,074	12	Outage of 8C or 8E, QNI, transient stability for loss of a Boyne Island Potline, Powerlink equation
N>>N-MPWW_02	0.3	1,834	611	Outage of MtPiper to Wallerawang(71), avoid overload on Marulan to Dapto(8) on Avon-Marulan(16) trip
Q:N_AR_CP1_BCK2L-G	5	1,721	29	Outage of Armidale capacitor bank (80MVar), limit Qld to NSW on QNI to avoid transient instability on 2 line to ground fault at Bulli Creek
N>>N-LDNC_DY	10	1,668	13	Outage of Liddell to Newcastle (81), avoid overload Armidale to Kempsey (965) on trip of Coffs Harbour to Nambucca (9W3)

### G3. NEW SOUTH WALES TO QUEENSLAND (TERRANORA) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
N>N-NIL_TE_E2	54	209,063	326	System normal - avoid overload of Armidale to Coffs Harbour(96C) on Armidale-Coffs Harbour(87) trip
N>N-NIL_F7_15M	14	25,710	150	System normal - avoid overload (15 min rating) of Armidale to Tamworth (86) on trip of other Armidale to Tamworth (85) line
N>N-NIL_TE_E1	5	25,313	452	System normal - avoid overload of Armidale to CoffsHarbour(96C) on Armidale to Coffs Harbour (87) trip
N^Q_NIL_B	4	11,888	229	System normal - avoid Voltage Collapse on loss of largest Qld Generator
N:Q_NIL_B4	0.3	5,136	1,712	System normal - NSW to Qld Transient Stability Limit for: Victoria to Snowy flows of 0 to 500 MW, V-SA negative, 8 units in service at Bayswater and Liddell
NQTE_ROC	14	3,256	20	System normal - Rate of Change (NSW to Qld) constraint (80 MW / 5 Min) for Terranora Interconnector
N>N-NIL_TE_C	19	1,592	7	System normal - avoid overload of Armidale to Koolkhan (966), on trip of Armidale to Coffs Harbour (87)
N>N+NIL_TE_D	2	1,201	55	System normal - Limit Terranora to avoid overload on Lismore330 to Lismore132(9U9) on Lismore330 to Lismore132 (9U8) trip
#N-Q-MNSP1_I	12	928	6	Discretionary constraint on Terranora interconnector. Flow south above 100
N>Q+NIL_F7	0.3	522	174	System normal - limit QNI and Terranora to avoid overloading (15 min rating) of Armidale to Tamworth (86) 330kV line on loss of other Armidale to Tamworth (85) 330kV line

## Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
N^Q_AR_VCB	3	26,187	727	Outage of Armidale SVC, avoid Voltage Collapse on loss of largest Qld Generator
N_X_MBTE2_A	0	9,592	2,398	Outage of two Terranora cables, NSW to Qld limit
N>N-KKLS_TE_2	111	7,186	5	Outage of Koolkhan to Lismore (967), avoid overload of Tenterfield to Lismore (96L) on trip of Coffs Harbour to Lismore (89)
N>N-ARTN_TE_C2	97	6,350	5	Outage of Armidale to Tenterfield (96T), avoid overload of Koolkhan to Lismore (967) on trip of Coffs Harbour to Lismore (89)
N>N-AR330BS3_A	4	5,709	117	Outage of Armidale 330kV Bus Section #3, avoid overload of Armidale transformer on Armidale-Coffs Harbour(87) trip
N>N-AR_TX_A	63	5,681	8	Outage of one Armidale 330/132kV transformer, avoid overload of (2 Hour rating) an Armidale 330/132kV transformer on trip of Armidale to Coffs Harbour (87)
N>N-ARKK_CH_CB892A	26	4,806	15	Outage of Armidale to Koolkhan (966) and Coffs Harbour CB892A, avoid overload of Armidale to Coffs Harbour (96C) on trip of Armidale to Coffs Harbour (87)
N>N-ARTN_TE_C1	31	2,891	8	Outage of Armidale to Tenterfield (96T), avoid overload of Koolkhan to Lismore (967) on trip of Coffs Harbour to Lismore (89)
N>N-ARTN_TE_B2	10	1,946	16	Outage of Armidale to Tenterfield (96T), avoid overload of Armidale to Coffs Harbour (96C) on trip of Armidale to Coffs Harbour (87)
N>N-CHKK_TE_1	4	1,902	44	Outage of Coffs Harbour to Koolkhan (96H), avoid overload of Armidale to Koolkhan (966) on trip of Coffs Harbour to Lismore (89)

#### G4. QUEENSLAND TO NEW SOUTH WALES (TERRANORA) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
N>>N-NIL_DY_1	153	78,485	43	System normal - avoid overload of Armidale to Kempsey(965) (15m rat) on Coffs Harbour to Nambucca(9W3) trip, Raleigh & Sawtell not ex Coffs Harbour
Q>NIL_757+758_B	587	36,766	5	System normal - Thermal limit for 110kV feeder ( 757 + 758) Mudgeeraba to Terranora (at Mudgeeraba). Summer and Winter ECS ratings selected by status..
Q>N-NIL_DY	39	9,219	20	System normal - limit Qld to NSW on QNI + Terranora to avoid overload (conditional 15 min rating) Armidale to Kempsey (965) on trip of Coffs Harbour to Nambucca (9W3), Raleigh and Sawtell not fed from Coffs Harbour
Q^NIL_GC	9	5,487	49	System normal - Gold Coast voltage stability limit, 275kV into Gold Coast at H4MU and H31MD and 110kV into Gold Coast at T81CC version 2006/07
N>>N-NIL_DX_1	8	2,944	30	System normal - avoid overload of Armidale to Kempsey(965) (15m rat) on Coffs Harbour to Nambucca(9W3) trip, one only of Raleigh, Sawtell loads supplied
QNTE_ROC	7	1,442	18	System normal - Rate of Change (Qld to NSW) constraint (80 MW / 5 Min) for Terranora Interconnector
N>>N-NIL_1E	1	425	61	System normal - avoid overload Liddel to Newcastl (81) on loss of Liddell to Tomago (82)
N>>N-NIL_DY_2	1	228	14	System normal - avoid overload Armidale to Kempsey(965) on Coffs Harbour to Nambucca(9W3) trip
N>>N-NIL_DC	2	68	3	System normal - avoid overload Armidale to Tamworth(86) on Armidale to Tamworth(85) trip
Q>>Q-NIL_806+8826_1	1	22	3	System normal - avoid overload Beenleigh to Coomera(704) on SwanBank H1-H51(8826)+Swanbank_H1-Mudgeeraba_H4(806) trip

## Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
N_MBTE2_B	44	176,557	338	Outage of two of three Terranora cables, Qld to NSW limit
Q^BK_VC_GC	0	91,793	22,948	Outage of Blackwall Static Var Compensator 275kV Gold Coast Voltage Stability limit, Offset = -25MW to Gold Coast voltage stability limit, 275kV into Gold Coast at H4MU and H31MD and 110kV into Gold Coast at T81CC).
Q>H4MU_TX_GC540	405	40,905	8	Outage of 275/110kV H4 Mudgeeraba transformer, Terranora flows constrained to maintain Gold Coast cutset transfer<=540MW
N>>N-ERNC_H	18	33,480	154	Outage Eraring to Newcastle (93), avoid overload Liddell to Newcastle (81) on trip of Liddell to Tomago (82)
Q>H4MU_TX_GC675	4	28,709	638	Outage 275/110kV H4 Mudgeeraba transformer, Terranora flows constrained to maintain GoldCoast cutset transfer<=675MW
Q>MUTE757_758_B	244	18,501	6	Outage of Terranora to Mudgeeraba 110kV feeders 757 or 758 thermal limit for Mudgeeraba to Terranora (at Mudgeeraba)
Q>H4MU_TX_GC700	2	15,954	760	Outage of 275/110kV H4 Mudgeeraba transformer, Terranora flows constrained to maintain Gold Coast cutset transfer<=700MW
Q>H4MU_TX_GC630	16	10,084	53	Outage of 275/110kV, H4 Mudgeeraba transformer, Terranora flows constrained to maintain Gold Coast cutset transfer<=630MW
N_MBTE1_B	46	9,589	17	Outage of one Terranora cable, Qld to NSW limit
QNS_0050	0	5,553	5,553	Qld to NSW summated QNI + Terranora upper transfer limit of 50 MW



## G5. SNOWY TO NEW SOUTH WALES INTERCONNECTOR

### Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
N>>N-NIL_1U	0.3	79,695	26,565	System normal - avoid overload Mt Piper 330/132kV transformer on loss of Mt Piper to Wallerawang (71)
H>>H-NIL_A	15	62,452	339	System normal - avoid overload Murray to Upper Tumut (65) 330kV line on loss of Murray to Lower Tumut (66) 330kV line
H^N_NIL_1	1	22,682	1,745	System normal - Snowy to NSW voltage stability limit
N:Q_NIL_B4	0.3	5,136	1,712	System normal - NSW to Qld Transient Stability Limit for Victoria to Snowy flows of 0 to 500 MW, V-SA negative, 8 units in service at Bayswater and Liddell
H^N_NIL_2	0.3	399	133	System normal - avoid low Canberra volts (Voltage stability limit) on Lower Tumut to Canberra(07) trip
H>>H-64_B	0.3	147	49	Outage of Lower Tumut to Upper Tumut (64) (normally out of service) avoid overload of Murray to LowerTumut (66) on Murray to Upper Tumut (65) trip

### Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
V>>V_LTMS_1	43	53,027	104	Outage of Lower Tumut to Murray (66), avoid overload of Dederang to Wodonga on trip of Murray to Upper Tumut (65)
N>>N-ERNC_H	18	33,480	154	Outage of Eraring to Newcastle (93), avoid overload of Liddell to Newcastle (81) on trip of Liddell to Tomago (82)
H>>H-LTMS_4	12	18,207	132	Outage of Lower Tumut to Murray(66), avoid overload of Murray to UpperTumut (65) on Dederang-Wodonga(DDWO) trip
N>>N-MPWW_03	0.2	9,854	4,927	Outage of Mt Piper to Wallerawang (71), avoid overload of Mt Piper 330/132kV transformer on trip of Nil
H>>H-LTMS_A	0.4	4,245	849	Outage of Lower Tumut to Murray (66), avoid overload of Murray to Upper Tumut (65) on Jindera-Wodonga(060) trip
N>>N-LDTM_15	8	3,816	42	Outage of Liddell to Tomago(82), avoid overload of Liddell to Newcastle(81) on Bayswater-Regentville(32) trip
V>>V-MSUT_1	3	2,384	64	Outage of Murray to Upper Tumut(65), avoid overload of Dederang to Wodonga(DDWO) on Lower Tumut to Murray(66) trip
N>>N-MPWW_02	0.3	1,834	611	Outage of MtPiper to Wallerawang(71), avoid overload of Marulan to Dapto(8) on Avon to Marulan(16) trip
N>>N-BWRG_G	10	1,431	12	Outage Bayswater to Regentville (31), avoid overload of Liddell to Tomago (82) on trip of Liddell to Newcastle (81)

## G6. NEW SOUTH WALES TO SNOWY INTERCONNECTOR

Constraints modelling nominal transmission conditions

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<b>CONSTRAINT ID</b>	<b>HOURS</b>	<b>CMV (\$)</b>	<b>AVG MV</b>	<b>DESCRIPTION</b>
H>>H-NIL_C	42	16,332	32	System normal - avoid overload of Upper Tumut to Murray (65) 330kV line on loss of Murray to Lower Tumut (66) 330kV line
N::H_NIL	9	1,015	9	System normal - NSW to Snowy Transient Limit
H>>H-NIL_J	2	480	22	System normal - avoid overloading Upper Tumut to Murray (65)
N>>N-NIL_1XS	1	23	2	System normal - avoid overload of Marulan to Yass (4) on trip of Marulan to Yass (5)
N::H_LTUT	0.3	20	7	Outage of Lower Tumut to Upper Tumut (64), NSW to Snowy Transient Limit

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## Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
H>>H-LTMS_B	4	1,676	39	Outage of Lower Tumut to Murray (66), avoid overload of Upper Tumut to Murray (65) on Lower Tumut to Wagga(051) trip
H>>H-MSUT_1A	1	105	10	Outage of Murray to Upper Tumut(65), avoid overload of Lower Tumut to Murray(66) on Lower Tumut to Wagga(051) trip
N:H_DDSM	1	48	6	Outage of Dederang to South Morang, avoid instability on Sydney West to Yass(39) or the other Dederang to South Morang line fault & trip
H>>H-BURC_2S	0.3	37	12	Outage of Buronga to Red Cliffs (0X1), avoid overload of Upper Tumut to Murray (65) on trip of Lower Tumut to Murray (66)
H>>H-DDWO_C	1	25	2	Outage of Dederang to Wodonga, avoid overload of Upper Tumut to Murray(65) (15/30 minute rating) on Lower Tumut to Murray(66) trip
N:H_HORC	0.4	23	5	Outage of Horsham to Red Cliffs
N>>N-CNKV_1S	1	15	1	Outage of Canberra to Kangaroo Valley (6), avoid overload of Marulan to Yass (4) on trip of Marulan to Yass (5)
N>>N-DTKV_1S	0.3	11	4	Outage of Dapto to KangarooValley (18), avoid overload of Marulan to Yass (4) on Marulan-Yass(5) trip

## G7. VICTORIA TO SNOWY INTERCONNECTOR

### Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
V>>V_NIL_3B_R	163	537,751	276	System normal - limit Victorian interconnectors and Victorian generation to avoid post-contingent overloading the South Morang 500/330kV (F2) transformer for trip of Rowville 500/220kV transformer, Yallourn unit 1 in 220kV mode, radial mode at Hazelwood
V>>H_NIL1A_R	3	187,373	5,678	System normal - limit Victorian interconnectors and Victorian generators to avoid thermal overload on South Morang to Dederang 330 kV line for loss of the parallel line, Radial
V>>SML_NIL_5A	1	148,620	8,742	System normal - limit Victorian generation and interconnectors to avoid overload on Geelong to Keilor No.1 220kV line for loss of the Moorabool 500/220kV transformer, swamped if Murraylink Very Fast Run Back enabled and Murraylink > 25MW
V>>SML_NIL_1	2	83,541	3,978	System normal - limit Victorian generators and interconnectors to avoid overloading Ballarat to Moorabool No.1 220 kV line for loss of Ballarat to Moorabool No.2 220 kV line, swamped if Murraylink Very Fast Run Back enabled and Murraylink > 25MW
V>>SML_NIL_5B	0.1	74,401	74,401	System normal - limit Victorian generation and interconnectors to avoid overload on Geelong to Keilor No.2 220kV line for loss of the Moorabool 500/220kV transformer, swamped if Murraylink Very Fast Run Back enabled and Murraylink > 25MW
H>>H-NIL_C	42	16,332	32	System normal - avoid O/L Upper Tumut to Murray (65) 330kV line on loss of Murray to Lower Tumut (66) 330kV line
V>>V_NIL_2B_R	105	15,328	12	System normal - limit Victorian interconnectors and Victorian generation to avoid pre-contingent overloading the South Morang 500/330kV (F2) transformer, Yallourn unit 1 in 220kV mode, radial mode at Hazelwood
V>>SML_NIL_4	4	8,539	199	System normal - limit Victorian generators and interconnectors to avoid overloading Ballarat to Moorabool No.2 220 kV line for loss of Ballarat to Moorabool No.1 220 kV line, swamped if Murraylink Very Fast Run Back enabled and Murraylink > 25MW
V::H_NILQF_BL_R	63	3,666	5	System normal - Basslink export to Tas, limit Victorian interconnectors, NSW to Qld on QNI and Victorian generation to avoid transient instability for fault and trip of a Hazelwood to South Morang 500kV line, radial mode at Hazelwood

## Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
V>>SML_BAML	25	441,249	1,486	Outage of Ballarat to Moorabool (No.1 or No.2) line, limit Murraylink from Victoria to SA to avoid overloading Moorabool to Terang line on loss of Ballarat to Moorabool (No.2 or No.1) line
V>>V_ROTSTX_3B_R	31	11,064	30	Outage of Rowville 500/220kV transformer, limit Victoria interconnectors and Victoria generation to avoid overload of South Morang 500/330kV (F2) transformer for trip of Cranbourne 500/220kV transformer, Yallourn unit 1 in 220kV mode, radial mode
V>>V_GTKT_3	1	4,644	580	Outage of Geelong to Keilor No.1 or No.2 220kV line, limit Victoria generation and interconnectors to avoid overload of the Geelong to Keilor No.3 220kV line for trip of the Moorabool 500/220kV transformer, swamped if Murraylink Very Fast Run Back enabled and Murraylink > 25MW
V>>V_EPMB	2	2,303	128	Outage of Eildon to Mt Beauty 220kV line, Mt Beauty 220kV Bustie CB closed, limit Southern Hydro generation to avoid overload of a Dederang to Mt Beauty 220kV line for loss of a Dederang to Mt Beauty 220kV line
V::H_HWSMVA_R	5	1,231	22	Outage of Hazelwood to South Morang 500 kV line, limit Victoria interconnectors and generators, avoid transient instability for fault and trip of a Hazelwood to South Morang 500 kV line, Radial
V>>V_MLTX_1	3	1,207	33	Outage of Moorabool 500/220kV transformer, limit Victoria generation and interconnectors to avoid overload of the Geelong to Keilor No.1 220kV line for trip of a parallel line
V::HHWRO3_R	8	1,049	11	Outage of Hazelwood to Rowville No.3 500kV line, limit Victoria to Snowy to avoid transient instability for fault and trip of a Hazelwood to South Morang 500kV line, Radial
V>>V_GTKT_1	4	933	21	Outage of Geelong to Keilor No.2 or No.3 220kV line, limit Victoria generation and interconnectors to avoid overload of the Geelong to Keilor No.1 220kV line for trip of the Moorabool 500/220kV transformer, swamped if Murraylink Very Fast Run Back enabled and Murraylink > 25MW
V::H_BABEVE_R	4	727	15	Outage of Ballarat to Bendigo 220kV line, limit Victoria generators and interconnectors to avoid transient instability for fault and trip of a Hazelwood to South Morang 500kV line, Radial
V::V_DDSTM	6	668	9	Outage of Dederang to South Morang 330kV line, limit Victoria to Snowy to avoid transient instability for fault and trip of a Dederang to South Morang 330kV line

## G8. SNOWY TO VICTORIA INTERCONNECTOR

### Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
H>>V_NIL_1A	2	172,626	6,394	System normal - limit Victoria interconnectors and Victoria generation to avoid overloading a Dederang to Murray 330kV line for loss of one of the two parallel lines, 15 min line ratings
H>>H-NIL_A	15	62,452	339	System normal - avoid overload of Murray to Upper Tumut (65) 330kV line on loss of Murray to Lower Tumut (66) 330kV line
N^N-X5_TRIP_A	11	38,874	286	Out of X5 tripping scheme, Darlington Point Capacitors on auto, avoid Area voltage collapse on Darlington Point to Wagga(63) trip
H>>V_NIL_4A	1	8,555	713	System normal - limit Victoria interconnectors and Victoria generation to avoid exceeding the continuous rating of the No.1 Dederang 330/220kV transformer with the DBUSS-Transformer control scheme armed
H^V_NIL_1	54	6,130	9	System normal - limit Snowy to Victoria and Snowy generation to avoid voltage collapse for loss of the largest Victoria generating unit, radial
H^V_NIL_1_P	62	4,610	6	System normal - limit Snowy to Victoria and Snowy generation to avoid voltage collapse for loss of the largest Victoria generating unit, 3/5 or 2-5 tied parallel modes or modified radial mode with 1-2 tied
V>>SML_NIL_6	0.3	197	49	System normal - limit Victoria generators and interconnectors to avoid overloading the Bendigo to Fosterville to Shepparton 220 kV line for trip of Moorabool 500/220kV transformer, swamped if Murraylink Very Fast Run Back enabled and Murraylink > 25MW
H>>H-64_B	0.3	147	49	Outage of Lower Tumut to Upper Tumut (64), avoid overload of Murray to Lower Tumut (66) on Murray to Upper Tumut (65) trip
H^V_NIL_2	0.1	25	25	System normal - limit Victoria interconnectors and Victoria generation to avoid voltage collapse for loss of a Dederang to Murray 330kV line

## Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
HV_0250	2	233,657	11,127	Discretionary Snowy to Vic transfer limit of 250 MW
V>>V_X_DDTX2_3_DBUSS	16	207,406	1,058	Outage of Dederang No.2 or No.3 330/220kV transformer and DBUSS transformer control scheme, limit Victoria generation and interconnectors to avoid overloading the Dederang No.1 transformer for loss of the other Dederang transformer
HV_0400	1	27,523	1,966	Discretionary Snowy to Victoria transfer limit of 400 MW
H^V_X_DDSM_TWO	4	7,546	168	Outage of both Dederang to South Morang 330kV lines, limit Victoria interconnectors and generation to avoid voltage collapse for loss of the largest Victoria generating unit
H^V_MSUT	14	4,425	26	Outage of Murray to Upper Tumut OR Murray to Lower Tumut 330kV line, limit Snowy to Victoria and Snowy generation to avoid voltage collapse for trip of Murray to Lower Tumut or Murray to Upper Tumut 330kV line
HV_0450	0.3	3,464	1,155	Discretionary Snowy to Victoria transfer limit of 450 MW
HV_0550	1	2,886	361	Discretionary Snowy to Victoria transfer limit of 550 MW
N>N-994_B	1	2,342	293	Outage of Wagga to Yanco(994), avoid overload of Wagga to Yanco(99F) on Wagga to DarlingtonPt(63) trip
V>>V_X_DDTX1_DBUSS_A	2	1,778	66	Outage of Dederang No.1 330/220kV transformer and DBUSS transformer control scheme, limit Victoria generation and interconnectors to avoid overloading the Dederang No.2 transformer for loss of the Dederang No.3 transformer
H^V_LTUT	26	1,775	6	Outage of Lower Tumut to Upper Tumut 330kV line, limit Snowy to Victoria to avoid voltage collapse for trip of the largest Victoria generating unit (500 MW)

## G9. VICTORIA TO SOUTH AUSTRALIA (HEYWOOD) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
VS_460	184	167,597	76	Victoria to SA (Heywood) interconnector upper transfer limit of 460 MW
#V-SA_I	1	49,157	3,511	Discretionary limit, Victoria to SA less than 250 MW into Victoria.
V>>S_SETB_N-2_SGKH	29	25,062	72	System normal; avoid overload of Snuggery to Keith line on trip of both South East to Tailem Bend 275 kV lines.
V::S_NIL	70	18,016	22	System normal -; Vic-SA South Australian import Stability limit; fully co-optimised.
V>>S_SETB_N-2_MTBL	11	13,908	102	System normal - avoid O/L Mt Gambier to Blanche line on trip of both South East to Tailem Bend 275 kV lines.
V::H_NILQF_BL_R	63	3,666	5	System normal - Basslink export to Tasmania, limit Victoria interconnectors, NSW to Qld on QNI and Victoria generation to avoid transient instability for fault and trip of a Hazelwood to South Morang 500kV line, radial mode at Hazelwood
V::H_NILQE_BL_R	55	1,925	3	System normal - Basslink export to Tasmania, limit Victoria interconnectors, NSW to Qld on QNI and Victoria generation to avoid transient instability for fault and trip of a Hazelwood to South Morang 500kV line, radial mode at Hazelwood
V::H_NILQC_BL_R	5	1,331	21	System normal - Basslink import from Tasmania, limit Victoria interconnectors, NSW to Qld on QNI and Victoria generation to avoid transient instability for fault and trip of a Hazelwood to South Morang 500kV line, radial mode at Hazelwood
V::H_NILVF_BL_R	7	619	8	System normal - Basslink export to Tasmania, limit Victoria interconnectors and Victoria generation to avoid transient instability for fault and trip of a Hazelwood to South Morang 500kV line, radial mode at Hazelwood
V>>S_NIL_SETB_MGBL	0.2	523	262	System normal -. Prevent Mt Gambier to Blanche overload for South East to Tailem Bend trip.
V>>S_NIL_SETB_KHTB	2	348	12	System normal -. Prevent overload of Keith to Tailem Bend #1 line for South East to Tailem Bend trip.
V::H_NILVE_BL_R	5	180	3	System normal - Basslink export to Tasmania, limit Victoria interconnectors and Victoria generation to avoid transient instability for fault and trip of a Hazelwood to South Morang 500kV line, radial mode at Hazelwood



## Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
SA_HYSE1	1	39,555	4,944	SA / Eastern separation between Heywood and South East, Victoria to SA Heywood upper limit of 0 MW
VS_120	6	35,720	496	Victoria to SA Heywood interconnector upper transfer limit of 120 MW
VS_100	8	24,289	261	Victoria to SA Heywood upper transfer limit of 100 MW
VS_140	3	19,915	664	Victoria to SA Heywood upper transfer limit of 140 MW
VS_110	2	19,534	888	Victoria to SA Heywood upper transfer limit of 110 MW
VS_130	3	18,849	483	Victoria to SA Heywood upper transfer limit of 130 MW
V::S_CGMB_KHTB12MAMO	22	11,284	42	Outage of Cherry Gardens to Mount Barker and Keith to Tailem Bend 1&2 and Mannum to Mobilong; SA to Victoria Stability Limit on trip of Northern Power Station.
V::S_SE_VC	62	5,714	8	Outage of one South East SVC; Victoria to SA Stability Limit for loss of one Northern units following two phase to ground fault on the Davenport to Northern line.

## G10. SOUTH AUSTRALIA TO VICTORIA (HEYWOOD) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
V>>V_NIL_3B_R	163	537,751	276	System normal, limit Victoria interconnectors and Victoria generation to avoid post-contingent overloading the South Morang 500/330kV (F2) transformer for trip of Rowville 500/220kV transformer, Yallourn unit 1 in 220kV mode, radial mode at Hazelwood
SV_300	94	88,213	78	SA to Victoria Heywood upper transfer limit of 300 MW
S>>V_NIL_CGTX_ACMP3	30	69,015	191	System normal -; Limit Interconnectors and generation to avoid overload of Angas Creek to Mannum P3 line for trip Cherry Garden 275/132kV transformer
V>>V_NIL_2B_R	105	15,328	12	System normal, limit Victoria interconnectors and Victoria generation to avoid pre-contingent overloading the South Morang 500/330kV (F2) transformer, Yallourn unit 1 in 220kV mode, radial mode at Hazelwood
S>>V_NIL_CGTX_MP2MA	0.1	13,094	13,094	System normal -; Limit Interconnectors and generation to avoid overload of Mannum P2 to Mannun 132 kV line for trip Cherry Garden 275/132kV transformer
SVS_420	16	11,437	60	Discretionary constraint. SA to Victoria across Heywood and Murraylink to less than 420
N:Q_NIL_B4	0.3	5,136	1,712	System normal - NSW to Qld Transient Stability Limit for Victoria to Snowy flows of 0 to 500 MW, V-SA negative, 8 units in service at Bayswater and Liddell
S>>V_SETB_N-2_TBKH1	5	3,704	62	System normal; avoid O/L Keith to Tailem Bend #1 on trip of both South East to Tailem Bend 275 kV lines.
N::H_NIL	9	1,015	9	System normal - NSW to Snowy Transient Limit
S>>V_NIL_CGTX_PAAC	14	864	5	System normal -; Limit Interconnectors and generation to avoid overload of Para to Millbrook and Angas Ck 132 kV line for trip Cherry Garden 275/132kV transformer
V>>V_NIL_2_P	2	243	9	System normal, limit Victoria interconnectors and Victoria generation to avoid pre-contingent overloading the South Morang 500/330kV (F2) transformer, Yallourn unit 1 in 220kV mode, parallel mode at Hazelwood

## Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
S>>V_PATB_PATB_MOTB	150	39,711	22	Outage of One Para to Tailem Bend 275 line. Avoid overload of Mobilong to Tailem bend 132kv on trip the remaining Para to Tailem Bend 275 kV line
S>V_SE_VC	5	21,637	393	Outage of South East SVC SA to Victoria Limit Avoid overload of 132kv AC-MAP3on trip Para to Tailem Bend
V>>V_ROTTS_TX_3B_R	31	11,064	30	Outage of Rowville 500/220kV transformer, limit Victoria interconnectors and Victoria generation to avoid overload of South Morang 500/330kV (F2) transformer for trip of Cranbourne 500/220kV transformer, Yallourn unit 1 in 220kV mode, radial mode
S>>V_PATB_PATB_CGTX	17	6,747	34	Outage of one Para to Tailem Bend 275 kV line; Limits to avoid overload of Cherry Gardens 275/132 kV transformer on trip the other Para to Tailem Bend line.
S>>V_PATB_N-2_CGTX	3	355	9	Outage of One Para to Tailem Bend 275 kV line; Limits to avoid overload of Cherry Gardens 275/132 kV transformer on trip the other Para to Tailem Bend line.
SVS_180	0.3	155	39	SA to Vic on Heywood and Murraylink upper transfer limit of 180 MW
S^V_SETB_SETB	2	126	6	Outage of one South East to Tailem Bend 275 kV line; Limit SA to Victoria (Heywood) and generation to prevent voltage collapse for trip the other South East to Tailem Bend line.
S>>V_TBTX_PAAC_CGTX	1	104	12	Out of Tailem Bend 275/132 kV transformer; Prevent overload of Cherry Gardens 275/132 kV transformer for Para to Angas Creek line trip.

## G11. VICTORIA TO SOUTH AUSTRALIA (MURRAYLINK) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
V>>H_NIL1A_R	3	187,373	5,678	System normal - limit Victorian interconnectors and Victoria generators to avoid thermal overload on South Morang to Dederang 330 kV line for loss of the parallel line, Radial
V>>SML_NIL_5A	1	148,620	8,742	System normal, limit Victoria generation and interconnectors to avoid overload on Geelong to Keilor No.1 220kV line for loss of the Moorabool 500/220kV transformer, swamped if Murraylink Very Fast Run Back enabled and Murraylink > 25MW
V>>SML_NIL_1	2	83,541	3,978	System normal, limit Victoria generators and interconnectors to avoid overloading Ballarat to Moorabool No.1 220 kV line for loss of Ballarat to Moorabool No.2 220 kV line, swamped if Murraylink Very Fast Run Back enabled and Murraylink > 25MW
V>>SML_NIL_5B	0.1	74,401	74,401	System normal, limit Victoria generation and interconnectors to avoid overload on Geelong to Keilor No.2 220kV line for loss of the Moorabool 500/220kV transformer, swamped if Murraylink Very Fast Run Back enabled and Murraylink > 25MW
S>>V_NIL_DVBG_DVBR	50	73,443	122	System normal -I; Limit Murraylink and SA generation to avoid overload Davenport to Brinkworth 275 kV line for trip Davenport to Bungama line.
S>>V_NIL_CGTX_ACMP3	30	69,015	191	System normal -; Limit Interconnectors and generation to avoid overload of Angas Creek to Mannum P3 line for trip Cherry Garden 275/132kV transformer.
VSML_220	34	40,971	100	Vic to SA on Murraylink upper transfer limit of 220 MW
S>>V_NIL_NIL_BRPA	16	28,197	151	System normal - Limit Murraylink and SA generation to avoid overload of Brinkworth to Para 275 kV line above the continuous rating following Davenport to Bungama line trip.
V>>V_NIL_2B_R	105	15,328	12	System normal, limit Victoria interconnectors and Victoria generation to avoid pre-contingent overloading the South Morang 500/330kV (F2) transformer, Yallourn unit 1 in 220kV mode, radial mode at Hazelwood

## Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
V>>SML_BAML	25	441,249	1,486	Outage of Ballarat to Moorabool (No.1 or No.2) line, limit Murraylink from Vic to SA to avoid overloading Moorabool to Terang line on loss of Ballarat to Moorabool (No.2 or No.1) line
VSML_000	319	92,301	24	Vic to SA on ML upper transfer limit of 0 MW
V>SMLHORC1	11	84,318	615	Outage of Horsham to Red Cliffs 220kV line, limit Murraylink from Vic to SA to avoid overloading Balranald to Darlington Pt (X5/1) 220kV line for trip of Bendigo to Kerang line
V>>V_LTMS_1	43	53,027	104	Outage of Lower Tumut to Murray (66), avoid overload of Dederang to Wodonga on trip of Murray to Upper Tumut (65)
N^N-X5_TRIP_A	11	38,874	286	Outage of X5 tripping scheme, Darlington Point Capacitors on auto, avoid Area voltage collapse on Darlington Point to Wagga(63) trip
H>>H-LTMS_4	12	18,207	132	Outage of LowerTumut to Murray(66), avoid overload of Murray to UpperTumut(65) on Dederang-Wodonga(DDWO) trip
V>SML_BESH_3	3	9,472	296	Outage of Bendigo to Shepparton 220kV line, limit Murraylink from Vic to SA to avoid overloading Ballarat to Moorabool No.1 220kV line on loss of Ballarat to Moorabool No.2 220kV line, swamped if Murraylink VFRB enabled and Murraylink > 25MW
V>SMLKGRC1	4	5,206	98	Outage of one Kerang to Red Cliffs 220kV line, limit Murraylink from Vic to SA to avoid overloading Balranald to Darlington Pt (X5/1) 220kV line for trip of Ballarat to Horsham line
V>>V_GTKT_3	1	4,644	580	Outage of Geelong to Keilor No.1 or No.2 220kV line, limit Vic generation and interconnectors to avoid O/L the Geelong to Keilor No.3 220kV line for trip of the Moorabool 500/220kV transformer, swamped if Murraylink VFRB enabled and Murraylink > 25MW
H>>H-LTMS_A	0.4	4,245	849	Outage of Lower Tumut to Murray (66), avoid overload of Murray to Upper Tumut (65) on Jindera-Wodonga(060) trip
#V-S-MNSP1_I	18	2,394	11	Outage, constrains Murraylink to flow into Victoria above 40 MW

## G12. SOUTH AUSTRALIA TO VICTORIA (MURRAYLINK) INTERCONNECTOR

Constraints modelling nominal transmission conditions

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<b>CONSTRAINT ID</b>	<b>HOURS</b>	<b>CMV (\$)</b>	<b>AVG MV</b>	<b>DESCRIPTION</b>
S>V_NIL_NIL_RBNW	160	749,349	390	System normal -; limit SA to Vic on Murraylink to avoid overloading North West Bend to Robertstown 132kV line.
H>>V_NIL_1A	2	172,626	6,394	System normal, limit Vic interconnectors and Vic generation to avoid overloading a Dederang to Murray 330kV line for loss of one of the two parallel lines, 15 min line ratings

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## Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV (\$)	AVG MV	DESCRIPTION
SVML_000	487	874,573	150	SA to Vic on ML upper transfer limit of 0 MW
SVS_420	16	11,437	60	Outage – Limit Victoria to SA across Heywood and Murraylink to 420 MW combined.
V>>V_ROTSTX_TX_3B_R	31	11,064	30	Outage = Rowville 500/220kV transformer, limit Vic interconnectors and Vic generation to avoid O/L South Morang 500/330kV (F2) transformer for trip of Cranbourne 500/220kV transformer, Yallourn unit 1 in 220kV mode, radial mode
S>VML_NWCB6024+25	4	3,858	92	Outage of North West Bend_CBs 6024 and 6025; limit SA to Victoria on Murraylink to avoid North West Bend transformer#3 O/L on trip NWB - MONASH #1 line.
S>>V_RBTX_RBTX_WTMW4	13	3,535	22	Outage of One Robertstown 275/132 kV transformer; Limit SA-V on ML to avoid OL Waterloo - MWP4 line for loss of the remaining Robtstown Transformer.
S>VML_RBTX_RB_WTMW4	4	3,061	70	Outage of One Robertstown Transfrmer, SA-V Murraylink limit to prevent overloading Waterloo_MWP4 132kV Line for loss of the other Robertstown transformer.
S>VML_NWCB6025_NWTX2	2	2,559	88	Outage of North West Bend_CB6025; limit SA to Vic on Murraylink to avoid North West Bend transformer #2 O/L on trip North West Bend - Monash line #2.
S>VML_NWCB6225X_TX2	3	1,504	37	Outage of North West Bend 132 kV circuit breakers CB6021 and CB6225 and 66 kV circuit breaker CB5605; limit SA to Victoria on Murraylink to avoid North West Bend transformer#2 O/L on trip NWB - MWP #1 line.
H>V_DDWO2	2	166	9	Outage of Dederang to Wodonga 330kV line, limit on Snowy to Vic to avoid overloading a Dederang to Murray 330kV line for loss of one of the two lines using 15 minute rating
SVS_180	0.3	155	39	SA to Vic on Heywood and and Murraylink upper transfer limit of 180 MW
#V-S-MNSP1_E	7	91	1	Constrains Murraylink Victoria to South Australia above 20 MW

### G13. QUEENSLAND INTRA-REGIONAL CONSTRAINTS

#### Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	DESCRIPTION
Q_CS_1900	82	Qld Central- Qld South upper transfer limit of 1900 MW
Q>MRTA	15	System normal – Oakey PS constrained for continuous rating of Middle Ridge-Tangkam 110kV lines
Q>TVAS7276_77_PRE	14	System normal - Post contingent Townsville Power Station to Alan Sherriff 132kV line 7276 or Townsville Power Station to Alan Sherriff .132kV line 7277. Precontingent transfer for initial contingent value for remaining inservice parallel line. 10000 washout applied following contingency
Q^NIL_1CS	12	System normal – Central to south Queensland transfer SystemNormal<=voltage stabilitycalc(1277.2+f(units on;MW,kV)- 50CalcMarg),calc below 1750, Limit set- 1750 (floor) ; Gladstone margin
Q>PRE855_871CAL	10	System normal - MVA max pre-contingent Transfer on 871 feeder for 855 feeder contingency
Q:NIL_CN1	10	System normal – Central to north Qld transient stability limit for loss of either Nebo-Strathmore (822 or 840) line.
Q>PRE855_871GL_ST	10	System normal - MVA max pre-contingent Transfer on 871 feeder for 855 feeder contingency
Q>TVAS7276_77_POST	6	System normal - post contingent Townsville Power Station to Alan Sherriff (7276) line or Townsville Power Station to Alan Sherriff (7277) line. Thermal limit for remaining in service parallel line.
Q^NIL_FNQ3	1	System normal - far north Qld voltage stability limit for loss of Chalumbin-Woree (877) line
Q^NIL_FNQ4	0	System normal - far north Qld voltage Stability limit for loss of either Chalumbin- Ross (857 or 858) line



## Constraints modelling transmission outages

CONSTRAINT ID	HOURS	DESCRIPTION
Q>PWSP_1350	157	Qld Central- Qld South upper transfer limit of 1350MW (discretionary), ( 5 of 5 equations )
Q_CS_1450	141	Qld Central- Qld South upper transfer limit of 1450MW (discretionary)
Q_CS_1700	83	Qld Central- Qld South upper transfer limit of 1700MW (discretionary)
Q_CS_1550	56	Qld Central- Qld South upper transfer limit of 1550MW (discretionary)
Q_CS_1650	42	Qld Central- Qld South upper transfer limit of 1650MW (discretionary)
Q_CS_1800	22	Qld Central- Qld South upper transfer limit of 1800MW (discretionary)
Q^PWSP_C2CS	19	Outage of Palmwoods-South Pine
Q>GGGL_813_814	11	Qld Central- Qld South upper transfer limit of 1650MW ( Thermal )
Q>TVAS7276_77_120PRE	11	Various system conditions which require - 120MW Max summated pre-contingent transfer Townsville PS-Alan Sheriff 132kV lines- cover next contingency being either 7277 or 7276.
Q_CS_1150	10	Qld Central- Qld South upper transfer limit of 1150MW (discretionary)
Q_CS_1000	10	Qld Central- Qld South upper transfer limit of 1000MW (discretionary)
Q<QBCG_02	9	Outage of Barcaldine-Clermont (7154) line, Barcaldine PS islanded
Q_CS_1100	9	Qld Central- Qld South upper transfer limit of 1100MW (discretionary)
Q>KACH_7191_7192	9	Outage of Kareeya to Chalumbin (7191, 7192) lines. Management of thermal limit on 132kV feeders 7176 and 7277

## G14. NEW SOUTH WALES INTRA-REGIONAL CONSTRAINTS

### Constraints modelling nominal transmission conditions

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<b>CONSTRAINT ID</b>	<b>HOURS</b>	<b>DESCRIPTION</b>
N>N-NIL_1C	2	System normal - load on 93 line on trip of line 25
N>N-NIL_01	1	System normal - load on 9 line on trip of line 18

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### Constraints modelling transmission outages

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<b>CONSTRAINT ID</b>	<b>HOURS</b>	<b>DESCRIPTION</b>
N_MBTE3	79	Outage of all three Terranora cables, Terranora import = Terranora Load
N>N-ERKC_05	0	Outage of Eraring-Kemps Creek (5A1 or 5A2) line, avoid overloading Eraring transformer on trip of Eraring-Kemps Creek (5A2) line

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**G15. SNOWY INTRA-REGIONAL CONSTRAINTS**

Constraints modelling nominal transmission conditions

**Nil.**

Constraints modelling transmission outages

**Nil.**

## G16. VICTORIA INTRA-REGIONAL CONSTRAINTS

### Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	DESCRIPTION
V>V_NIL_4	101	System normal - limit Hazelwood units 3,4,5- avoid overloading on Hazelwood transformer

### Constraints modelling transmission outages

CONSTRAINT ID	HOURS	DESCRIPTION
V>V_HWTS_TX3_PAR_3-5	16	Outage of Hazelwood (No.3 or No.4) transformer, avoid overloading of Rowville-Yallourn (No.5, No.6, No.7 or No.8) lines for loss of Hazelwood (No.3 or No.4) transformer
V>V_HWTS_TX1_PAR_3-5	10	Outage of Hazelwood (No.1 or No.2 ) transformer, avoid overloading of Hazelwood-Rowville (No.1 or No.2) lines for loss of Hazelwood (No.1 or No.2) transformer
V_LV6_4500	2	4500 MW upper limit on Latrobe Valley generation excluding Yallourn units
V_KIEWA_040	0	Discretionary upper limit for Kiewa area Generation of 40 MW
V_KIEWA_045	0	Discretionary upper limit for Kiewa area Generation of 45 MW

## G17. SOUTH AUSTRALIA INTRA-REGIONAL CONSTRAINTS

### Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	DESCRIPTION
S^NIL_SGBL_LB2MAX	73	System normal - Limit Lake Bonney 2 and Snuggery generation to maintain voltage stability on Snuggery end fault on the Snuggery-Blanche line.
S>NIL_KHSG_C_SGMIN	4	System normal - run Snuggery generation to maintain Keith-Snuggery line flow below the continuous rating.
S>NIL_BLSN_KHSN	1	System normal - Snuggery generation limit to avoid Snuggery-Keith line overloading on the trip of Blanche-Snuggery line
S>NIL_PL_GENMAX_YDMD	0.1	System normal - Maximum generation at Port Lincoln for the rating of Yadnarie-Middleback line.
S>NIL_PL_GENMAX	0.1	System normal - Maximum generation at Port Lincoln for the rating of Yadnarie-Middleback line

### Constraints modelling transmission outages

CONSTRAINT ID	HOURS	DESCRIPTION
S>PFWH	9	Outage of Playford-Whyalla line, limit Playford PS to avoid overloading of the remaining line for trip of Playford-Davenport line
S_PPT210	4	Limit Pelican Point generation to 210MW
S>PGPP_LFTL_NOTI	3	Outage of Parafield Gardens West-Pelican Point line, limit generation to avoid overloading of New Osborne-Torrens Island lines for trip of Lefevre-Torrens Island line.
S>KHTB12_PWSE_SGBL	3	Outage of Keith-Tailem Bend lines; limit Ladbroke Grove and Snuggery generation to avoid overloading Snuggery-Blanche line on the trip of Penola West-South East line.
S_ANGA_1+2	1	Angaston generation limit to 0

## G18. TASMANIA INTRA-REGIONAL CONSTRAINTS

### Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	DESCRIPTION
T>T_NIL_BL_110_19	14	System normal - Basslink in service, avoid overloading of Waddamana-Lake Echo Tee line for loss of Tungatinah-Lake Echo Tee- Waddamana No.2 line.
T>T_NIL_BL_110_25	8	System normal - Basslink in service, avoid overloading the Waddamana-Lindisfarne line for loss of the Tungatinah-Lake Echo Tee- Waddamana No.1 line
T>T_NIL_BL_IMP_1B	8	System normal - Basslink not exporting, limit Tasmanian generation to avoid post-contingent overloading either Gordon-Chapel St line for trip of the other Gordon-Chapel St line

### Constraints modelling transmission outages

CONSTRAINT ID	HOURS	DESCRIPTION
T>T_FASH_1_2_C1	17	Outage of Farrell to Sheffield line, Farrell 220kV bus split, Hamp. link closed, Bastyan+Mack supplying transformers other generators supplying 220kV line- Sheffield, limit Bastyan and Mackintosh <= 110% of West Coast load
T_T_TU_BG_80	16	80 MW upper limit on Tungatinah and Butlers Gorge generation
T>T_FASH_1_2_B2	15	Outage of Farrell to Sheffield No.1 or 2 line, Farrell 220kV bus split, Hamp. link closed, JButters+Bastyan+Mack supplying transformers other generators supplying 220kV line- Sheffield, limit JButters, Bastyan and Mackintosh >= 90% of West Coast load
T>T_FASH_1_2_C3	13	Outage of Farrell to Sheffield No.1 or 2 line, Farrell 220kV bus split, Hamp. link closed, Bastyan and Mack supplying transformers other generators supplying 220kV line- Sheffield, limit JButters, Reece1, Reece2, Tribute <= 300 MW
T>T_HAPM_220_3B	12	Outage of Hadspen to Palmerston 220kV line, avoid overloading of the Palmerston- Hadspen No.1 220kV line for loss of the Palmerston- Sheffield line
T>T_LIPM_110_2A	8	Outage of Liapootah to Palmerston line, avoid overloading on the Palmerston- Waddamana line (flow- North) for loss of the other Liapootah- Palmerston line

## G19. Constraints used for Grid Support

CONSTRAINT ID	HOURS	DESCRIPTION
NSA_Q_COLNSV_120	131	Network Support Agreement
NSA_S_SNUG1_05	41	Network Support Agreement
NSA_Q_COLNSV_115	32	Network Support Agreement
NSA_Q_COLNSV_160	32	Network Support Agreement
NSA_Q_COLNSV_100	28	Network Support Agreement
NSA_Q_COLNSV_150	27	Network Support Agreement
NSA_Q_COLNSV_170	27	Network Support Agreement
NSA_Q_COLNSV_065	24	Network Support Agreement
NSA_Q_COLNSV_090	23	Network Support Agreement
NSA_Q_COLNSV_165	22	Network Support Agreement
NSA_Q_COLNSV_080	21	Network Support Agreement
NSA_Q_GSTONE34_450	20	Network Support Agreement
@Q-CVL>=NSA	20	Network Support Agreement
NSA_Q_COLNSV_175	18	Network Support Agreement
#MSTUART2_E	16	Network Support Agreement
NSA_Q_COLNSV_105	15	Network Support Agreement
NSA_Q_COLNSV_110	15	Network Support Agreement

**G20. Constraints used during power system security directions**

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<b>CONSTRAINT ID</b>	<b>HOURS</b>	<b>DESCRIPTION</b>
#BARRON-2_E	0	Barron unit two generation = 30

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