AUSTRALIAN ENERGY REGULATOR

Indicators of the market impact of transmission congestion

Report for 2005–06

February 2007

Contents

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.[1] The AER has adopted a two stage process for the improvement of the current service standards regime, by moving towards a regime that was directly linked to market outcomes. The first stage of that process is the publication of three annual reports covering the market impacts of transmission congestion for the financial years 2003-04, 2004-05 and 2005-06. This report is the third annual report in response to that decision. As a second stage, in early 2007, the AER will consult with the market in order to develop a service standards regime based on the understandings gained through these reports.

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
- be used as a tool to develop possible economic incentives.

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 reflect 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. It therefore reflects the negative efficiency effects 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 2005–06, 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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1 *Indicators of the Market Impact of Transmission Congestion—Decision*, AER, 9 June 2006.

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 can indicate the quantum of the total market impact, while the MCC indicates the underlying cause at the margin.

In its qualitative assessment, this report focuses on the constraints identified as those having had a major impact during 2005–06 and explains the circumstances that led to these impacts.

On 29 May 2005 Tasmania joined the National Electricity Market (NEM). The indicators in this report include for the first time congestion within the Tasmanian transmission network. Basslink commenced full operation on 29 April 2006. Congestion on Basslink is not included in the indicators[2].

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. Like those other measures, therefore, it may be affected when a generator submits an offer that differs significantly from its actual costs.

During 2005–06 the TCC was $66 million with two thirds of this accumulating on just 10 days. This compares to $45 million in 2004–05 and $36 million in 2003–04.

Table 1 identifies for those 10 days the location of the network congestion as identified by the MCC.

[2] 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.

Table 1 —High TCC events

Date	Locations	TCC
13/10/2005	Central to South Queensland (lightning)	$2.4m
31/10/2005	New South Wales (emergency outage of Wallerawang to Sydney West and Wallerawang to Ingleburn)	$3.6m
9/11/2005	Central to South Queensland (outage of Gladstone bus tie transformer); Queensland to New South Wales (Lismore SVC outage); Snowy to New South Wales (System normal) Victoria to Snowy (negative residue management)	$4.7m
10/11/2005	Queensland to New South Wales (lightning); Snowy to New South Wales (system normal) and Victoria to Snowy (negative residue management)	$3.6m
30/11/2005	Central to South Queensland (lightning); Victoria to South Australia (outage of South East to Tailem Bend with no prior notice)	$2.2m
1/12/2005	Central to South Queensland (lightning)	$2.2m
7/12/2005	Central to South Queensland (system normal); Snowy to New South Wales (system normal) Victoria to Snowy (negative residue management)	$7.6m
26/01/2006	Snowy to Victoria (system normal; outage between Dederang and South Morang; and negative residue management)	$1.8m
2/02/2006	Central to South Queensland (system normal); Queensland to New South Wales (System normal; and northern 132 kV reconfiguration for low reserves); Snowy to New South Wales (System normal); Victoria to Snowy (negative residue management);	$12.7m
24/02/2006	Victoria to Snowy (outages between Wagga and Yanco, and at Robertstown)	$2m

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:

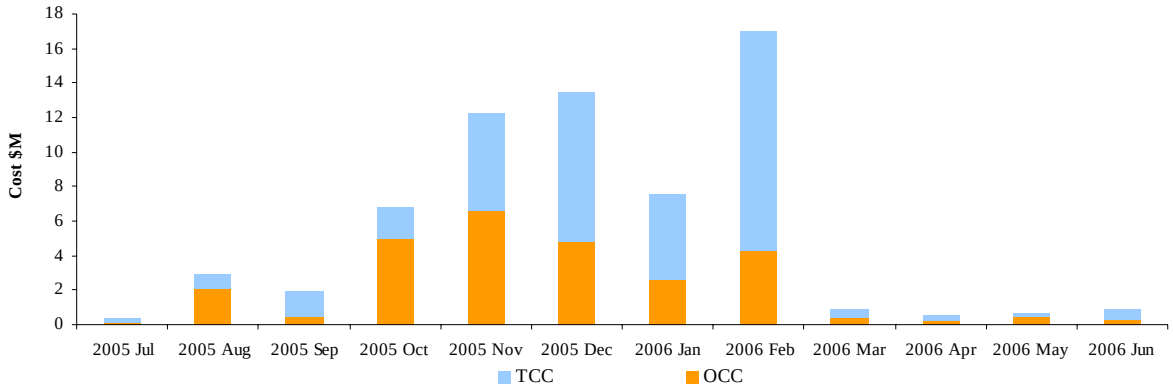
> 'How much lower would be the total cost of producing sufficient electricity to meet demand if all the limitations on the transmission network *due to outages* were removed?'

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 2005–06 was $27 million or 40 per cent of the TCC for the period. This compares to $16 million in 2004–05 and $9 million in 2003–04.

Figure 1 shows the monthly breakdown of the TCC with the proportion attributed each month to the OCC. The six highest days, accounted for around half of the total OCC (occurring over the period October to January).

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 over the year. A single cumulative marginal value, analysed in isolation, provides little information. When the full set of constraints that bound over the year is compared, however, the relative severity of pinch points is revealed.

The MCC indicates that in 2005 – 06 there were:

- 32 network constraints that significantly affected interconnectors (compared to 15 in 2004-05 and five in 2003-04). All interconnectors were impacted;
- nine network constraints that significantly affected market outcomes within regions on the mainland (compared to nine in 2004-05 and seven in 2003-04); and
- 13 network constraints that significantly affected market outcomes in Tasmania.

Qualitative assessment

This analysis is undertaken to determine some of the key causes of network congestion.

There were two significant market events related to transmission network outages. On 31 October, emergency outages of transmission elements close to the generators west of Sydney impacted on generation and imports into New South Wales. On 23 and 24 February, planned outages in southern New South Wales and around Robertstown in South Australia restricted imports into Victoria from Snowy on a day of record Victorian demand.

Inter-regional congestion occurred at significant levels between all regions during 2005-06. Flows into South Australia across the Heywood interconnector were

constrained for 1400 hours or 16 per cent of the time (compared to around 1000 hours in 2004-05 and 1300 hours in 2003-04). The average marginal value of congestion was, however, relatively low.

The Snowy to New South Wales interconnector was constrained for around 90 hours. Flows at these times were lower than the 3000 MW nominal limit. The marginal value of congestion was, on average, relatively high. Apart from the emergency outages on 31 October, these limitations reflected the inherent design of the network and did not result from network outages.

Congestion on the Queensland to New South Wales interconnector (QNI) occurred for around 650 hours, double that for each of the previous two years, with most of this congestion resulting from the inherent design of the network.

For the second consecutive year, significant market impacts on the Victoria to Snowy interconnector occurred as a result of intervention by NEMMCO to manage the accumulation of negative settlement residues caused by counter-priced flows. NEMMCO applied discretionary constraints for 27 hours to manage the accumulation of negative settlement residues (compared to 34 hours in 2004-05). NEMMCO intervened for a further 20 hours to manage negative settlement residues for flows from Snowy to New South Wales.

A number of measures have been implemented recently to address these counter-priced flows including: the Constraint Support Contracts and Constraint Support Pricing (CSC/CSP) trial that commenced in October 2005; an increase in the threshold for intervention by NEMMCO to better manage the accumulation of negative residues from July 2006; and a Rule change that came into effect in September 2006 which alters the distribution of settlement residues between the two Snowy interconnectors. Of these measures only the CSC/CSP trial was in place in time to affect the indicators in this report.

Network outages affected the availability of Murraylink during the year for around 336 hours, (compared to around 302 hours in 2004-05). Network outages in south west New South Wales reduced the capability of flows into South Australia (at times to zero) for a further 154 hours.

The greatest intra-regional congestion occurred in Queensland between generation in central Queensland and the load centre around Brisbane. The duration of the congestion totalled around 170 hours (compared to 270 hours in 2004-05).

The Hazelwood transformers in the Latrobe Valley in Victoria led to intra-regional congestion for 14 hours, a significant reduction compared to 2004-05 (101 hours) and 2003-04 (163 hours). A change in the operation of the affected generation plant driven by new ownership reduced the impacts.

Intra-regional congestion in Tasmania is included for the first time in this report. The majority of congestion resulted from planned network outages.

In addition, network outages local to a single generator had significant impacts on those generators. Often little prior notice was provided to the generators.

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. 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 has been removed from the indicator.

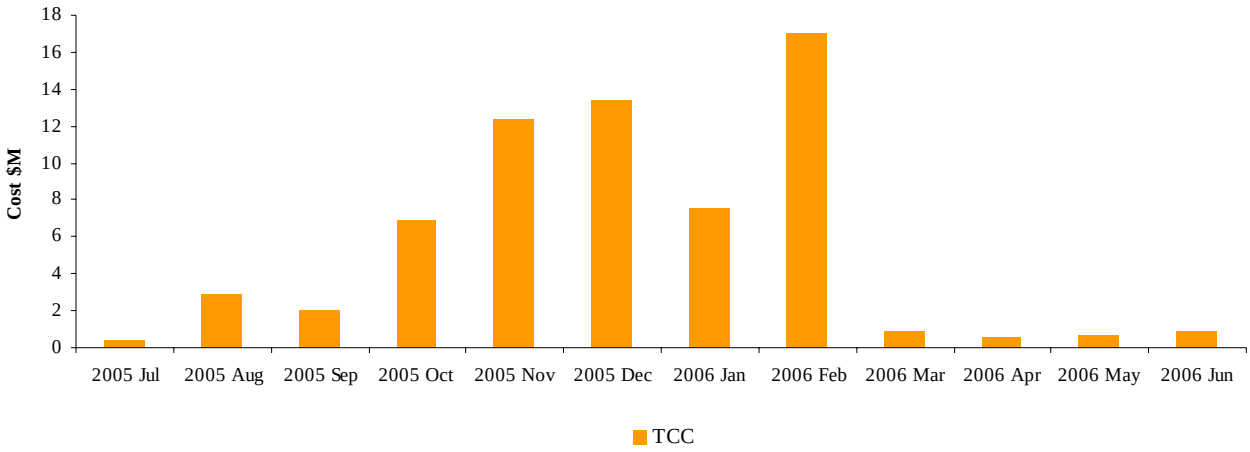
A detailed description of how the TCC is calculated is in the AER decision—Indicators of the market impact of transmission congestion[3].

1.1 TCC results

The TCC has steadily increased over the three annual reports produced to date, from $36 million in 2003–04, to $45 million in 2004–05 and $66 million for 2005–06.

Figure 2 shows the TCC for each month. Two thirds of the total amount accumulated on just 10 days of the year, (over the period October to February). Table 2 describes the circumstances for those 10 days.

Figure 2 —TCC by month



[3] *Indicators of the Market Impact of Transmission Congestion—Decision: Appendices A & B.* AER, 9 June 2006,

Table 2—Significant TCC events

Date	TCC	Description
13/10/2005	$2.4 million	***Lightning – Central to South Queensland*** Lightning[4] in the vicinity of the Tarong to Calvale double circuit reduced the limit on flows between central and south Queensland from the normal rating of 1900 MW to 1200 MW. Around 1000 MW of capacity in central and north Queensland was constrained off as a result. Much of this capacity was priced at $-1000/MWh with generator rebidding contributing.
31/10/2005	$3.6 million	***Emergency outages in New South Wales*** On 30 October an overhead earthwire on a major transmission line between the Wallerawang power station and the South Sydney substation (line 76) failed, probably as a result of a lightning strike. Repairs to line 76 were undertaken on 31 October and required the adjacent line 77 to be taken out of service. Together the two lines form one of the major supply routes from the western generators into Sydney. The outage constrained off significant capacity at a number of generators including Snowy Hydro, Mount Piper and Wallerawang. During the outages of the lines, spot prices in New South Wales exceeded $5000/MWh for five trading intervals, peaking at $6724/MWh.
9/11/2005	$4.7 million	***High demand in New South Wales and outage in Queensland*** In Sydney temperatures reached 35 degrees, which saw demand reach a high of 11 721 MW. From 2.10 pm, flows into New South Wales were constrained on all three interconnectors and, at times, most of the generation within New South Wales was also constrained. Imports across QNI were reduced by 100 MW by a network outage at Lismore. A planned network outage in central Queensland reduced the transfer capability from central to south Queensland. As a result more than 2000 MW of generation capacity in central Queensland was rebid to zero or less, mostly from prices of less than $20/MWh. At times, around 750 MW of this capacity was constrained off. NEMMCO intervened on the Victoria to Snowy interconnector to prevent the accumulation of negative settlement residues. At times the interconnector capability was reduced to zero.
10/11/2005	$3.6 million	***High summer demand and lightning in NSW and Queensland*** High temperature, demand and prices continued from the previous day. At 2.55 pm, flows into New South Wales across QNI were reduced by more than 500 MW following advice from both Transgrid and Powerlink of lightning in the vicinity of the interconnector. This reduction continued until around 6 pm. NEMMCO intervened on the Victoria to Snowy interconnector to prevent the accumulation of negative settlements residues. At times the interconnector capability was reduced to zero.

[4] Severe weather conditions such as lightning in the vicinity of transmission lines can lead to a change in the operation of the network. Normally the network is operated assuming the loss of one network element. Under these severe weather conditions, the network is operated assuming that multiple circuits are at risk, which reduces the capability of network transfers.

Date	TCC	Description
30/11/2005	$2.2 million	***Lightning – Central to South Queensland and short notice outage in South Australia*** Lightning in the vicinity of the Tarong to Calvale double circuit reduced flows between central and south Queensland from the normal rating of 1900 MW to 1200 MW. Around 650 MW of capacity in central and north Queensland was constrained off as a result. Much of this capacity was priced at $-1000/MWh with generator rebidding contributing. At around 3 pm NEMMCO reduced the import capability into South Australia across the Heywood interconnector from 460 MW to 200 MW in preparation for an outage of the South East to Tailem Bend line, in South Australia. The outage was required to return critical transmission plant that had been undergoing emergency repairs following damage that had occurred on the previous day. No notice was given for that outage. The line was returned to service at 4.10 pm. This led to a price in South Australia of $5000/MWh whilst prices in Victoria remained below $50/MWh.
1/12/2005	$2.2 million	***Lightning – Central to South Queensland*** Lightning in the vicinity of the Tarong to Calvale double circuit reduced flows between central and south Queensland from the normal rating of 1900 MW to 1200 MW. Around 850 MW of capacity in central and north Queensland was constrained off as a result. Much of this capacity was priced at $-1000/MWh with generator rebidding contributing.
7/12/2005	$7.6 million	***High demand in New South Wales and Queensland*** In Sydney, the temperature peaked at 39 degrees, which saw demand reach 12 900 MW, the highest-ever for summer. Demand in Queensland was around 8000 MW, only 200 MW short of the record set the previous day. Transmission constraints between central and south Queensland constrained off up to 200 MW of low priced capacity in central Queensland. Exports from Queensland into New South Wales peaked at 800 MW, around 300 MW below the nominal limit. Flows into New South Wales from Snowy were around 2900 MW, and at the limit, throughout this period. NEMMCO intervened on the Victoria to Snowy interconnector to prevent the accumulation of negative settlements residues. At times the interconnector capability was reduced to 50 MW.
26/1/2006	$1.8 million	***High demand in SA and Victoria and unplanned network outage*** Extreme temperatures on Australia Day saw demand in Victoria and South Australia at high levels for a public holiday and around 300 MW higher than forecast. For system security reasons NEMMCO reduced flows on the Snowy to Victoria interconnector to 1200, then 1100 MW at 1.05 pm (from the normal rating of 1700 MW[5]). At 3.44 pm an unplanned outage of the Dederang to South Morang No 2 330kV line further reduced the Snowy to Victoria transfer limit to 900 MW.

[5] The nominal import limit from Snowy into Victoria is 1700 MW. At times, through the use of network control ancillary services, this limit can increase to around 1900 MW.

Date	TCC	Description
2/2/2006	$12.7 million	***Record high demands in NSW and record prices in Queensland*** High temperatures led to record demand of around 12 300 MW in New South Wales. The high demands combined with low reserves in New South Wales saw prices exceeding $9000/MWh in both New South Wales and Queensland. Maximum spot prices reached $9739/MWh in New South Wales and the highest price ever recorded in Queensland of $9157/MWh. Directions were issued to Directlink to manage network issues associated with the Gold Coast and northern New South Wales during the low reserve period. To increase transfer capability from Queensland to New South Wales, NEMMCO instructed Transgrid to reconfigure the 132kV network in northern New South Wales NEMMCO intervened on the Victoria to Snowy interconnector to prevent the accumulation of negative settlements residues. At times the interconnector capability was reduced to zero.
24/2/2006	$2.0 million	***Transmission line outage in New South Wales*** A transmission line outage in New South Wales between Wagga and Yanco limited flows from Snowy into Victoria to between 500 MW and 200 MW compared to flows of around 1400 MW immediately before the outage. A new record demand for Victoria of around 8700 MW occurred later in the day.

2 Outage cost of constraints

2.1 OCC results

Forty per cent of the TCC, or $27 million, is attributable to network outages (represented here as the outage cost of constraints or OCC). Figure 3 shows for each month during 2005-06 the summated TCC and the proportion that has been allocated as arising from network outages.

Network outages had significant impacts on dispatch during the year, with only a few events contributing around half of the total OCC. These events occurred:

- on 31 October[6] when the OCC totalled $2.3 million. Outages of the 76 and 77 lines saw imports across the Snowy interconnector restricted to as little as 700 MW and 300 MW during the two outages on the day. This compares to the nominal limit on flows from Snowy of 3000 MW. Extreme prices were experienced in New South Wales during these outages, largely as a result of the reduced import capability

- on 23 – 24 February[7] when the OCC totalled $3 million, outages in New South Wales between Wagga and Yanco and in South Australia around Robertstown

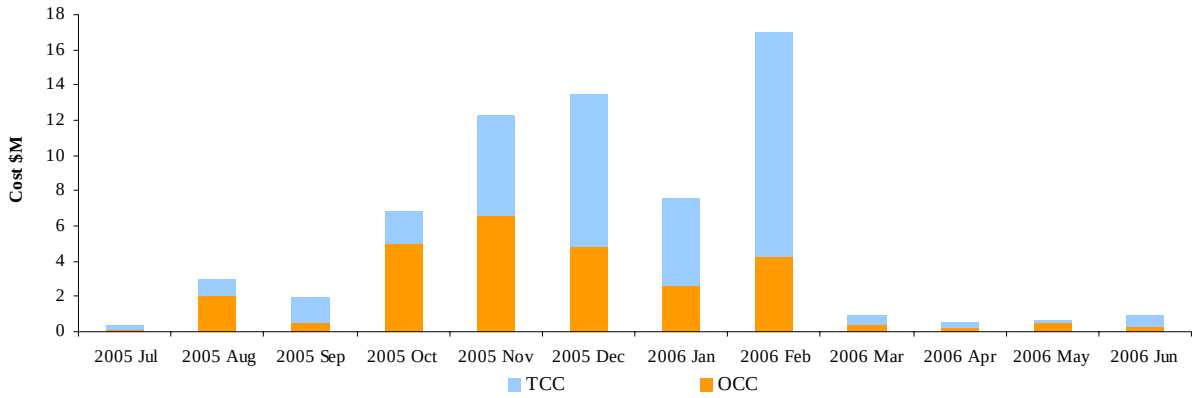
[6] See constraint N>>N-WWSS+WWIG_E in Appendix A for further details.

[7] See constraint N>N-994_A in Appendix A for further details.

saw flows from Snowy into Victoria restricted to as little as zero. The nominal capability of the interconnector is 1700 MW. Inaccurate limit forecasting during these outages contributed to the impacts of the outage

- on 13 October, 30 November and 1 December when lightning in central Queensland reduced transfers between central and south Queensland. This had significant impacts on central Queensland generation which saw a number of generators rebid capacity to the price floor to minimise those impacts on volume. These three periods of lightning accounted for around $6.5 million of OCC.

Figure 3 –TCC and OCC by month



The OCC has steadily increased over the three annual reports, from $9 million in 2003–04, to $16 million in 2004–05 and $27 million for 2005–06.

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.

The threshold for further assessment of inter-regional constraints[8] with a cumulative marginal market impact over the year was set at $30 000/MW. For the case of intra-regional constraints the threshold was 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[9].

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8 Fully optimised or option 4 constraints were included in the inter-regional classification.

9 *Indicators of the Market Impact of Transmission Congestion—Decision: Appendix C*, AER, 9 June 2006.

3.1 MCC results

During 2005–06 between 150 and 250 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 2005–06 there were around 800 constraints that affected the market at least once, with around half classified as inter-regional and half as intra-regional. This is similar to the results from the previous two years. In assessing high impact constraints, where possible, constraints that related to the same network limitation were grouped. The details of the constraints that materially affected market outcomes are provided in appendix H.

There were 32 inter-regional network limits or constraints with a cumulative marginal value over the year of more than $30 000/MWh (a significant increase from the previous years, with 15 in 2004-05 and five in 2003-04). Those constraints are detailed in table 3 along with the cumulative marginal value (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).

Table 3—High impact inter-regional constraints

Constraint	Duration (hours)	CMV ($)[10]	Type — description
N>N-994_A	18	1 961 676	Outage — Victoria to Snowy and Murraylink into South Australia (outage of Wagga to Yanco in New South Wales)
S>VML_RBTX_RB_WTMW; S>>V_RBTX_RBTX_PARS	10	1 750 973	Outage — Murraylink into Victoria (outage of Robertstown transformer in South Australia)
H>>H-64_B; H>>H-64_A; H>>H-64_H; H>>H-64_G	87	476 524	System normal — Snowy to New South Wales.
S>>V_NIL_RBTX_RBTX	3	409 269	System normal — Murraylink (into Victoria)
V-SN Discretionary constraints	27	385 440	Discretionary constraints applied to the Victoria to Snowy interconnector - primarily for the management of negative settlement residues
N>>N-NIL_1N	53	370 045	System normal — Queensland to New South Wales
VS_460	1,008	221 731	System normal — 460 MW limit on Heywood (into South Australia)
SV_300	15	202 058	System normal — 300 MW limit on Heywood (into Victoria)
H>>H-64_DX; H>>H-64_4X; H>>H-64_CX; H>>H-64_3X	20	200 232	System normal — Snowy to Victoria. Market reconfiguration with Snowy node moved from Murray to Dederang for negative residue management

[10] 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.

Constraint	Duration (hours)	CMV ($)[10]	Type — description
N>>N-WWSS+WWIG_E	3	190 633	Outage — New South Wales imports across all interconnectors (emergency outage of Wallerawang to Sydney West and Wallerawang to Ingleburn)
Q:N_LS_VC1	4	170 832	Outage — Queensland to New South Wales (outage of Lismore SVC)
Q>N-9W2_01; Q>N-9W2_C	17	158 422	Outage — Queensland to New South Wales (outage of 9W2 line between Kempsey and Nambucca)
N>>N-NIL_28	3	142 390	System normal — New South Wales imports from Queensland and Snowy
V^SML_X5TR	154	132 832	Outage — MurrayLink (into South Australia) (outage of X5 tripping scheme in NSW)
Q:N_ARDM_B	5	78 801	Outage — Queensland to New South Wales (outage of either 8C or 8E lines between Armidale and Dumaresq)
Q>N-NIL_DY	34	59 884	System normal — Queensland to New South Wales
N>Q+NIL_F7	14	54 185	System normal — New South Wales to Queensland
V>>S-NIL_SETB_MGBL	7	52 000	System normal — Heywood (into South Australia).
64 line out of service Southern flows	53	49 411	System normal — New South Wales to Snowy
H>N-NIL_C_15M	2	48 536	System normal — Snowy to New South Wales
Q:N_NIL_OSC	484	46 819	System normal — Queensland to New South Wales
VSML_000	336	45 914	Outage — MurrayLink (restrict to zero flow) (typically for outages of the interconnector)
V::S_NIL	391	40 579	System normal — Heywood (into South Australia)
S>VML_NIL1	27	39 557	System normal — Heywood (into Victoria)
HV_0900	14	38 540	Discretionary constraint — Snowy to Victoria (manage network outages through Snowy)
V>S_SETB	83	38 229	Outage — Heywood (into South Australia) (outage of South East to Tailem Bend)
Q:N_NIL_BCK2L-G	59	37 328	System normal — Queensland to New South Wales
Q:N_BI_POT	236	35 842	System normal — Queensland to New South Wales
S>>V_NIL	2	33 602	System normal — Heywood (into Victoria)
HV_1100	2	33 438	Discretionary constraint — Snowy to Victoria (Manage overloads through Snowy region)

Constraint	Duration (hours)	CMV ($)[10]	Type — description
N^Q_NIL_B	8	32 074	System normal — New South Wales to Queensland.
V^SML_NIL2	16	30 935	System normal — Murraylink (into South Australia)

There were nine intra-regional network limits on the mainland that bound for more than 10 hours (compared to nine in 2004-05 and seven in 2003-04). Those constraints are detailed in table 4 along with the accumulated 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 5 identifies the same information for the 15 intra-regional constraints that affected dispatch in Tasmania during the year.

Table 4—High impact mainland intra-regional constraints

Constraint ID	Duration (hours)	Type — description
S_PPT200; S_PPT160	139	Outage — limits Pelican Point generation. (outage of transmission equipment around Lefevre and Pelican Point)
V>V_NIL_4	91	System normal — limits 660 MW of Latrobe Valley generation at Hazelwood units 3, 4 and 5 to less than 636 MW to avoid overload of Hazelwood transformer.
Q_CS_1900	83	System normal — limits flow from central to south Queensland to 1900 MW. Around 5700 MW of Queensland generation affected by this constraint.
Q_CS_1700	63	Outage — limits flow from central to south Queensland to 1700 MW. Around 5700 MW of Queensland generation affected by this constraint. (typically for outages in central Queensland, often used in conjunction with Q_GLD34_500)
Q_GLD34_500	41	Outage — constrains on Gladstone 3 and 4 (outages around Gladstone and Boyne Island)
Q>PRE855_871CAL; Q>PRE855_871GL_ST	30	System normal — to manage flows on 871 line (in central Queensland). Constrains Gladstone and Stanwell on and Callide B and C off.
Q_CS_1200	24	Lightning — limits transfers from central to south Queensland to 1200 MW when lightning is in the vicinity.
V>V1NIL; V>V2NIL	14	System normal — Hazelwood transformer. Limits 2080 MW of Latrobe Valley generation behind the transformer.
N>N+LDNC_07; N>N-81__02; N>N+81__07; N>N-81__07; N>N-81__27	13	Outage — primarily to manage overloads of the 82 line between Liddell and Tomago. Affects up to 11 000 MW of generation capacity in New South Wales. (outages of the 81 line between Liddell and Newcastle)

Table 5—High impact Tasmanian intra-regional constraints

Constraint ID	Duration (hours)	Type — description
T>T_BWWA_110_6; T>T_BWWA_110_7	90	Long term outage of Bridgewater to Waddamana line
T>T_NIL_BL_IMP_7C	65	System normal —loading on Farrell to Sheffield
T:T_NIL_1	41	System normal — avoid transient instability
T_T_FASH2_MOD_1	36	Outage — Farrell to Sheffield line
T_T_X_FASH_A	32	Outage — Farrell to Sheffield lines
T>T_PMSH_220_1	23	Outage — Palmerston to Sheffield line
T>T_NIL_BL_110_19	19	System normal — loading on Waddamana to Lake Echo Tee.
T>T_TAMB_110_1	15	Outage — Tarraleah to Meadowbank
T>T_X_MBNN_TATU1-2_1	13	Outage — Meadowbank to New Norfolk
T>T_GTSH_220_1	12	Outage — Georgetown to Sheffield line
T>T_X_MBNN_TATU1-2_2	11	Outage — Meadowbank to New Norfolk
T>T_X_CSNN_BWWA	11	Outages — Chapel St to New Norfolk line and Bridgewater to Waddamana line
T>T_CRRI+RI_SPLIT_7	10	Outage — Creek Road to Risdon line

3.2 Qualitative assessment

This section provides further information on individual constraints highlighted in tables 3, 4 and 5 as having a high market impact. This analysis has been performed to determine some of the key drivers to those impacts. The assessment includes commentary on the following:

- The accuracy of forecast outage information (including, the accuracy of timing and impact of those planned outages that resulted in significant MCC or TCCs).
- The impacts from unplanned outages (including short-notice outages).
- The accuracy of forecast network capability (targeting constraints with significant MCC or TCC) to focus efforts on continually improving the accuracy of forecast network capability.
- The impacts of network constraints on the cost of frequency control ancillary services (including the causes of the constraints) to reduce these impacts over time.
- Other factors that may affect the MCC and TCC, for example some constraints invoked to manage power system directions by NEMMCO or grid support.

The analysis of these constraints is presented in Appendix A, and has led to the identification of locations of significant transmission congestion and the status of the network when this congestion occurred.

Inter-regional congestion

This section describes the significant congestion between regions as indicated by the MCC.

For the second consecutive year, significant congestion occurred on exports from Victoria into New South Wales as a result of constraints between the Murray and Tumut sides of the Snowy region. This congestion, combined with the existence of loop flows around the Snowy region led to accrual of negative settlement residues on the Victoria to Snowy interconnector. To manage the negative settlement residues NEMMCO limited flows on the Victoria to Snowy interconnector for 27 hours. Although usually short in duration, this intervention often constrained exports from Victoria to low levels (sometimes zero) on days when prices in New South Wales were at extreme levels. Flows along the Snowy interconnector at the time of intervention were typically around 2500 MW, just short of the 3000 MW nominal limit. At times, with flows south from Snowy into Victoria, the same loop flows saw negative settlement residues accrue across Snowy to New South Wales. NEMMCO intervened for a further 20 hours to manage these negative settlement residues.

The Snowy to New South Wales interconnector was constrained for short periods at levels of 500 MW and 800 MW less than the 3000 MW nominal limit to avoid overloads of lines in southern New South Wales. Whilst of short duration, significant price separation occurred when the interconnector was constrained.

Imports into South Australia from Victoria again saw high levels of network congestion. The nominal Heywood limit of 460 MW bound for 1008 hours. In addition a fully optimised constraint, which came into effect on 29 December, bound for 391 hours at slightly lower import levels. Together these constraints limited imports across the Heywood interconnector for 1400 hours or 16 per cent of the time. Over the previous two years, imports into South Australia were limited by system normal constraints for 1320 hours in 2003-04 and 975 hours in 2004-05.

Network congestion from Queensland to New South Wales occurred for around 650 hours, double that for the previous two years, with most of this congestion resulting from the inherent design of the network. Management of potential overloads of the 132kV network in northern New South Wales significantly reduced flows from Queensland to New South Wales at times. This issue arose for 30 days during the summer and resulted in transfer limits as low as 100 MW into New South Wales, (the nominal capability of the interconnector is 1078 MW). At times before it became regulated, NEMMCO directed Directlink to supply south eastern Queensland, leading to counter priced flows. Further market impacts occurred on 10 November when lightning led NEMMCO to reduce flows south to 325 MW (which is around 800 MW lower than the nominal limit) to manage system security. At the same time, high November temperatures and demands in New South Wales saw prices reach $8650/MWh.

Network outages reduced Murraylink's availability for 336 hours over 58 days during the year. These outages consisted of 287 hours of planned and 48 hours of unplanned outages of the interconnector itself. Further network outages in south western New South Wales reduced Murraylink's availability for a further 154 hours over 45 days. Flows into South Australia were reduced, at times to zero.

Two further network outages had significant impacts affecting several interconnectors simultaneously:

- On 31 October two outages of the 77 line south of Sydney (to repair damage to the 76 line) saw imports across the Snowy interconnector restricted to as little as 300 MW over each outage. Imports from Queensland were also reduced. Extreme prices were experienced in New South Wales during these outages, largely as a result of the reduced import capability.

- On 23 and 24 February significant market impacts occurred as a result of planned outages of the 994 line between Wagga and Yanco in southern New South Wales coincident with a Robertstown transformer in South Australia. Constraints used by NEMMCO to manage the two separate outages led to counter price flows out of Victoria into the Snowy region. At the same time, actual Victoria demand was up to 1000 MW higher than forecast and at near record levels, with spot prices peaking at over $9000/MWh in Victoria.

Intra-regional congestion

This section describes the significant points of congestion within a single region as indicated by the MCC.

Constraints between central Queensland and the load centre around Brisbane affected the dispatch of plant in central and north Queensland for 170 hours during the year (compared to 270 hours the previous year). Flows were limited to 1900 MW (the normal limit) for 83 hours over 45 days and to 1700 MW for 63 hours over 15 days (for network outages). Lightning reduced the capability further, to a maximum of 1200 MW for 24 hours over 14 days.

In central Queensland constraints on the 871 line between Calvale and Wurdong affected market outcomes for 30 hours over nine days (compared to 190 hours in 2004-05). The constraints affected generation at Gladstone, Stanwell and Callide B and C. These constraints reflected the inherent physical limitations of the network and did not result from outages of network equipment.

Gladstone units three and four were constrained on for outages around Boyne Island for 41 hours during the year, which is a similar duration to 2004-05.

The Hazelwood transformers in Victoria had significant impacts on the dispatch of 2000 MW of generation in the Latrobe Valley for 14 hours, significantly lower than the 100 hours during 2004-05 and 163 hours during 2003-04. This was driven by a change in generation ownership, which improved the coordination of the operation of the affected generation.

The most significant intra-regional congestion in New South Wales was caused by outages of the 81 line between Liddell and Newcastle. Constraints managing this outage affected dispatch for around 13 hours (down from 94 hours in 2004-05).

Intra-regional congestion in Tasmania is included for the first time in this report. Ten of the 13 network constraints resulted from planned network outages.

At times, network outages had significant impacts on a single power station. The most significant resulted from outages of the LeFevre to Pelican Point line, which limited generation at Pelican Point to a maximum output of either 200 MW or 160 MW (compared to its capacity of 478 MW). The constraints bound for a total of around 134 hours over 16 days. An average of 17 days notice was provided through the market systems of the need for these outages.

Directions

60 directions were issued during the year. The total cost of these directions for the year was less than $1 million. This compares to $4.2 million in compensation payments in 2004-05 and around $5 million in 2003-04.

Inter-regional settlement residues

The settlement residues totalled $257 million for 2005–06 with the majority accruing for imports into New South Wales across the QNI and Snowy to New South Wales interconnectors. This represents an increase from a total of $232 million in 2004-05 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, which means that in general the inter-regional settlement residues closely matched those that were anticipated through the SRA process on this interconnector. On 31 October, however, the capability was significantly reduced as a result of the emergency network outages on the day.

The Victoria to Snowy interconnector capability (and at other times the capability for imports from Snowy into Victoria) was frequently limited by intervention by NEMMCO to manage the accumulation of negative settlements.

Frequency control ancillary services

Planned network outages on 68 days led to increased requirements for frequency control ancillary services and accounted for an estimated $3 million, or around 10 per cent of the total cost, for frequency services for 2005-06.

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 unexpected interactions were also responsible for counter price energy flows at times across the Basslink interconnector.

Appendices

Appendix A Qualitative analysis

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 so-called fully co-optimised constraints. 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 Directlink)

Constraint: N>>N-NIL_1N (31 Oct)

This system normal constraint is of the fully co-optimised form and was first used in July 2005. The constraint co-optimises flows along the QNI and Directlink interconnectors into New South Wales with around 11 670 MW of generation in New South Wales. The constraint manages loading on the 82 line between Liddell and Tomago for the unplanned loss of the 81 line between Liddell and Newcastle.

This constraint replaced the two constraints N>N-NIL_1N and Q>N-NIL_1N. The constraint N>N-NIL_1N was formulated as an intra-regional constraint on New South Wales generation with the constraint Q>N-NIL_1N formulated as an inter-regional constraint acting on flows from Queensland into New South Wales across both interconnectors.

The two original constraints bound for a total of 5 hours during the previous year whilst the new constraint bound for 54 hours between July and November over 24 days. However, the most significant market impacts (as determined by the cumulative marginal value of the constraint or CMV) accumulated over one hour on 31 October during the emergency outages of the 76 and 77 lines in New South Wales. On this day a number of constraint limits were violated.[11]

[11] The AER published a report into this incident. It is available at www.AER.gov.au.

Constraint: Q:N_LS_VC1 (9 Nov)

This constraint manages outages of the Lismore SVC (static VAr compensator) in northern New South Wales, limiting flow from Queensland to New South Wales across QNI.

The SVC was out of service on 14 days during the year and bound on five of those days for a total of four hours. Five of those outages were over consecutive days from Monday 7 November to Friday 11 November for planned outages. Transgrid notified NEMMCO through the Network Outage Scheduler (NOS) of the need to take these outages on 26 October, 13 days ahead. The outages were approved by NEMMCO and progressed to LTP status on the same day.

When binding this constraint sets a limit on flow south from Queensland of 985 MW, 100 MW lower than the nominal limit. The most significant market impacts accumulated on 9 November when the constraint bound for two hours. On the day, prices in New South Wales reached above $1000/MWh for more than two hours.

Constraint: Q>N-9W2_01, Q>N-9W2_C (30 Dec, 2 Feb)

These constraints manage outages of the 9W2 line in northern New South Wales between Kempsey and Nambucca, preventing overloads on Armidale to Kempsey. These constraints were, however, more often used to manage network reconfiguration of the northern New South Wales 132 kV network. The constraints limit flows into New South Wales from Queensland across both interconnectors.

The constraints were used over 20 days during the summer to manage network reconfiguration. These constraints would often result in reduced transfer limits from Queensland to New South Wales, sometimes as low as 100 MW into New South Wales, the nominal capability on the interconnector is 1078 MW. At times, NEMMCO was also directing Directlink to supply south eastern Queensland, leading to counter priced flows.

This constraint only bound once when used during the year for a planned outage, this occurred on 7 April. Transgrid gave 9 days notice through the NOS of the need to take the outage. NEMMCO approved it (and progressed the outage to LTP status) the next day.

The most significant market impacts occurred over two days, on 30 December 2005 and 2 February 2006. On both occasions, high prices were recorded in New South Wales with prices in Queensland diverging. On 30 December, the Queensland to New South Wales interconnector was limited to around 100 MW. On 2 February, the interconnector was limited to around 300 MW.

Constraint: Q:N_ARDM_B (10 Nov)

This constraint is used to manage the outage of the 8C or 8E line between Armidale and Dumaresq to maintain transient stability for the loss of a Boyne Island Potline in central Queensland. The constraint was used for planned outages of these lines over two days during September. Transgrid gave 28 days notice through the NOS of the need to take the outages. The outages were approved by NEMMCO (and progressed to LTP status) on the same day.

The constraints were also used to manage reclassifications of the loss of both lines as a single credible contingency on six occasions during the year. These reclassifications were all the result of storm activity in the vicinity.

The most significant market impacts occurred on 10 November when lightning led to the reclassification of the Queensland to New South Wales interconnector. Flow south during this reclassification was limited to 325 MW, which is around 800 MW lower than the nominal limit. At the same time, high November temperatures and demands in New South Wales saw prices reach $8650/MWh.

Constraint: Q>N-NIL_DY (31 Dec, 2 Feb)

This system normal constraint restricts flow from Queensland into New South Wales across both interconnectors. The constraint manages the overload of the 965 line between Armidale and Kempsey in northern New South Wales for the unplanned loss of the 9W3 line between Coffs Harbour and Nambucca.

The constraint bound on 24 days during the year for a total of 34 hours. The most significant market impacts occurred on two days: 31 December 2005 and 2 February 2006. On both days, prices in New South Wales at times diverged from, and were much higher than prices in Queensland.

On 31 December, the constraint bound for around three hours, with New South Wales prices diverging from Queensland by an average of $429/MWh. The export limit was around 300 MW lower than the nominal limit when binding.

On 2 February, this constraint bound for only three dispatch intervals, but when binding, flow on the Queensland to New South Wales interconnector was limited to as low as 300 MW (around 800 MW lower than the nominal limit) and at these times, prices diverged from New South Wales by an average of $9262/MWh.

Constraint: N>Q+NIL_F7 (3 Jan, 24 Jan)

This system normal constraint manages the overload on the 86 line between Armidale and Tamworth for the unplanned loss of the parallel 85 line. The constraint restricts flows from New South Wales into Queensland across both interconnectors and bound on 9 days during the year for a total of 14 hours. The most significant market impacts occurred on two days: Tuesday 3 and Tuesday 24 January.

On 3 January the constraint bound for two hours, limiting flow into Queensland across QNI to below 400 MW. Prices in Queensland diverged from the rest of the market, peaking at $5134/MWh compared to peak prices in New South Wales of $268/MWh.

On 24 January the constraint bound for around six hours, limiting flow into Queensland across QNI to around 400 MW. Prices in Queensland increased above those in New South Wales by around $270/MWh from midday to 6 pm.

Constraint: Q:N_NIL_OSC (31 Oct)

This system normal constraint restricts flows south to maintain oscillatory stability for the loss of QNI. 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 194 days during the year for a total of 484 hours. When binding the constraint almost always restricted flows into New South Wales to 1078 MW. The most significant market impacts occurred on 31 October when emergency outages of the 77 and 76 lines in central New South Wales were taking place. The constraint only bound for short periods totalling less than one hour at 1078 MW. Extreme price separation was occurring at times between Queensland and New South Wales.

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 37 days during the year, for a total of 59 hours, setting an average limit of around 1050 MW across the interconnector, close to its nominal limit.

Constraint: Q:N_BI_POT

This system normal constraint restricts flows into New South Wales across QNI to avoid transient instability on the trip of a Boyne Island potline.

The constraint bound on 40 days during the year between 13 July 2005 and 22 August 2005 for a total of 236 hours. On 13 July this constraint was revised through the introduction of an operating margin which reduced the limit by 15 MW. Subsequently this constraint bound on occasions until 22 August when it was revoked.

Constraint: N^Q_NIL_B (4 Apr)

This system normal constraint restricts flow into Queensland across QNI and Directlink to avoid voltage collapse on the loss of the largest Queensland generator.

The constraint bound on 8 days during the year for a total of 8 hours. The most significant market impact occurred on 4 April, when total imports were reduced to as low as 300 MW with 400 MW flows northwards on QNI and counter price flows southwards on Directlink of up to 100 MW. Prices on this day reached $3359/MWh in Queensland, with New South Wales prices at around $35/MWh. Demands in Queensland on the day reached 7700 MW, the highest since February.

A.1.2 Snowy to New South Wales interconnector

Constraint: H>>H-64_B, H>>H-64_A, H>>H-64_H, H>>H-64_G (9, 10 Nov, 7 Dec, 2 Feb)

These system normal fully co-optimised constraints manage northern flow from Victoria into New South Wales across the Snowy region over the 65 and 66 lines between the Murray and Tumut sides of the region. The 64 line between Upper and Lower Tumut is open, its normal configuration. These constraints are all part of the Constraint Support Contracts and Constraints Support Pricing trial (CSC/CSP) which commenced in October 2005. [12]

These constraints simultaneously restrict flows across the Victoria to Snowy interconnector, the Snowy to New South Wales interconnector and Upper and Lower Tumut generation. At times they result in counter price flows out of Victoria into Snowy, causing NEMMCO to intervene to manage the accumulation of negative settlements[13] across the Victoria to Snowy interconnector. NEMMCO's intervention at times restricted Victorian exports to Snowy to as low as zero.

The constraint H>>H-64_B had by far the greatest market impact of any single constraint in this list, binding for 86 hours and with a CMV of $476 524/MWh. This compares to 34 hours and $249 178/MWh for the previous year. The most significant market impacts occurred over four days: 9 and 10 November; 7 December and 2 February. On each day, prices in New South Wales reached above $5000/MWh with discretionary constraints subsequently applied by NEMMCO, restricting Victoria to Snowy flows to prevent the accumulation of negative settlement residues. The limit for flows from Snowy into New South Wales averaged 2517 MW over these four days when the constraint bound, around 500 MW short of the nominal capability.

In general, when this constraint bound, flows from Snowy into New South Wales were restricted to an average of 2261 MW, or around 700 MW short of the nominal capability.

Constraint: H>>H-64_DX, H>>H-64_4X, H>>H-64_CX, H>>H-64_3X (26 Jan)

These fully co-optimised system normal constraints manage southern flow from Upper and Lower Tumut in the Snowy region across the 65 and 66 lines to Murray. The 64 line between Upper and Lower Tumut is open, which is its normal configuration. These constraints also reflect the market reconfiguration with the notional Murray node shifted to Dederang to manage negative settlement residues. These constraints are included in the CSC/CSP trial and limit all generation with in the Snowy region and force flows into New South Wales across the Snowy to New South Wales generator.

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[12] A number of these constraints existed prior to this time, to manage security issues in the Snowy region.

[13] See Appendix G in the 2004-05 Market Impacts of Transmission congestion report for further details of the causes of negative settlement residues.

These constraints were used on 5 days during the year: 19, 20, 22 and 26 January; and 3 March 2006. This was the first time that constraints which re-orient the Snowy region to Dederang were used.

On 26 January, these constraints were invoked to reduce the accumulation of negative settlement residues across the Snowy to New South Wales interconnector. On this day extreme price separation between New South Wales and Victoria saw the TCC accumulate $1.8 million. These constraints were invoked following intervention by NEMMCO earlier in the day to manage post contingent overloads through the Snowy region with discretionary constraints.

Constraint: N>>N-WWSS+WWIG_E (31 Oct)

This constraint was created on 31 October 2005 to manage the unplanned outage of the 76 line between Wallerawang and Sydney South and the emergency outage of the 77 line between Wallerawang and Ingleburn. Largely as a result of these outages, prices in New South Wales were above $5000/MWh for five trading intervals during the day and reached as high as $6724/MWh.

On 30 October 2005 an overhead earthwire on a major transmission line between the Wallerawang power station and the South Sydney substation (line 76) failed, probably as a result of a lightning strike. The earthwire fell onto the transmission line causing it to short circuit, and taking the line out of service.

The repair of the broken earthwire was complicated by bad weather conditions and the remote location of the failure. In addition, TransGrid determined that in order to remove the broken earthwire it would be necessary, for safety reasons, to take the adjacent line 77 out of service. In other words a simultaneous outage of both lines 76 and 77 was required. Together the two lines form one of the major supply routes from the western generators into Sydney.

TransGrid submitted a request to NEMMCO at 1.30 pm on Sunday 30 October for an outage of line 77 in order to remove the earthwire. TransGrid withdrew this outage request at 4.15 pm as the weather conditions deteriorated, and requested an outage of line 77 from the first available time after daybreak on the morning of Monday 31 October. Notice to the market of this outage was issued at 7.15pm on Sunday. Later that evening NEMMCO issued a further notice indicating that the outage had been deferred, as system security could not be assured. NEMMCO requested that TransGrid review options to manage those security issues.

At 8.50 am on Monday 31 October 2005, TransGrid advised NEMMCO that the failure of the earthwire was now considered a system emergency and the line 77 outage needed to go ahead urgently. Furthermore, weather conditions were again deteriorating, reducing the window in which TransGrid could conduct the necessary works. At 9.10 am, NEMMCO advised TransGrid that (based on further studies and additional security arrangements) the line 77 outage could proceed. NEMMCO did not issue a market notice at this time.

At 9.20 am on 31 October 2005 NEMMCO invoked network constraint sets in the market systems to manage the combined outage of lines 76 and 77, and at 9.25 am line 77 was taken out of service. From the dispatch intervals ending 9.20 am onwards, a number of constraints bound (meaning that the market was impacted) and other

constraints were violated (meaning that those constraints were unable to maintain security). Due to the persistence of constraint violations, at 9.55 am NEMMCO requested TransGrid to recall line 77. Line 77 returned to service almost an hour later, at approximately 10.53 am, with the earthwire still entangled in line 76.

During the morning outage, the power system remained insecure for approximately 35 minutes. New constraints were formulated as a result, this included the constraint N>>N-WWSS+WWIG_E.

At 11.58 am, TransGrid resubmitted its line 77 outage request to NEMMCO. NEMMCO granted permission to proceed with the outage of line 77 at 1.35 pm. The removal of the earthwire was completed at 3.47 pm and line 77 returned to service at 4.20 pm. During this outage a number of network constraints in New South Wales and Queensland bound, with five constraints violated.

The AER's investigation into the events of this day found that TransGrid had acted appropriately in managing this outage. It was noted that improvements in the provision of information by NEMMCO to the market were required. The AER has sought an undertaking from NEMMCO to review its outage management procedures and training to ensure that every reasonable effort is made to keep the market informed of network issues where there is likely to be a material market impact.

Constraint: N>>N-NIL_28 (31 Oct, 10 Nov)

This constraint is a system normal limit which manages the flow over the 08 line between Marulan and Dapto for the unplanned loss of the 16 line between Marulan and Avon. This constraint restricts imports into New South Wales across Snowy, QNI and Directlink and impacts on around 9000 MW of generation capacity within New South Wales.

This constraint bound for three days during the year for a total of three hours. The majority of the CMV accrued on 31 October when the constraint bound for two hours. The high marginal value was largely as a result of the emergency outages of the 76 and 77 lines on the day.

Constraint: 64 line out of service Southern flows (20, 26 Jan)

This is a grouping of a number of system normal constraints which manage southern flows from the Tumut to Murray sides of the Snowy region with the 64 line between Upper and Lower Tumut open (its normal configuration). The constraints in this grouping are H>>H-64_D, H>>H-64_J, H>>H-64_C, H>>H-64_4, H>>H-64_3, H>>H-64_C and H>>H-64_L.

The most significant market impacts occurred on two days in January.

On Friday 20 January prices were aligned across the southern regions and peaked at $3067/MWh in South Australia. Prices in New South Wales peaked at less than $60/MWh, with demand in South Australia reached a new record. Flows from Snowy into Victoria were around 1200 MW, or around 400 MW short of the forecast limit at the time and around 700 MW short of the nominal limit. At the same time the H>>H-64_J constraint was forcing flow out of Snowy and into New South Wales counter price.

On Thursday 26 January similar conditions prevailed. Prices in Victoria reached $7758/MWh whilst prices in New South Wales were less than $60/MWh. At times, the price in Snowy was significantly higher than New South Wales, with counter price flows occurring on the Snowy to New South Wales interconnector. Flows south out of Snowy into Victoria were lower than the nominal levels. However, NEMMCO had intervened on the Victoria to Snowy interconnector restricting flows into Victoria to 1100 MW to manage post contingent overloads. Flows into New South Wales were around 800 MW. At 2.55 pm, NEMMCO invoked constraints which re-orient the Snowy region from Murray to Dederang to help manage the accumulation of negative settlement resides (See the constraints above H>>H-64_DX, H>>H-64_4X, H>>H-64_CX, H>>H-64_3X).

Constraint: H>N-NIL_C_15M (2 Feb)

This system normal constraint manages the overload of the 03 line between Lower Tumut and Yass for the unplanned loss of the 07 line between Canberra and Yass in southern New South Wales. The 03 and 07 lines make up part of the Snowy to New South Wales interconnector.

This constraint bound for 2 hours during the year (similar to last year) almost all on Thursday 2 February. Prices on this day reached $9739/MWh in New South Wales with prices in Victoria at less than $372/MWh. The Snowy to New South Wales interconnector was flowing at over 3000 MW when this constraint bound, at the nominal limit.

A.1.3 Victoria to Snowy interconnector

Constraint: N>N-994 (23, 24 Feb)

This constraint manages outages of the 994 line between Wagga and Yanco in southern New South Wales. The constraint restricts flows from Snowy into Victoria and across Murraylink from Victoria into South Australia. At times the constraint forces flow from South Australia into Victoria across Murraylink.

This constraint was created on 20 February for an outage on 21 February. Over the remainder of the year, the constraint was used on 26 occasions; this included four consecutive daily outages on 21 to 24 February and two daily outages from 13 to 23 March and 3 to 14 April. The constraint bound for a total of 18 hours over seven days. For those outages when the constraint bound, Transgrid gave on average of 20 days notice through the NOS of the need to take the outage. The outages were approved by NEMMCO (and progressed to LTP status) the next day. Despite NEMMCO's approval of the outage almost four weeks ahead, the use of this constraint for the February outages was not flagged until the day before the first outage commenced.

The most significant market impacts occurred over 23 and 24 February, when the constraint bound in total for 11 hours. On this occasion in addition to the Wagga to Yanco outage, a planned outage of a Robertstown transformer in South Australia was required. Constraints used to manage this Robertstown outage were forcing flows from South Australia into Victoria across Murraylink, whilst the constraint N>N-994_A was forcing flow across Murraylink in the opposite direction. The conflicting action of these constraints led to forced flows out of Victoria into the

Snowy region, counter price. As a result NEMMCO invoked discretionary constraints to prevent the accumulation of negative settlement residues across Victoria to Snowy. The market systems were at the time forecasting flows of 1300 MW from Snowy to Victoria. At the same time, actual Victoria demand was up to 1000 MW higher than forecast and at near record levels.

At around 1 pm, with this constraint starting to violate, NEMMCO and TransGrid instigated an agreed contingency plan which saw the Wagga load radialised. Whilst this reduced the potential reliability of supply to the local area, it immediately increased the limit on flows from Snowy by 1300 MW. This saw imports into Victoria increase and the spot price fall from $2920/MWh to $30/MWh.

At around 2.30 pm, following the early return of the Robertstown transformer in South Australia, the network around Wagga was returned to its normal configuration and the limit on flows from Snowy was immediately reduced by around 1000 MW to 400 MW. As a result the spot price in Victoria increased, reaching $6997/MWh at 4 pm. The line was returned to service during the 4 pm trading interval.

Market notification, through the market notices was typically lagging two hours behind the actions taken by NEMMCO.

Similar conditions on 24 February saw the Snowy to Victoria interconnector limited from around 8 am to as low as 200 MW into Victoria before the outage was returned to service earlier than forecast at around midday. Spot prices during the outage reached $9134/MWh in Victoria. A new record demand for Victoria occurred later in the day.

Constraint: Discretionary constraints of the form VH_* (9-10 Nov, 7 Dec, 2 Feb)

There were 14 discretionary constraints applied to the Victoria to Snowy interconnector over the financial year which have been grouped together for analysis.

These constraints were used to manage the accumulation of negative settlement residues across the Victoria to Snowy interconnector and bound for 23 hours during the year (compared to 34 hours the previous year). The most significant market impacts occurred on three days: 9 November, 7 December and 2 February. Prices in New South Wales on all three days exceeded $5000/MWh whilst the Victoria to Snowy interconnector was limited to as low as zero by constraints invoked by NEMMCO. Prices in Victoria and South Australia at the time were often as low as $30/MWh. These outcomes are consistent with the previous year.[14]

[14] On 14 September 2006, a Rule change proposed by Loy Yang Marketing Management Company (LYMMCO), Southern Hydro, International Power, TRUenergy, NRG Flinders Hydro Tasmania and NEMMCO was approved by the AEMC. This Rule change will allow the negative residues that accumulate on the Victoria to Snowy interconnector to be funded by the positive residues that accumulate on the Snowy to New South Wales interconnector when CSC/CSP constraints bind. This will reduce the need for NEMMCO to intervene to limit the exports from Victoria into New South Wales through the Snowy region.

Constraint: HV_0900 (26 Jan, 23 May)

This is a discretionary constraint that limits flow from Snowy into Victoria to 900 MW. This constraint was used on 6 occasions during the year and bound for a total of 14 hours. The most significant market impacts occurred over 6 hours on 26 January and 23 May.

On 26 January, high prices in Victoria and South Australia occurred for much of the day. At around 4 pm an unplanned outage between Dederang and South Morang led to a reduction in the capability of the Snowy to Victoria interconnector. As a result NEMMCO invoked this constraint. The constraint bound for less than one hour, but at times saw five-minute dispatch prices separate between Victoria and New South Wales by more than $9000/MWh.

On 23 May this constraint was used to manage a planned outage between Dederang and South Morang. SPAustNet first notified NEMMCO of the requirement for the outage 10 days prior. NEMMCO progressed the outage to LTP status on the same day. The constraint bound for around 8 hours on this day, including for a short period in the morning when a direction on BassLink saw high prices in Victoria and South Australia.

Constraint: HV_1100 (26 Jan)

This constraint is a discretionary constraint which limits flow across the Snowy to Victoria interconnector to 1100 MW. The constraint was used once during the year, on 26 January, (which is described in section A.1.2: 64 line out of service for Southern flows). This constraint was used to manage post contingent overloads through the Snowy region. Prices on this day reached $7758/MWh in Victoria and were less than $60/MWh in New South Wales.

A.1.4 Victoria to South Australia Heywood interconnector

Constraint: VS_460

This system normal constraint manages the nominal capability of 460 MW maximum flow across the Heywood interconnector into South Australia.

The constraint bound on 274 days during the year for a total of 1008 hours (consistent with the previous year) with a CMV of $221 000 (compared to $469 000 the previous year).

Constraint: SV_300 (24 Feb)

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 15 hours during the year over nine days. The most significant market impact occurred on 24 February 2006 during the outages of the Wagga to Yanco line in New South Wales and the Robertstown transformer in South Australia. Prices in South Australia and Victoria diverged from the other regions, with South Australia peaking at $957/MWh and Victoria peaking at $9134/MWh.

Constraint: V>>S-NIL_SETB_MGBL (19 Jan)

This system normal constraint manages the overload of the Mt Gambier to Blanche line for the unplanned loss of the South East to Tailem bend line. The constraint was first created on 29 September 2005.

This fully co-optimised constraint simultaneously restricts flow into South Australia across the Heywood interconnector, constrains on generation at Snuggery, and constrains off generation at Ladbroke Grove.

The constraint has bound on two occasions. The most significant market impact occurred on 19 January, with the limit on flows of around 420 MW, which is 40 MW lower than the nominal limit. Prices in Victoria and South Australia exceeded $4000/MWh.

Constraint: V::S_NIL

This fully co-optimised system normal constraint was created on 29 December 2005 and bound as soon as it was invoked, reducing the limit for flow from Victoria to South Australia across the Heywood interconnector by 65 MW. This constraint manages the stability limit in South Australia by simultaneously restricting imports into South Australia across the Heywood interconnector, and constraining off generation at Snuggery, and Ladbroke Grove.

Since it was created, this constraint has limited imports into South Australia across the Heywood interconnector for 391 hours.

Constraint: V>S_SETB (30 Nov, 15 Dec)

This constraint manages an outage of one circuit between South East and Tailem Bend in South Australia (forming part of the Heywood interconnector) to avoid overloads of the parallel 132 kV network for the loss of the remaining South East to Tailem Bend circuit. The constraint is also often used to manage reclassifications of the loss of both circuits as a single credible contingency when lightning is in the vicinity.

The constraint was used on 28 days during the year for reclassifications as a result of lightning. The constraint was used for a further six days for two planned outages. Electranet gave on average 50 days notice through the NOS of the need to take the outages. NEMMCO progressed the outages to LTP status around 10 days before the outages took place.

The constraint bound for a total of 83 hours during the year over the 34 days. The most significant market impacts occurred on 30 November and 15 December.

On 30 November when the price in South Australia peaked at $5000/MWh whilst prices in Victoria remained below $50/MWh. This price event occurred at around 3pm when constraints were invoked, effective immediately, to ramp down the import capability across the Heywood interconnector from 460MW to 200MW in preparation for an outage of the South East to Tailem Bend line, in South Australia. The outage was required to return critical plant that had been undergoing emergency repairs following damage that had occurred on the previous day. No notice was given for that outage. The line was returned to service at 4.10pm.

On 15 December at 10 am in response to the reclassification of the loss of the interconnector, the constraint was invoked immediately, without ramping the interconnector down. This reduced the import limit from 440 MW to 80 MW in one dispatch interval, which saw the five-minute dispatch price spike to $10 000/MWh, also for one interval. NEMMCO immediately revoked the constraint, then invoked ramping constraints to reduce the imports gradually. Once the limit had been reduced sufficiently, the constraint was again invoked.

Constraint: S>>V_NIL (23 Feb)

This fully co-optimised system normal constraint was created on 16 January 2006 and limits flows from South Australia across the Heywood interconnector. The constraint simultaneously restricts exports and constrains on generation at Ladbroke and Snuggery. The constraint bound on two days during the year, for less than two hours. The most significant market impact occurred on 23 February as a result of the extreme conditions in Victoria that saw demands above 8000 MW and limited imports into Victoria due to network outages in New South Wales and South Australia (see A.1.5).

A.1.5 Victoria to South Australia MurrayLink interconnector

Constraint: S>VML_RBTX_RB_WTMW4, S>>V_RBTX_RBTX_PARS (23, 24 Feb)

These two constraints manage outages of the Robertstown transformers in South Australia. Constraint S>VML_RBTX_RB_WTMW4 limits flow from South Australia into Victoria to avoid overload of the Waterloo to Morgan line for the loss of the remaining Robertstown transformer. Constraint S>>V_RBTX_RBTX_PARS limits flow from South Australia to Victoria and constrains on generation at Northern, Playford and Mintaro to avoid the overload of Para to Roseworthy for the loss of the remaining Robertstown transformer.

Both constraints were used on only two days during the year: Thursday 23 and Friday 24 February for planned outages of the Robertstown transformer. Constraint S>>V_RBTX_RBTX_PARS bound for four hours on Thursday with constraint S>VML_RBTX_RB_WTMW4 binding for five hours on Friday. ElectraNet gave 21 days notice through the NOS of the need to take the outage. The outages were approved by NEMMCO and progressed to LTP status four days later, around 17 days before the outage took place.

These outages coincided with the outages of the Wagga to Yanco line in New South Wales, which is described in section A.1.3, constraint: N>N-994_A.

Constraint: S>>V_NIL_RBTX_RBTX (23 Feb)

This system normal constraint manages the overload of a Robertstown transformer for the unplanned loss of the other Robertstown transformer. This constraint bound on seven days during the year, with the most significant market impact occurring on Thursday 23 February. Following the completion of an outage of the transformer earlier in the day, this constraint limited flows from South Australia into Victoria across Murraylink. At the time an outage of the Wagga to Yanco line in New South Wales was forcing flow into Victoria, (this is described in section A.1.3). The limit on Murraylink during this period was around 100 MW.

Constraint: V^SML_X5TR (17, 24 Nov, 14 Dec, 8 May)

This constraint manages the outage of a control scheme in New South Wales. This control scheme normally enables greater flows from Victoria into South Australia across the MurrayLink interconnector.

This set was invoked to manage a number of network outages in the 132 kV and 330 kV network around Wagga in south western New South Wales.

This constraint bound for a total of 154 hours during the year over 45 days. On days when the constraint bound, an average 13 days notification of the need to take the outage was given through the NOS by Transgrid, (ranging from one day to 22 days notice). 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 four days: 17 and 24 November; 14 December and 8 May. On each occasion the price in South Australia increased compared to the rest of the market. The capability of imports across the interconnector was often reduced to zero during these outages.

Constraint: VSML_000

This constraint limits flows from Victoria to South Australia across Murraylink to zero, to manage outages of the MurrayLink cable or outages between MurrayLink and Redcliffs in Victoria.

The constraint was used on 58 days during the year. 10 of these were for planned network outages, with an average of 95 days notice given through the NOS of the need to take the outages. The remainder were as a result of unplanned outages or tests that were carried out on the interconnector. In total the constraint bound for a total of 336 hours during the year.

Constraint: S>VML_NIL1 (9 Nov)

This system normal constraint restricts flow across Murraylink into Victoria to avoid overloads at North West Bend for the unplanned loss of the Monash to North West Bend number 1 132 kV line.

The constraint bound on 16 days during the year for a total of 27 hours. Almost all of the CMV accumulated on 9 November, when prices in New South Wales peaked at $9167/MWh. Prices in Victoria peaked at $3860/MWh and in South Australia at $1144/MWh. The limit on flows across Murraylink was around 115 MW, which is close to the nominal limit.

Constraint: V^SML_NIL2

This system normal constraint restricts flow from Victoria to South Australia across Murraylink to avoid voltage collapse for the loss of the X5 line between Darlington Point and Buronga.

The constraint bound on 11 days during the year for a total of 16 hours. The most significant market impact occurred on 30 November when the price in South Australia peaked at $5000/MWh whilst prices in Victoria remained below $50/MWh. This price event (which is described A.1.4) occurred at around 3pm when constraints were

invoked, effective immediately, to ramp down the import capability across the Heywood interconnector from 460MW to 200MW in preparation for an outage of the South East to Tailem Bend line, in South Australia. The outage was required to return critical plant that had been undergoing emergency repairs following damage that had occurred on the previous day. No notice was given for that outage. The line was returned to service at 4.10pm.

The Murraylink interconnector was operating at its nominal limit of around 220 MW at the time.

A.2 Intra-regional constraints

A.2.1 Queensland

Constraint: Q_CS_1900 (2 Feb)

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

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 a total of 83 hours over 45 days. This compares to 44 hours over 24 days the previous year. The most significant market impacts occurred on 1 February and 2 February, when it bound for 12 hours each day. On 2 February the TCC reached $12.7 million, its largest daily accumulation over the last three years. Up to around 180 MW of central Queensland generation was constrained off as a result of this constraint.

Constraint: Q_CS_1700 (9 Nov)

This constraint limits flows from central to south Queensland to a maximum of 1700 MW. It is used in conjunction with Q_GLD34_500 to manage the outage of the Gladstone Bus Tie Transformer.

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 a total of 63 hours over 15 days. When the constraint bound, an average of 30 days notice was given by Powerlink through the NOS of the need to take the outage. NEMMCO progressed the outage to LTP status on these occasions 6 days before the outages were planned to take place.

On 9 November the constraint bound for a total of 10 hours. The TCC on this day was $4.7 million, the third highest daily accumulation for the year. Up to around 750 MW of central Queensland generation was constrained off at around 10 am with around 300 MW constrained off for the remainder of the outage. On this occasion the outage was planned 41 days in advance, NEMMCO progressed the outage to LTP status 8 days before the outage commenced.

Constraint: Q_GLD34_500

This constraint is used in to manage the outages of both the 813 and the 814 lines between Gladstone and Gin Gin, and the Gladstone Bus Tie Transformer. Generation from Gladstone units three and four is constrained on, with total output from both units kept at a minimum of 500 MW.

The constraint bound for a total of 41 hours over 12 days during the year. A similar constraint bound for a total of 39 hours over 14 days the previous year. Powerlink gave an average 11 days notice of the need to take the outage through the NOS. NEMMCO progressed the outages to LTP status on average 5 days before the outage commenced.

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.

The constraints bound on 9 days for around 30 hours in total, often binding at the same time. This compares to around 190 hours the previous year. On 8 January, the constraints bound for a total of 20 hours, with Q>PRE855_871CAL having the greatest impact on generation (Callide B and Callide C units were constrained off by a total of around 300 MW).

Constraint: Q_CS_1200 (13 Oct, 30 Nov, 1 Dec)

This system normal constraint limits flows from central to south Queensland to a maximum of 1200 MW in the presence of storm activity or lightning in central Queensland. This condition leads to the reclassification of the loss of the double circuit between Tarong and Calvale as a credible event.

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 a total of 24 hours over 14 days. On 30 November the constraint bound for 5 hours. The TCC on this day reached $2.2 million.

A.2.2 New South Wales/Snowy

Constraint: N>N+LDNC_07, N>N-81__02, N>N+81__07, N>N-81__07, N>N-81__27

Outages of the 81 line between Liddell and Newcastle are managed by a number of constraints with: N>N+LDNC_07; N>N-81__02; N>N+81__07; N>N-81__07; and N>N-81__27 having the most significant impacts.

These constraints bound for a total of 12 hours during the year over 8 days. This compares to 94 hours the previous year over 19 days. The line came out of service on 55 days during the year, which compares to 42 days for the previous year.

For the outages that impacted on market outcomes, Transgrid gave an average of 39 days notice of the requirement for the outages through the NOS, the same as for the previous year. NEMMCO progressed these outages to LTP status an average of 30 days before the outage commenced.

These constraints impact on a significant proportion of New South Wales generation, ranging from around 4500 MW for the constraints N>N-81__07 and N>N+LDNC_07 to as much as 11520 MW (or more than 95 per cent of the total registered generation in NSW) for the constraint N>N-81__27. As a result, when binding, these constraints at times cause hundreds of megawatts of generation to be dispatched out of merit order.

A.2.3 Victoria

Constraint V>V_NIL_4

This system normal constraint limits the generation of Hazelwood units 3,4 and 5 to less than 636 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 2004 SOO publication showed the maximum capacity of these Hazelwood units to be slightly higher than the continuous rating of the transformer. The three units affected by this constraint have a combined maximum capacity of around 650MW.

Separately, works are being implemented to improve the configuration of the Hazelwood switchyard. A result of this work will be the elimination of this constraint.

This constraint was first introduced to the market on 7 November 2005 and bound for a total of 91 hours during the year over 21 days.

Constraint: V>V1NIL and V>V2NIL

These system normal constraints manage the loading on the Hazelwood transformers, which are situated in the Latrobe Valley. During 2005-06 these constraints bound on 10 days for a total of 14 hours (compared to 30 days for a total of 101 hours, for the previous year). Further details of this network limitation, its impact and causes are provided in the 2003-04 report[15] (Appendix B section B.2.3).

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[15] Indicators of the market impact of transmission congestion – Report for 2003-04

The reduction in the impacts of these constraints is a result of a change of ownership of the generation affected by this constraint, which has led to a greater level of co-ordination of the dispatch of plant.

A.2.4 South Australia

Constraint: S_PPT200, S_PPT160

These constraints are used to manage the outage of the LeFevre to Pelican Point line. They constrain generation at Pelican Point to a maximum output of either 200 MW or 160 MW. The capacity of Pelican Point is 478 MW.

The constraints bound for a total of around 134 hours over 16 days. The S_PPT200 constraint bound for a total of around 113 hours over twelve consecutive days for an outage beginning on 11 October. Electranet gave 41 days notice of the need to take the outage, initially expected to commence on 10 October. On the morning of 10 October, the outage was postponed for a day.

For the remaining four days of outages where the S_PPT160 constraint bound, Electranet gave an average of 11 days notice of the need for the outage.

A.2.5 Tasmania

Constraint: T>T_BWWA_110_6 and T>T_BWWA_110_7

These two constraints manage outages of Bridgewater to Waddamana. Together these constraints manage overloads of the Meadowbank to New Norfolk or Tungatinah to Tarraleah line for loss of lines around Tarraleah. The constraints impact on around 990 MW of generation capacity.

Together the two constraints bound for 90 hours over 34 days, associated with one long term outage between July and November. Transend initially planned to take the outage between 23 June and 2 December, however the day before the outage was to commence it was delayed until 7 July 2005. Transend initially gave 30 days notice through the NOS of the requirement for the 5 month outage.

Constraint: T>T_NIL_BL_IMP_7C

This system normal constraint limits Tasmania generation to avoid the overloading of one of the Farrell to Sheffield lines on the trip of the other (when the Hampshire link is open and Basslink is not exporting). The constraint impacts around 620 MW of generation capacity.

The constraint bound for a total of around 65 hours over 35 days. On five of these days it bound for over 35 hours.

Constraint: T:T_NIL_1

This system normal constraint is used to avoid transient instability for the fault and trip of a Farrell to Sheffield line (when Basslink is importing). The constraint impacts on around 1500 MW of generation capacity.

The constraint bound for a total of around 40 hours over 20 days. On 29 July and 4 August it bound for over 20 hours in total.

Constraint: T_T_FASH2_MOD_1

This constraint manages the outage of the Farrell to Sheffield No.2 line and limits John Butters and Mackintosh, around 225 MW of generation capacity to 110 per cent of the west coast load. The only constraint set that this constraint belongs to was retired in February 2006.

The constraint was invoked over 14 days and affected dispatch on 4 of those days for a total of 36 hours. When binding, an average of 11 days notice was given by Transend, through the NOS, of the need to take the outage. The outages were progressed to the LTP status by NEMMCO an average of 6 days ahead.

Constraint: T_T_X_FASH_A

This constraint manages outages of both Farrell to Sheffield lines and limits west coast generation, around 620 MW of generation capacity to 110 per cent of west coast load.

The constraint first bound on 7 February during an unplanned outage. The constraint was invoked on six days and bound on four of those days for a total of 32 hours. When binding, an average of 8 days notice was given by Transend, through the NOS, of the need to take the outage.

Constraint: T>T_PMSH_220_1

This constraint manages the outage of the Palmerston to Sheffield 220kV line. It manages the overload on the Georgetown to Sheffield No.1 line for the loss of the Georgetown to Sheffield No.2 line. It affects around 1500 MW of generation capacity.

The constraint bound on five days for a total of 23 hours. Transend gave an average of 16 days notice through the NOS of the requirement for the outage.

Constraint: T>T_NIL_BL_110_19

This system normal constraint manages the overload of the Waddamana to Lake Echo Tee No.1 line (flow to North) for the loss of the Tungatinah to Lake Echo Tee to Waddamana No.2 line, radialising the Bridgewater to Waddamana line from Bridgewater, when Basslink is in service. It affects around 720 MW of generation.

The constraint bound on 17 days between January and March for a total of 19 hours.

Constraint: T>T_TAMB_110_1

This constraint manages the outage of the Tarraleah - Meadowbank line 110kV line. It affects around 160 MW of generation capacity.

There were three days of outages. Transend gave around a week's notice of the outage. The outages were approved by NEMMCO with two days notice. The constraint bound on all three days for a total of 15 hours.

Constraint: T>T_X_MBNN_TATU1-2_1

This constraint manages the outage of the Meadowbank to New Norfolk with both Tarraleah to Tungatinah lines open. It manages the overload of either Waddamana to

Lake Echo Tee lines for the loss of one of the two parallel circuits. It affects around 160 MW of generation.

There were three days of outages. Transend gave around a week's notice of the outage. The constraint bound on two of those days for a total of 13 hours.

Constraint: T>T_GTSH_220_1

This constraint manages the outage of theGeorgetown to Sheffield 220kV line. It manages the overload of the Sheffield to Palmerston line for the loss of the other Georgetown to Sheffield line. It affects around 1500 MW of generation capacity.

There were five outages lasting a total of 12 days with between 60 and six days notice given. The constraint bound on four of those days. One of these four days accounted for seven of the 12 hours that this constraint was binding in total.

Constraint: T>T_X_MBNN_TATU1-2_2

This constraint manages the outage of the Meadowbank to New Norfolk line with both Tarraleah to Tungatinah lines open. It manages the overload of either Tarraleah to New Norfolk line for the loss of one of the two parallel circuits. It affects around 130 MW of generation capacity.

There were three daily outages given, with around a week's notice to the market. The constraint bound on two of the days for a total of 11 hours.

Constraint: T>T_X_CSNN_BWWA

This constraint manages the outage of Chapel Street to New Norfolk and the Bridgewater to Waddamana lines. It manages the overload of the New Norfolk to Creek Rd line. It affects around 250 MW of generation capacity.

There was one outage with 39 days notice given by Transend. NEMMCO approved this outage (and progressed it to LTP) six days before the outage was to commence. Another two daily outages were notified nine and 10 days before the commencement date, which NEMMCO then approved (and progressed to LTP) on the day before commencement. There was a further one day outage where no notice was given. The constraint bound on four days for a total of 11 hours, with one of the days binding for nine hours.

Constraint: T>T_CRRI+RI_SPLIT_7

This constraint manages the outage of the Creek Road to Risdon line. It manages the overload of the Waddamana to Lake Echo No. 1 line for the loss of Tungatinah to Lake Echo Tee to Waddamana No.2 line. It affects around 1000 MW of generation capacity.

On 24 January an unplanned outage affected dispatch for three days. This outage, whilst unplanned, was initially forecast to last 20 days before it was finished early. During the three days, the constraint bound for a total of 10 hours.

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 $257 million for the 2005–06 financial year with the majority accruing for imports into NSW across the QNI and Snowy to New South Wales interconnectors. Three quarters 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.

Most residues for the year accumulated on the Snowy to New South Wales interconnector. Analysis shows that in general the interconnector capability was at near nominal limits, which means that the inter-regional settlement residues closely matched those that were anticipated through the SRA process on this interconnector. This is borne out most appropriately on 2 February where the TCC reached its highest ever daily accumulation of $12.7 million with the daily accumulation of residues of $49 million. This was not, however, the case on 31 October. Whilst the settlement residues accrued $24 million, the interconnector capability was reduced significantly below the nominal limit of 3000 MW for over fours hours during the day.

The Victoria to Snowy interconnector capability was frequently limited by intervention by NEMMCO to manage the accumulation of negative settlements. Reduced settlement residues were also seen on 23 and 24 February across the Snowy to Victoria interconnector which was limited, at times to zero, by the interaction of network outages in Victoria and South Australia.

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

Date	Settlement residues		TCC
31/10/2005	$24 million	9%	$3.6 million
9/11/2005	$33 million	13%	$4.7 million
10/11/2005	$17 million	7%	$3.6 million
7/12/2005	$41 million	16%	$7.6 million
30/12/2005	$4 million	2%	$1.0 million
21/1/2006	$3 million	1%	$0.4 million
26/1/2006	$4 million	2%	$1.8 million
2/2/2006	$49 million	19%	$12.7 million
23/2/2006	$3 million	1%	$0.9 million
24/2/2006	$10 million	4%	$2.0 million

Appendix C All network constraints

Table C1, sourced from the AEMC Reliability Panel 2005–06 annual review, provides a summary of the notice given for all outages by TNSP's to NEMMCO through the NOS. This 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

Region	QLD	NSW[1]	VIC	SA	TAS	Murray link	Terranora[4]	Total
Total outages[2]	964	1127	1195	657	522	13	9	4487
Scheduled with less than four days notice	29%	24%	37%	27%	30%	50%	75%	30%
Forced outages[3]	7%	8%	8%	12%	10%	23%	56%	9%

Notes

[1] The NSW TNSP arranges Snowy outages.

[2] Only primary plant outages (affecting load carrying capability) are included.

[3] Outages not previously notified to NEMMCO, including failures and amendments by TNSPs in response to unforseen extreme conditions.

[4] Directlink became a regulated interconnector on 22 March 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 on the Frequency Control Ancillary Service (FCAS) markets. Typically the cost of FCAS is less than 1 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 a result of unplanned network events, largely outside of the control of TNSPs.

The total cost of turnover in the FCAS market in 2005–06 was $30 million. Planned network outages on 68 days led to increased requirements for FCAS and accounted for an estimated $3 million of this cost.

Unexpected 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 unexpected interactions at times led to counter price energy flows across the Basslink interconnector. These impacts were not captured by the TCC and OCC. For example, on 23 May, the interaction of the no-go zone and the frequency markets in Tasmania saw the energy price in Tasmania reaching above $6509/MWh whilst exporting energy to Victoria with an energy price of $30/MWh. At the same time there were shortages of local supply in multiple frequency markets in Tasmania, with the price for some of these services reaching the price cap of $10,000/MW.

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, generators offers have been substituted with $300/MWh. This is an approximation only and does not reflect the true cost of the directions.

NEMMCO issued 60 directions throughout the year to manage local security issues, (compared to 41 during 2004-05 and 10 in 2003-04). 52 of these directions applied to Directlink, to make itself available for dispatch in the direction of New South Wales to Queensland. On 18 December a generator in north Queensland was directed to maintain the power system in a secure operating state.

Hydro Tasmania was directed 6 times to provide frequency services in Tasmania. BassLink was directed to make itself available for dispatch in the direction Victoria to Tasmania on 23 May.

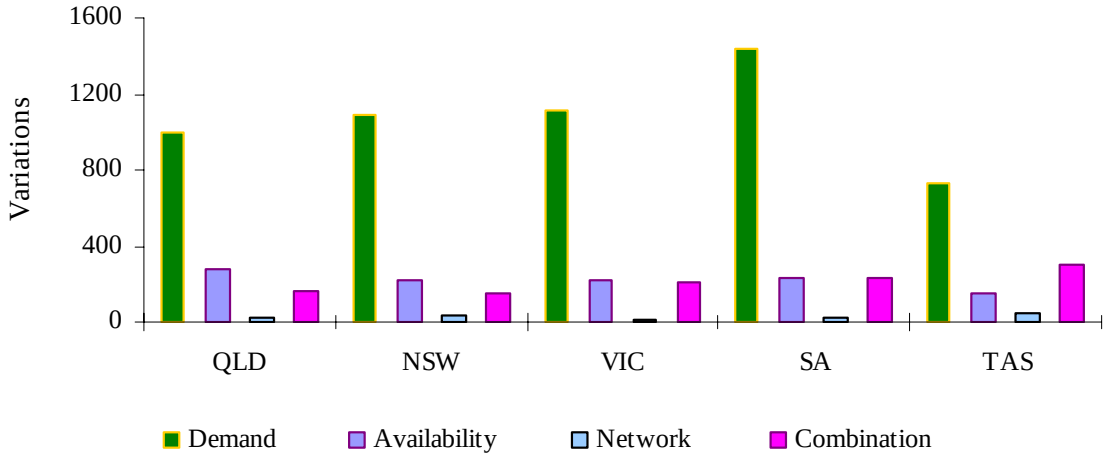
The total compensation paid to the directed generators was less than $1 million (all to Queensland participants). This compares to $4.2 million in compensation payments in 2004-05 and around $5 million in 2003-04.

In addition, a 4.8.9 instruction was issued to Transgrid by NEMMCO to radialise a 132kV line in northern New South Wales on 2 February 2006 to facilitate an increase in transfers from Queensland into New South Wales.

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 2005-06 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 2005-2006 financial year, the AER reported on 377 events (covering 1050 trading intervals).

The table below identifies those 26 events (covering 108 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
3-Aug-05	Tas	At 4.40pm, Transend notified NEMMCO of lightning in the vicinity of the double circuit Farrell to Sheffield 220kV lines and that the loss of both lines was a credible contingency event. NEMMCO invoked constraints to manage this reclassification from 4.55pm. As much as 200MW was constrained off at John Butters, Mackintosh, Reece, Tribute and Bastyan.
10-Aug-05	Tas	Binding network constraints in predispatch and dispatch impacted on forecast and actual prices. The 5-minute price spiked to $9,000/MWh at 7.25pm.
12-Aug-05	Tas	Conditions at the time saw demand close to forecast. Network constraints affected as much as 160MW of generation, mostly at Gordon. Forecasts showed the unit constrained on at its maximum of 246MW through this period. It was, however, constrained off by as much as 160MW in despatch. Most of this capacity was replaced by higher priced capacity at Poatina and John Butters.
16-Aug-05	SA	An unplanned reduction by 200 MW to the limit across Murraylink saw flows reduced from 90 MW to zero from 1.45pm. The 5 minute price increased from $31/MWh to $292/MWh with this reduction. Flows into South Australia via Heywood were above the limit of 460 MW, from 1.20pm to 1.50pm, by as much as 100 MW.

9-Sep-05	Tas	At 11.40am, following advice from Transend of lightning in the vicinity of the two Farrell to Sheffield lines, NEMMCO reclassified the coincident loss of both lines as a credible contingency event. Constraints were invoked to manage this reclassification. These constrains reduced the generation at Mackintosh and Reece 1 by 130MW, increased the requirement for raise 6 second service by 70MW, and removed 70MW of capacity from the raise 6 second market. As a result, the 6 second requirement could not be met for the 11.40 and 11.45am despatch intervals.
13-Sep-05	Qld	Violated constraints led to unusual dispatch outcomes between 8.30am and 9.30am, resulting in constrained off generation and inconsistent limits on DirectLink and the New South Wales to Queensland interconnector.
19-Sep-05	Mainland	Flows into New South Wales from Queensland across QNI were limited by a planned transformer outage at Armidale in New South Wales. Actual interconnector capability and resulting flows were, however, around 700MW higher than forecast four hours earlier.
20-Sep-05	Mainland	Prices were aligned across the southern mainland regions throughout this period and were higher than forecast. Flows into New South Wales from Queensland, were as much as 500MW lower than the four hour ahead forecast.
11-Oct-05	Tas	Problems with line ratings led to prices above $5,000/MWh at 7.30am and 1.30pm. Prices at other times were not affected by these problems. At around 7.10am a failure of Transend's SCADA system saw the correct network ratings replaced with ratings close to zero across Tasmania. This led to step changes to and violations of around 40 network constraints1 across the region. The constraint violations continued until 7.30am when the ratings were replaced. From 1.10pm similar rating and constraint issues occurred following a planned changeover of operational systems.
12-Oct-05	Tas	A planned network outage restricted Bastyan, Reece and Tribute from providing raise 6 second services, whilst increasing the requirement for the service to cover the loss of these same units. The varying start and end times of the outage combined with the dispatch of these units led to increased ancillary services requirements at the beginning and end of the outage.
31-Oct-05	NSW	An emergency outage south of Sydney was required with the constraints that were used to manage the outages having unexpected interactions with system normal constraints. At times all generation within New South Wales and all interconnectors into New South Wales were constrained.
10-Nov-05	NSW/Qld	At 2.55pm, flows into New South Wales across the Queensland to New South Wales interconnector were reduced by more than 500MW following advice from both Transgrid and Powerlink of lightning in the vicinity of the interconnector. The lightning ceased to be a problem around 6pm.
25-Nov-05	SA	Lightning in the vicinity the Heywood interconnector led to flows into South Australia reduced by around 300MW compared to forecast
30-Nov-05	SA	At around 3pm, constraints were invoked, effective immediately, to ramp down the import capability across the Heywood interconnector from 460MW to 200MW in preparation for an outage of the South East to Tailem Bend line, in South Australia. The outage was required to return critical plant that had been undergoing emergency repairs following damage that had occurred on the previous day. No notice was given for that outage. The line was returned to service at 4.10pm.
1-Dec-05	Tas	Commissioning tests of the new Basslink interconnector between Tasmania and the mainland saw with flows for the first time of up to 140MW on Thursday 1 December. During testing, incorrect SCADA and status indications, related to Basslink, led to three price spikes between 2.15pm and 3.15pm. The 5-minute price reached a high of $8 000/MWh, while the price of lower 6 second frequency control ancillary service spiked to $10 000/MW during the same period. NEMMCO reported that the pricing and dispatch outcomes were not consistent with the actual power system conditions.

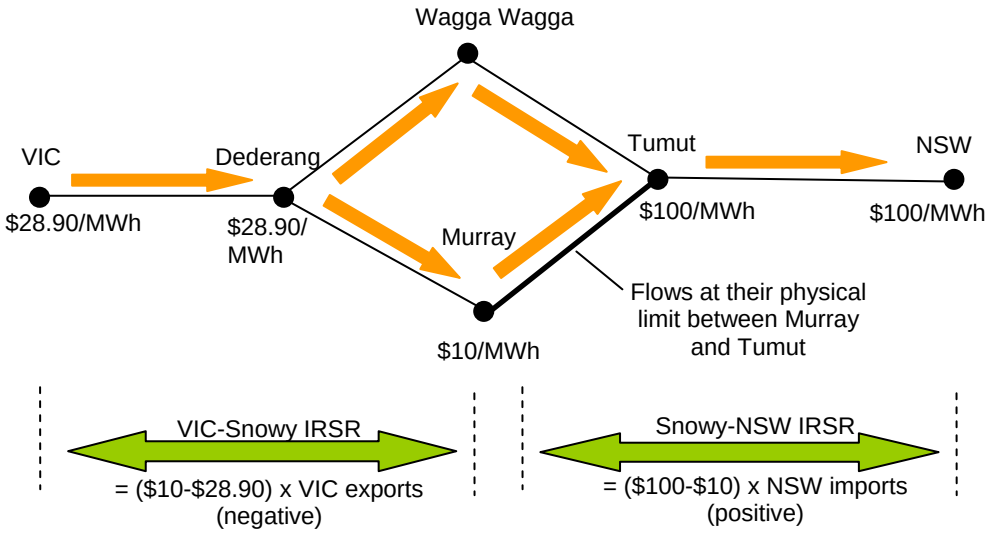
15-Dec-05	SA	Following advice from ElectraNet of lightning in the vicinity of the Heywood interconnector, NEMMCO reduced the limit for flows from Victoria from around 440MW at 9.55am to 80MW at 10am. This step reduction was not able to be met, with flows reduced by around 260MW but remaining above the limit. The five-minute dispatch price spiked from $24/MWh to $9 999.99. The constraint reducing the limit was then removed and the limit returned to around 440MW at 10.05am. Further constraints were then invoked from 10.10am which ramped down flows on the interconnector to 50MW over the next 20 minutes, with the price remaining below $32/MWh.
17-Dec-05	Tas	Basslink was forecast to flow 100MW north for the trading interval ending 12pm and 100MW south for the 12.30pm trading interval. At 12.05pm, however, the flow continued northwards at 50MW. There was a step change in the offer profile for the 12.30pm trading interval for Reece unit 1 coincident with the forecast reduction in exports from Tasmania. This change in offer profile saw 100MW of capacity reallocated from prices of $40/MWh at 12pm to more than $2 000/MWh from 12.05pm. At 12.05pm, a significant increase in the requirement for all frequency control services across the market occurred. The requirement for the Tasmanian lower 6 second service was not met, leading to a $10 000/MW price for this service. The combined effect of the increase in the requirement for ancillary services, higher than forecast exports and the offer profile change led to the price for energy spiking to $5 000/MWh at 12.05pm. At 12.10pm the flow on Basslink moved to 100MW south, the ancillary services requirements reduced and as a result the price returned to less than $40/MWh.
1-Jan-06	SA	Conditions at the time saw demand almost 400MW lower than forecast. Earlier in the day, exports north into Snowy were limited to as low as 500 MW to manage an unplanned network outage in the Snowy region. Following the return of this plant at 5.05pm, exports increased and prices re-aligned with those in New South Wales and Queensland.
16-Jan-06	SA	The limit on the MurrayLink interconnector was reduced from 216MW to 40MW at 3.15pm. This followed the introduction of a constraint by NEMMCO. The limit returned to around 210MW from 3.35pm.
23 and 24 - Feb - 05	Vic/SA	Transmission outages in New South Wales and South Australia were the cause of the restrictions on power flows into Victoria from Snowy. Flows across the Victoria to Snowy interconnector into Victoria were as low as zero.
22-Mar-06	Vic/SA	An outage in New South Wales between Wagga and Yanco restricted flows into Victoria from Snowy to around 1100 MW, which is around 600 MW below its nominal limit. At 3.35 pm a step change in the limit set by the constraint modelling this outage saw a 400 MW reduction in flows from Snowy into Victoria. At the same time around 90 MW was forced counter-price from South Australia to Victoria across the Murraylink interconnector. Flows across the Heywood interconnector increased by around 100 MW to the limit of 460 MW in response.
28-Mar-06	Tas	At 7am the Basslink interconnector was flowing southwards at its limit of 196 MW. At 7.05 am a scheduled outage of Basslink commenced. This outage was reflected in a zero offer for Basslink (from the initial offer the previous day), and a zero capability for the link as a result of a network outage in Victoria (notified through the market systems from around 8pm the previous evening). Basslink has a rate of change limit of 200 MW per 5-minute dispatch interval, and a ±50 MW "no-go" zone. The actual metered flow at the start of the 7.05am dispatch interval was 226 MW. In attempting to change from 226 MW to zero in one dispatch interval, three of the four constraints mentioned were violated (the zero Basslink offer; the zero network capability; and the "no-go" zone constraint). The rate of change constraint was not violated, leading to a target on the interconnector of 26 MW. The step reduction in imports into Tasmania across Basslink led to a significant increase in the requirement for local generation and local ancillary services. This saw a number of generators ramped up at their maximum ramp rate, and a number of generators trapped in the provision of ancillary services. The combination of these factors led a shortfall in the availability of generation in Tasmania to meet this change in imports. As a result, the dispatch algorithm's supply demand balance constraint was violated, setting a price of $10 000/MWh.

3-Apr-06	SA	A 30-minute planned network outage of a Heywood-Moorabool 500KV line, which reduces the capability of the Victoria to South Australia interconnector, was scheduled to commence from 10am. This outage was included in the forecast systems from the previous Wednesday. In readiness for the network outage, the export limit from Victoria to South Australia was reduced from 460 MW to 250 MW in one 5-minute dispatch interval. The 5 minute dispatch price spiked from $32/MWh to $4998/MWh at 10.05am. This price was first forecast an hour earlier. The import capability was not ramped down, which is the usual practice to minimise the market impacts for planned network outages.
20-Jun-06	Tas	A slight increase in the requirement for locally sourced raise regulation and 6 second contingency services in Tasmania at 11.35 am and 11.40 am, in conjunction with Basslink approaching the no-go zone of 50 MW, led to five-minute $10 000/MW prices in both services. Co-optimisation of these services with energy saw high prices reflected into the energy market.
26-Jun-06	Tas	Prices were higher than forecast with BassLink flowing north, counter price into Victoria at 10.35 am and 10.40 am. At 10.35 am, the price of energy spiked to $842/MWh, coinciding with a step change in Hydro Tasmania's offer profile, leading to a 218 MW reduction in capacity priced below $50/MWh. This step change was as part of Hydro Tasmania's day-ahead bids and was not a result of a rebid. Flows north across BassLink were kept at 73 MW as a result of co-optimisation between the energy market and six frequency markets, with the price of locally sourced raise regulation reaching $635/MWh.
30-Jun-06	Tas	Flows across BassLink had been counter price since 10.35 am, as a combined result of: a step change in the offer profile of Hydro Tasmania's capacity; a network limitation in Tasmania; and the co-optimisation of energy with five frequency control ancillary services. At 11.15 am, the price in Tasmania spiked from $250/MWh to $8000/MWh. This followed a small increase in demand and locally sourced raise frequency services. There was no energy offers available in Tasmania priced between $250/MWh and $8000/MWh.

Appendix G Negative settlement residues

There are two circumstances under which negative settlement residues can arise: in the presence of an intra-regional constraint and in the presence of a constraint on an electrical loop between regions. One such electrical loop arises in the Snowy region of the NEM. Power can flow from northern Victoria to southern NSW along two electrical paths. One path passes through the Snowy mountains region, passing along a transmission line between the Murray and Tumut generating stations. The other path bypasses the Snowy mountain region altogether, passing through Wagga Wagga in NSW. This loop is illustrated in the simplified diagram below:

Figure 1: Stylised diagram of power flows and prices in the Snowy region at the time of binding Murray-Tumut constraint (northerly direction)



As long as none of the transmission lines in this loop are binding, the locational price for electrical power is the same (ignoring losses) at all the points on this loop. However, at times of high power flow across the Snowy region, the flow on the transmission line between Murray and Tumut often reaches its physical limit. When the Murray-Tumut constraint binds, different prices for electricity arise at different locations around the loop.

Specifically, when the Murray-Tumut constraint is binding in the northerly direction, the price at the Murray node is the lowest on the loop (say, $10/MWh). Prices increase around the loop in a clockwise direction, reaching their highest point at the Tumut node (say, $100/MWh). Since the price at Dederang in Victoria must therefore be higher than the price at Murray in the Snowy region, power is flowing from a higher-priced region to a lower-priced region, as illustrated in Figure 1. These are known as “counter-price flows”. Counter-price flows give rise to negative settlement residues. NEMMCO, which cannot afford to accumulate substantial negative settlement residues, will usually be forced to intervene.

Appendix H 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).

H1. New South Wales to Queensland (QNI)

H2 Queensland to New South Wales (QNI)

H3. New South Wales to Queensland (Directlink)

H4 Queensland to New South Wales (Directlink)

H5. Snowy to New South Wales

H6. New South Wales to Snowy

H7. Victoria to Snowy

H8. Snowy to Victoria

H9. Victoria to South Australia (Heywood)

H10. South Australia to Victoria (Heywood)

H11. Victoria to South Australia (Murraylink)

H12. South Australia to Victoria (Murraylink)

H13. Queensland intra-regional constraints

H14. New South Wales intra-regional constraints

H15 Snowy intra-regional constraints

H16. Victoria intra-regional constraints

H17 South Australia intra-regional constraints

H18 Tasmania intra-regional constraints

H19 Constraints used in grid support

H20 Constraints used in power system directions

H1. NEW SOUTH WALES TO QUEENSLAND (QNI) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
N>Q+NIL_F7	14	54,185	317	System normal, limits QNI and Directlink to avoid overloading Armidale to Tamworth 330kV line on loss of other Armidale to Tamworth 330kV line
N^Q_NIL_B	8	32,074	349	System normal, avoid Voltage Collapse on loss of largest Qld Generator
CHI_Q_TR_Q	1	20,831	2,604	CHIMERA Tarong Limit

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
Q>>BCKBR_PRE	1	10,410	651	Outage of the 330kV Bulli Ck-Braemar 9901 or 9902 or a 330/275 kV Transformer.

H2. QUEENSLAND TO NEW SOUTH WALES (QNI) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
N>>N-NIL_1N	53	370,045	586	System normal, avoid Liddell-Tomago(82) overload on Liddell-Newcastle(81) trip
N>>N-NIL_28	3	142,390	4,746	System normal, avoid Marulan-Dapto(8) overload on Marulan-Avon(16) trip
Q>N-NIL_DY	34	59,884	147	System normal, limit flows on QNI + Directlink to avoid overload on Armidale to Kempsey (965) on trip of Coffs Harbour to Nambucca (9W3)
Q:N_NIL_OSC	484	46,819	8	System normal, limit flows on QNI to avoid oscillatory instability
Q:N_NIL_BCK2L-G	59	37,328	53	System normal, limit flows on QNI to avoid transient instability on 2 phase to ground fault at Bulli Creek
Q:N_BI_POT	236	35,842	13	System normal, limit flows on QNI to avoid transient instability on trip of a Boyne Island potline, Millmerran in-service
Q>N_NIL_8L_8M	72	20,594	24	System normal, limit flows on QNI to avoid overloading 8L or 8M on trip of the other

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
N>>N-WWSS+WWIG_E	3	190,633	6,354	Outage of Sydney South-Wallerawang(76) + Ingleburn- Wallerawang (77), avoid Marulan-Dapto(8) overload on Marulan-Avon(16) trip
Q:N_LS_VC1	4	170,832	3,417	Outage of Lismore SVC
Outage of 9W2 line in northern NSW	37	160,725	364	Outage of Kempsey-Nambucca(9W2) (aggregation of constraints below)
Q>N-9W2_01	5	80,430	1,387	Outage of Kempsey-Nambucca(9W2), avoid Armidale-Kempsey(965)
Q:N_ARDM_B	5	78,801	1,433	Outage of 8C or 8E
Q>N-9W2_C	12	77,993	553	Outage of Kempsey-Nambucca(9W2), avoid Armidale-Kempsey(965) overload on Kurri-Stroud(96F) trip
N>Q_AR_TX	36	15,043	35	Outage of Armidale 330/132kV Transformer, avoid last remaining transformer overload on 2nd transformer trip
N>>N-81_1T	68	14,459	18	Outage of Liddell-Newcastle(81), avoid Liddell-Tomago(82) overload
Q>N_X_81_96H_01	41	8,697	18	Outage of Liddell - Newcastle (81) and Coffs Harbour - Koolkhan (96H) lines, limit flows on QNI and Directlink to avoid overloading Armidale to Kempsey (965) line
Q:N_AR_VC_A	4	7,009	156	Outage of Armidale SVC, Oscillatory Stability for the loss of either 8C or 8E (Armidale to Dumaresq) 330kV and high Qld demand

H3. NEW SOUTH WALES TO QUEENSLAND (DIRECTLINK) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
N>Q+NIL_F7	14	54,185	317	System normal, limit QNI and Directlink to avoid overloading of Armidale to Tamworth (86) 330kV line on loss of other Armidale to Tamworth (85) 330kV line
N^Q_NIL_B	8	32,074	349	System normal, avoid Voltage Collapse on loss of largest Qld Generator
N>Q-NIL_1A	1	881	98	System normal, avoid 33 overload on 34 trip (or converse)
N:Q_NIL_B9	9	256	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
N>Q_AR_TX	36	15,043	35	Outage of Armidale 330/132kV Transformer, avoid last remaining Transformer overload on 2nd Transformer trip

H4. QUEENSLAND TO NEW SOUTH WALES (DIRECTLINK) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
N>>N-NIL_1N	53	370,045	586	System normal, avoid Liddell->Tomago(82) overload on Liddell-Newcastle(81) trip
N>>N-NIL_28	3	142,390	4,746	System normal, avoid Marulan->Dapto(8) overload on Marulan-Avon(16) trip
Q>N-NIL_DY	34	59,884	147	System normal, limit flows on QNI + Directlink to avoid overload Armidale to Kempsey (965) on trip of Coffs Harbour to Nambucca (9W3), Raleigh and Sawtell not fed from Coffs Harbour
N>>N-NIL_1T	19	1,236	5	System normal, avoid Liddell->Tomago(82) overload
Q>N-NIL_DC	30	566	2	System normal, limit flows on QNI and Directlink to avoid Armidale->Tamworth(86) overload on Armidale-Tamworth(85) trip

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
N>>N-WWSS+WWIG_E	3	190,633	6,354	Outage of Sydney South-Wallerawang(76) + Ingleburn- Wallerawang(77), avoid Marulan->Dapto(8) overload on Marulan-Avon(16) trip
9W2 outage	17	158,422	796	Outage of 9W2 line between Kempsey and Nambucca
Q>N-9W2_01	5	80,430	1,387	Outage of Kempsey-Nambucca(9W2), avoid Armidale-Kempsey(965) overload
Q>N-9W2_C	12	77,993	553	Outage of Kempsey-Nambucca(9W2), avoid Armidale-Kempsey(965) overload on Kurri-Stroud(96F) trip
N>>N-81_1T	68	14,459	18	Outage of Liddell-Newcastle(81), avoid Liddell-Tomago(82) overload
Q>N_X_81_96H_01	41	8,697	18	Outage of Liddell - Newcastle (81) and Coffs Harbour - Koolkhan (96H) lines, limit flows on QNI and Directlink to avoid overloading Armidale to Kempsey (965) line
Q>N-9W2_A	18	1,604	7	Outage of Kempsey-Nambucca(9W2), avoid Armidale-Kempsey(965) overload on Kurri-Stroud(96F) trip
N>>N-81_1T	29	1,595	5	Outage of Liddell-Newcastle(81), avoid Liddell-Tomago(82) overload
N>>N-LDTM_15	15	1,451	8	Outage of Liddell-Tomago(82), avoid Liddell-Newcastle(81) overload on Bayswater-Regentville(32) trip
Q>N-9W2_E	2	699	25	Outage of Kempsey-Nambucca(9W2), avoid Armidale-Kempsey(965) overload on Kurri-Stroud(96F) trip
N::N_LDNC_1	7	322	4	Outage of Liddell-Newcastle(81), transient stability limit (Qld to NSW) for loss of Liddell-Tomago (82) line

H5. SNOWY TO NEW SOUTH WALES INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
64 line out of service Northwards flow	87	476,524	459.079	System normal, 64 line out of service. Constraints in CSC/CSP trial.
H>>H-64_B	86	464,912	453	System normal, 64 line out of service, avoid Murray->LowerTumut(66) overload on MSS-UT(65) trip
N>>N-NIL_28	3	142,390	4,746	System normal, avoid Marulan-Dapto(8) overload on Marulan-Avon(16) trip
H>N-NIL_C_15M	2	48,536	2,555	System normal, avoid overloading Lower Tumut to Yass (03) 330kV line on loss of Canberra to Lower Tumut (07) 330kV line
H>>H-NIL_A	10	11,841	99	System normal, avoid overload of Murray to Upper Tumut (65) 330kV line on loss of Murray to Lower Tumut (66) 330kV line
H>>H-64_A	0.1	11,343	11,343	Outage of Lower Tumut to Upper Tumut (64) 330kV line, avoid overloading Murray to Upper Tumut (65) on loss of Murray to Lower Tumut (66)
N>>N-NIL_1T	19	1,236	5	System normal, avoid Liddell-Tomago(82) overload

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
N>>N-WWSS+WWIG_E	3	190,633	6,354	Outage of Sydney South- Wallerawang (76) + Ingleburn- Wallerawang (77), avoid Marulan-Dapto(8) overload on Marulan-Avon(16) trip
N>>N-81_1T	29	1,595	5	Outage of Liddell-Newcastle(81), avoid Liddell-Tomago(82) overload
N>>N-LDTM_15	15	1,451	8	Outage of Liddell-Tomago(82), avoid Liddell->Newcastle(81) overload on Bayswater-Regentville(32) trip
H>>N-LTMS_1	1	983	82	Outage of LT-MS(66), avoid Wodonga->Jindera(060) overload on MS-UT(65) trip

H6. NEW SOUTH WALES TO SNOWY INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
64 line out of service, northward flow with re-orientation of Murray to Dederang node.	20	200,232	838	System normal, 64 line out of service (normal status). Murray node re-oriented to Dederang. Constraints in CSC/CSP trial.
H>>H-64_DX	18	187,553	868	System normal, 64 line out of service (normal status). avoid LT->MS(66) overload on MS-UT(65) trip. Murray node re-oriented to Dederang.
64 line out of service Southern flows	53	49,411	78	System normal, 64 line out of service (normal status). Constraints in CSC/CSP trial.
H>>H-64_D	7	15,726	202	Outage of Lower Tumut to Upper Tumut (64) 330kV line, avoid overloading Lower Tumut to Murray (66) on loss of Murray to Upper Tumut (65)
H>>H-64_J	26	14,645	47	Outage of Lower Tumut to Upper Tumut (64) 330kV line, avoid overloading Lower Tumut to Murray (66) on loss of Murray to Upper Tumut (65)
H>>H-64_C	18	9,185	43	Outage of LowerTumut-UpperTumut(64), avoid UpperTumut->Murray(65) overload on LowerTumut-Murray(66) trip
H>>H-64_4X	0.2	8,820	4,410	Outage of LT-UT(64), avoid LT->MS(66) overload on MS-UT(65) trip. Murray re-oriented to Dederang.
H>>H-64_4	0.1	8,522	8,522	Outage of LT-UT(64), avoid LT->MS(66) overload on MS-UT(65) trip. 30_min ratings
H>>H-64_CX	2	3,006	158	Outage of LT-UT(64), avoid UT->MS(65) overload on MS-LT(66) trip. Murray re-oriented to Dederang.
H>>H-64_3X	0.2	854	427	Outage of LT-UT(64), avoid UT->MS(65) overload on MS-LT(66) trip. Murray re-oriented to Dederang.
H>>H-64_3	0.1	749	749	Outage of LT-UT(64), avoid UT->MS(65) overload on MS-LT(66) trip.

Constraints modelling transmission outages - Nil.

H7. VICTORIA TO SNOWY INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
Discretionary constraints, Southern flow	27	385,440	1,201	Discretionary constraints used to manage negative settlement residues
VH_0050	4	182,002	3,792	Discretionary constraints used to manage negative settlement residues
VH_0000	4	132,665	2,653	Discretionary constraints used to manage negative settlement residues
VH_0100	4	39,251	818	Discretionary constraints used to manage negative settlement residues
H>>H-64_D	7	15,726	202	System normal, 64 line out of service (normal status). Avoid LT->MS(66) overload on MS-UT(65) trip
H>>H-64_4	0	8,522	8,522	System normal, 64 line out of service (normal status). Avoid LT->MS(66) overload on MS-UT(65) trip
VH_0200	2	6,611	315	Discretionary constraints used to manage negative settlement residues
VH_0150	2	5,322	197	Discretionary constraints used to manage negative settlement residues
VH_0400	1	4,780	435	Discretionary constraints used to manage negative settlement residues
VH_0500	3	4,229	103	Discretionary constraints used to manage negative settlement residues
V>>H_NIL_2_R	80	4,198	4	System normal, limit Vic interconnectors and Vic generation to avoid overloading the South Morang 500/330kV (F2) transformer
VH_0300	2	3,560	198	Discretionary constraints used to manage negative settlement residues
VH_0650	0	2,874	1,437	Discretionary constraints used to manage negative settlement residues

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
VH>V1KTTX	13	2,752	18	Outage of Keilor 500/220kV transformer, limit Vic to Snowy and Vic to SA on Murraylink to avoid overloading the South Morang 500/330kV (F2) transformer

H8. SNOWY TO VICTORIA INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
H>>H-64_B	86	464,912	453	System normal, 64 line out of service (normal status). Avoid Murray->LowerTumut(66) overload on M-UT(65) trip
HV_0900	14	38,540	227	Discretionary constraints used to manage flows through Snowy
HV_1100	2	33,438	1,592	Discretionary constraints used to manage flows through Snowy
H^V_NIL1	21	13,741	55	System normal, limit Snowy to Vic to avoid voltage collapse for loss of the largest Vic generating unit
H>>H-NIL_A	10	11,841	99	System normal, avoid overload of Murray to Upper Tumut (65) 330kV line on loss of Murray to Lower Tumut (66) 330kV line
H^^V_LTMS	1	7,009	501	Outage of Lower Tumut to Murray 330kV line, limit Snowy to Vic to avoid voltage deviation at Darlington Point for trip of Lower Tumut to Wagga (051) 330kV line or Upper Tumut to Murray 330kV line
H^V_LTUT	61	6,465	9	Outage of Lower Tumut to Upper Tumut 330kV line, limit Snowy to Vic to avoid voltage collapse for trip of the largest Vic generating unit
HV_V2DDMS	11	2,971	22	Outage of Dederang to Murray 330kV line, limit Snowy to Vic to avoid voltage collapse for trip of a Dederang to Murray 330kV line

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
N>N-994_A	18	1,961,676	8,999	Outage of Wagga-Yanco(994), avoid Wagga->Yanco(99F) overload on Wagga-DarlingtonPt(63) trip

H9. VICTORIA TO SOUTH AUSTRALIA (HEYWOOD) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
VS_460	1,008	221,731	18	Upper limit on Heywood
V>>S-NIL_SETB_MGBL	7	52,000	658	System normal. Prevent Mt Gambier - Blanche overload for South East - Tailem Bend trip
V::S_NIL	391	40,579	9	System normal. South Australian import Stability limit.
V>>S_NIL	35	10,662	25	System normal; thermal transfer limit
V::H_NILQF_BL_R	33	994	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 Sth Morang 500kV line, radial mode at Hazelwood
V::H_NILQC_R	18	947	4	System normal, 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 500 kV line

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
V>S_SETB	83	38,229	38	Outage of one South East to Tailem Bend 275kV line, avoid overload of Blanche to Snuggery, Blanche to Mt Gambier or Keith to Tailem Bend (No.1 or 2) lines on trip for loss of the remaining South East to Tailem Bend line)
VS_250	84	29,046	29	Upper limit on Heywood of 250 MW
V>>S_BNSG	34	9,701	24	Outage of Blanche-Snuggery 132kV line; Avoid overload of Kinc-Keith on trip SE-TB
V>S_PATB	37	3,171	7	Outage of 275kV Para-Tailem Bend, Vic-SA Limit to avoid 132kV line overload
V:HHWROB_C	13	1,761	12	Outage of Hazelwood to Rowville No.4 500kV line, limit Vic to Snowy to avoid transient instability
V:HHWROC_C	9	1,397	13	Outage of Hazelwood to Rowville No.4 500kV line, limit Vic to Snowy to avoid transient instability
VS_170	10	1,068	9	Upper limit on Heywood of 170 MW
S>V_PATB	2	919	40	Outage of Para-Tailem Bend, Avoid overload 132kv line
V>S_LEPP	2	857	45	Outage of 275kV LeFevre-Pelican Point limit Vic to SA to avoid 132kV line overload
VS_180	10	570	5	Upper limit on Heywood of 180 MW

H10. SOUTH AUSTRALIA TO VICTORIA (HEYWOOD) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
SV_300	15	202,058	1,142	Upper limit on Heywood of 300 MW
S>>V_NIL	2	33,602	1,600	System normal SA-Vic system normal transfer limit
S>V_NIL	3	9,367	260	System normal, SA-Vic system normal transfer limit

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
SV_250	0	8,281	1,656	Upper limit on Heywood of 250 MW
S>V_PA_VC	2	866	35	Outage of one Para SVC, SA-Vic Thermal overload, transfer limit for loss of the remaining Para SVC

H11. VICTORIA TO SOUTH AUSTRALIA (MURRAYLINK) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
S>>V_NIL_RBTX_RBTX	3	409,269	11,061	System normal limit SA to Vic on Murraylink and Mintaro generation to avoid overloading a Robertstown transformer on trip of the other Robertstown transformer
H>>H-64_DX	18	187,553	868	System normal, 64 line out of service (normal status). Avoid LT->MS(66) overload on MS-UT(65) trip
S>VML_NIL1	27	39,557	124	System normal, limit SA to Vic on Murraylink to avoid overloading North West Bend CB on loss of Monash to North West Bend # 1 132kV line
S>VML_NIL5	7	14,518	184	System normal, limit SA to Vic on Murraylink to avoid overloading a Robertstown 275/132kV transformer on trip of the other Robertstown 275/132kV transformer
H>>H-64_4X	0	8,820	4,410	System normal, 64 line out of service (normal status). Avoid LT->MS(66) overload on MS-UT(65) trip
H>>H-64_CX	2	3,006	158	System normal, 64 line out of service (normal status). Avoid UT->MS(65) overload on MS-LT(66) trip

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
Robertstown outage	10	1,750,973	14,352	Outages of Robertstown transformer
S>VML_RBTX_RB_WTMW4	6	1,561,067	22,624	Outage of One Robertstown Transformer, SA-V Murraylink limit to prevent overloading Waterloo_MWP4 132kV Line for loss of the other Robertstown transformer.
S>>V_RBTX_RBTX_PARS	4	189,905	3,583	Outage of One Robertstown Transfrmer, SA-V Murraylink and SA genrator limit to prevent overloading Para_Roseworthy 132kV Line for loss of the other Robertstown transformer.

H12. SOUTH AUSTRALIA TO VICTORIA (MURRAYLINK) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
H>>H-64_B	56	155,402	232	System normal, 64 line out of service (normal status). Avoid Murray->LowerTumut(66) overload on M-UT(65) trip
V^SML_NIL2	16	30,935	159	System normal, limit Vic to SA on Murraylink to avoid voltage collapse for loss of Darlington Pt to Buronga (X5) 220kV line, without any NSW runback scheme
VSML_220	18	7,219	34	Vic to SA upper limit on Murraylink
V>>H_NIL_2_R	80	4,198	4	System normal, limit Vic interconnectors and Vic generation to avoid pre-contingent overloading the South Morang 500/330kV (F2) transformer, radial mode at Hazelwood
V>SML_NIL7	5	3,333	58	System normal, limit Vic to SA on Murraylink to avoid overloading Ballarat North to Ararat 66 kV line for loss of Ballarat to Horsham 220 kV line

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
N>N-994_A	18	1,961,676	8,999	Outage of Wagga-Yanco(994), avoid Wagga->Yanco(99F) overload on Wagga-DarlingtonPt(63) trip; Fb
V^SML_X5TR	154	132,832	72	Outage of X5 trip scheme, limit Murraylink flow avoid bad V on 63 trip
VSML_000	336	45,914	11	zero limit on Murraylink Victoria to South Australia
V^SML_NSWRB_2	14	26,915	157	Outage of NSW Murraylink runback scheme, limit Vic to SA on Murraylink to avoid voltage collapse for loss of Darlington Pt to Buronga (X5) 220kV line
V>SML_VFRB_7	21	21,938	87	Outage of Murraylink VF runback scheme, limit Vic to SA on Murraylink to avoid overload on the Ballarat North to Ararat 66kV line for loss of the Ballarat to Horsham 220kV line
V>SMLBESH3	1	5,976	996	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
V>SMLBAHO1	31	4,409	12	Outage of Ballarat to Horsham or Bendigo to Kerang line, limit Murraylink from Vic to SA to avoid overload Buronga to Balranald to Darlington Point (X5) line

H13. QUEENSLAND INTRA-REGIONAL CONSTRAINTS

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	DESCRIPTION
Q_CS_1900	83	Qld Central to Qld South upper transfer limit of 1900 MW
871 line	30	System normal. Limits transfers across line 871 between Curvale and Wurdong for the trip of line 855 Stanwell and Calvale.
Q>PRE855_871CAL	17	SystemNormal MVA Max precontingent Transfer on Fdr 871for fdr 855 contingency, Cal PS calculated max.
Q>PRE855_871GL_ST	13	SystemNormal MVA Max precontingent Transfer on Fdr 871for fdr 855 contingency, Glad PS and Stn PS summated calculated min.
Q:NIL_CN1	8	Outage of Nil, Central Qld to North Qld transient stability limit for loss of either Nebo to Strathmore (822 or 840) 275kV line.
Q^NIL_1CS	5	Outage of Nil , CQ-SQ Transfer SystemNormal<=voltage stabilitycalc(1277.2+f(units on;MW,kV)- 50CalcMarg),calc below 1750, 1900 washout applied ; Gladstone Qmargin
CHI_QKAH	1	CHIMERA, Kareeya Power Station
Q>PRE855_871CAL	0.4	System Normal. Transfer on Fdr 871 for fdr 855 contingency
CHI_Q_TRNG	0.3	CHIMERA - Tarong Limit
Q>TVAS7276_77_POST	0.3	System normal, overload Townsville PS - Alan Sherriff 132kV line 7276 or Towns.PS -Alan Sh.132kV line 7277.

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	DESCRIPTION
Q_CS_1700	63	Qld Central to Qld South upper transfer limit of 1700MW (discretionary)
Q_GLD34_500	41	Gladstone 3 + 4 Units Generation >= 500
Q_KMBG_7184	33	out of 7184 Kamerunga Barron Gorge PS 132kV line
Q_MSPTS_7242	24	Outage of 7242 Mt Stuart Power Station Townsville South 132kV line
Q_CS_1200	24	Qld Central to Qld South upper transfer limit of 1200MW (discretionary)
Q_KMBG_7143	8	Outage of 7143 Kamerunga Barron Gorge PS 132kV line
Q<QBCG_01	5	Outage of Clermont to Lilyvale (7153) line, Barcaldine PS islanded
Q_SWE_8829	4	Outage of Swanbank E to Swanbank E PS 275kV Line 8829
Q_CS_1500	4	Qld Central to Qld South upper transfer limit of 1500MW (discretionary)
Q>TVAS7276_7277	3	Outage of Townsville PS -Alan Sherriff 1 32kV line 7276 or Towns.PS -Alan Sh.1 32kV line 7277. Thermal limit for remaining inservice parallel line
Q_CV_CB4212	3	Outage of Collinsville 132kV CB4212
Q_CS_1150	2	Qld Central to Qld South upper transfer limit of 1150MW (discretionary)
Q:NE_CP_120MVAR	1	Outage of H11 Nebo 120MVAR capacitor
Q:NE_SVC	1	Outage of Nebo SVC, Central Qld to North Qld transient stability limit
Q_CS_1400	0.4	Qld Central to Qld South upper transfer limit of 1400MW (discretionary)
Q_CS_1600	0.4	Qld Central to Qld South upper transfer limit of 1600MW (discretionary
Q_CS_1050	0.3	Qld Central to Qld South upper transfer limit of 1050MW (discretionary)

CONSTRAINT ID	HOURS	DESCRIPTION
Q_CS_1300	0.3	Qld Central to Qld South upper transfer limit of 1300MW (discretionary)
Q>GLBC_811-812	0.2	Outage of 275kV Gladstone -Bouldercombe Feeder 811or 812
Q_CNRM_7174	0.2	Outage of 7174 Chinchilla Roma 132kV line
Q_CS_1000	0.1	Qld Central to Qld South upper transfer limit of 1000MW (discretionary)

H14. NEW SOUTH WALES INTRA-REGIONAL CONSTRAINTS

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	DESCRIPTION
N>N-NIL_1C	2	System normal, load on 93 on trip of 25
N>N-NIL_1N	2	System normal, avoid Liddell->Tomago(82) overload on Liddell-Newcastle(81) trip
N>N-NIL_1A	1	System normal, avoid 33 overload on 34 trip (or converse)
N>N-NIL_01	0.4	System normal, load on 9 on trip of 18
N>N-NIL_1E	0.3	System normal, load on 81 on trip of 82
N>N-NIL_03	0.2	System normal, load on 9 on trip of 6

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	DESCRIPTION
Outage of 81 lines	13	
N>N+LDNC_07	7	Outage of Liddell-Newcastle(81), avoid Eraring->Newcastle(93) overload(15min rating) on Liddell-Tomago(82) trip
N_X_6_18	7	Bendeela and Kangaroo Valley PS upper limit set to zero due to multiple outage of Canberra to Kang
N>N-81__02	2	Outage of Liddell-Newcastle(81); avoid Liddell->Tomago(82) overload on Eraring-Newcastle(93) trip
N>N-76+77A	2	Outage of Wallerawang-SydneySth(76)+Ingleburn(77),Load 35 on trip 36
N>N-82__15	2	Outage of Liddell-Tomago(82), avoid Liddell->Newcastle(81) overload on 32 trip
N>N-76__17	1	Outage of Sydney South- Wallerawang (76), avoid Marulan->Dapto(8) overload on Avon-Marulan(16) trip

N>N+81__07	1	Outage of 81,avoid overloading 93 on trip of 82
N>N-81__07	1	Outage of Liddell-Newcastle(81); avoid Eraring->Newcastle(93) overload on Liddell-Tomago(82) trip
N:N_LDNC_1	1	Outage of Liddell-Newcastle(81), avoid instability on Liddell-Tomago(82) fault
N>N-76+77E	1	Outage of Wallerawang-Sydney Sth(76)+Ingleburn(77), Load 8 on trip 16
N>N-76+777	0.3	Outage of Wallerawang-Sydney Sth(76)+Ingleburn(77), Load 94E on trip 71.
N>N-76__02	0.3	Outage of 76 , loading of 81 on trip of 82
N>N-81__27	0.2	Outage of 81 , loading of 82 on trip of NIL
N>N-77__17	0.2	Outage of Ingleburn-Wwang(77), avoid Marulan->Dapto(8) overload on Avon-Marulan(16) trip

H15. SNOWY INTRA-REGIONAL CONSTRAINTS

Constraints modelling nominal transmission conditions

Nil.

Constraints modelling transmission outages

Nil.

H16. VICTORIA INTRA-REGIONAL CONSTRAINTS

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	DESCRIPTION
V>V_NIL_4	91	System normal, limit Hazelwood units 3,4,5 to avoid overload on Hazelwood 500/220kV No.1 transformer, Hazelwood in radial mode.
Hazelwood transformers	14	Hazelwood transformer constraint. Yallourn unit 1 switched to either 220 kV or 500 kV network. Affects generation at Morwell, Bairnsdale, Hazelwood, Jeeralang A and B and Yallourn unit 1. Aggregation of constraint V>V1NIL and V>V2NIL.
V>V1NIL	14	System normal, limit Yallourn unit 1+Hazelwood units 1,2,6,7,8+Jeeralang+ Bairnsdale+Morwell to avoid overload on Hazelwood 500/220kV No.2,3,4 transformers for loss of one transformer, Yallourn unit 1 in 500kV mode, Hazelwood in radial mode.
V>YW_1400	0.4	Discretionary Yallourn W generation limit 1400MW
V>YW_1350	0.3	Discretionary Yallourn W generation limit 1350MW
V>V2NIL	0.3	System normal, limit Hazelwood units 1,2,6,7,8, Jeeralang, Bairnsdale, Morwell generation to avoid overload on Hazelwood 500/220kV No.2,3,4 transformers for loss of one of these transformers, Yallourn unit 1 in 220kV mode and Hazelwood in radial mode.

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	DESCRIPTION
V_LY_BUS4	20	Loy Yang B upper limit set to zero due to outage of Loy Yang No 4 500kV Bus.
V_MB_BUS1	15	Dartmouth PS upper limit set to zero due to outage of Mt Beauty No 1 220kV Bus
V_APPT	5	Anglesea PS upper limit set to zero due to outage of Anglesea PS to Port Henry 220kV line.
V>V_HWSM_YW500_R	2	Outage of Hazelwood to South Morang 500kV line, limit Latrobe Valley generation except Yallourn units 2,3,4 to avoid overloading the remaining Hazelwood to South Morang 500kV line for trip of the Hazelwood to Rowville No.4 500kV line, Radial

H17. SOUTH AUSTRALIA INTRA-REGIONAL CONSTRAINTS

Constraints modelling nominal transmission conditions

Nil.

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	DESCRIPTION
Network outages affecting Pelican Point	139	Outages affecting Pelican Point around Le Fevre.
S_PPT200	113	Pelican Point <=200, Outage of PGW-CB6579 or Pel .Pt-Lefev Line or other plant
S_PPT160	21	Pelican Point <=160,Outage of TIPS-LefevLn (Lefevre supplied from Pel Pt)
S-SG_0	8	Snuggery 132 kV Turbine Bus out of service.
S_PPT180	5	Pelican Point <=180,Outage of TIPS-LefevLn
S_PLN_ISL1	4	Outage of Whyalla to Yadnarie line, Port Lincoln PS islanded
S_NPS_490	2	Discretionary upper limit for Northern generation of 490 MW
S_NPS_450	1	Discretionary upper limit for Northern generation of 450 MW
S>SN_CB6028	0.3	Outage of Snuggery CB6028, prevent overload of #4 132/33 kV transformer for trip of Snuggery T1 or T3 transformer.
S>DVPA_BRPA	0.3	Outage of Davenport to Para, Limit NPS, Playf, Hallet, Mintaro and Pt Linc generation to avoid Brinkworth-Para line overload on Davenport - Robertstown line trip
@TIPB>250	0.3	Torrens Island B discretionary constraint greater than 250 MW
S_PWLG_LG1	0.2	Outage of Penola West to Ladbroke Grove 132 kV circuit
S>S_SNTX3A	0.1	Outage of Snuggery #3 132/33 kV transformer, prevent overload of #4 132/33 kV transformer for trip of Snuggery-Blanche line

H18. TASMANIA INTRA-REGIONAL CONSTRAINTS

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	DESCRIPTION
T>T_NIL_BL_IMP_7C	65	System normal, Basslink not exporting, Hampshire link open, limit Tas gen to avoid post-contingent overloading of a Farrell to Sheffield 220kV line for trip of the other Farrell to Sheffield line with no SPS action
T:T_NIL_1	41	System normal, Basslink importing only, avoid transient instability for fault and trip of a Farrell to Sheffield line)
T>T_NIL_BL_110_19	19	System normal, Basslink in service, avoid overload the Waddamana to Lake Echo Tee No.1 line (flow to North) for loss of the Tungatinah to Lake Echo Tee to Waddamana No.2 line radialising Bridgewater to Waddamana line from Bridgewater
T>T_NIL_BL_110_18B	9	System normal, Basslink in service, avoid overloading the Tungatinah to Lake Echo Tee No.2 110kV line (flow to North) for loss of the Tungatinah to Lake Echo Tee to Waddamana No.1 110kV line with Waddamana bus split

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	DESCRIPTION
T>T_BWWA_110_6	77	Outage of Bridgewater to Waddamana 110kV line, avoid overload the Tarraleah to New Norfolk No.2 line for loss of the Meadowbank to New Norfolk line
T_T_FASH2_MOD_1	36	Outage of Farrell to Sheffield No.2 line, Farrell 220kV bus split JButters supplying transformers other generators supplying the 220kV line to Sheffield, Hampshire link closed, limit John Butters + Mackintosh <= 110% of West Coast load
T_T_X_FASH_A	32	Outage of both Farrell to Sheffield lines, limit West Coast gen <= 110% of West Coast load
T>T_PMSH_220_1	23	Outage of Palmerston to Sheffield 220kV line, avoid O/L Georgetown to Sheffield No.1 line for loss of a Georgetown to Sheffield No.2 line
T>T_TAMB_110_1	15	Outage of Tarraleah - Meadowbank line 110kV line: To maximise capacity with opening up the two circuits between TU and TA
T>T_X_MBNN_TATU1-2_1	13	Outage of Meadowbank to New Norfolk with both Tarraleah to Tungatinah 110kV lines opened, avoid overload either Waddamana to Lake Echo Tee 110kV lines for loss of one of the two parallel circuits

Constraints modelling transmission outages (cont)

CONSTRAINT ID	HOURS	DESCRIPTION
T>T_BWWA_110_7	13	Outage of Bridgewater to Waddamana 110kV line, avoid overload a Tungatinah to Tarraleah line for loss of the other Tungatinah to Tarraleah line
T>T_GTSH_220_1	12	Outage of Georgetown to Sheffield 220kV line, avoid overload the Sheffield to Palmerston line for loss of the other Georgetown to Sheffield line
T>T_X_MBNN_TATU1-2_2	11	Outage of Meadowbank to New Norfolk with both Tarraleah to Tungatinah 110kV lines opened, avoid overload either Tarraleah to New Norfolk 110kV lines for loss of one of the two parallel circuits
T>T_X_CSNN_BWWA	11	Outage of Chapel St to New Norfolk line and Bridgewater to Waddamana line, avoid O/L New Norfolk to Creek Rd line for loss of Waddamana to Lake Echo Tee #1 line with Waddamana bus split ofloading Waddamana to Lake Echo Tee # 2 line
T>T_CRRI+RI_SPLIT_7	10	Outage of Creek Road to Risdon 110kV line with Risdon Bus Split, avoid O/L the Waddamana to Lake Echo No.1 line for loss of the Tungatinah to Lake Echo Tee to Waddamana No.2 line
T_T_FASH1_B_1	9	Outage of Farrell to Sheffield No.2 line, Farrell 220kV bus split JButters supplying transformers other generators supplying the 220kV line to Sheffield, Hampshire link closed, limit John Butters + Mackintosh <= 110% of West Coast load
T>T_CS_TX4	8	Outage of Chapel St No.4 220/110kV transformer, avoid overloading a Chapel St 220/110kV transformer for loss of a parallel transformer.
T_T_FASH1_A_1	7	Outage of Farrell to Sheffield No.1 line with Bastyan + John Butters + Reece 2 supplying Sheffield, Hampshire link closed, limit Reece 1 + Tribute + Mackintosh <= 110% of West Coast load
T_FARC1	6	Outage of Farrell-Reece 1 220kV line
T_FARC2	6	Outage of Farrell-Reece 2 220kV line
T>T_CRRI+RI_SPLIT_9	6	Outage of Creek Road to Risdon 110kV line with Risdon Bus Split, avoid O/L Tungatinah to Lake Echo Tee No.1 line for loss of Tungatinah to Lake Echo Tee to Waddamana No.2 line

H19. Constraints used for Grid Support

CONSTRAINT ID	HOURS	DESCRIPTION
@Q-CVL>=NSA	604	Powerlink Network Support Agreement
@Q_CN_QCVL_NSA	381	Powerlink Network Support Agreement
Q:CN1QMSP1	225	Powerlink Network Support Agreement
Q_CN_QCVL_120	117	Powerlink Network Support Agreement
Q_CN_QCVL_090	63	Powerlink Network Support Agreement
Q:CN1QMSP2	33	Powerlink Network Support Agreement
Q_CN_QCVL_160	31	Powerlink Network Support Agreement
@Q-CVL>=172	31	Powerlink Network Support Agreement
Q_CN_QCVL_110	21	Powerlink Network Support Agreement
S_POR01_10	20	Electranet Network Support Agreement
Q_CN_QCVL_170	20	Powerlink Network Support Agreement
Q_CN_QCVL_180	20	Powerlink Network Support Agreement
Q_CN_QCVL_130	19	Powerlink Network Support Agreement
Q_CN_QCVL_100	17	Powerlink Network Support Agreement
T_GO_MIN_170	11	Transend Network Support Agreement

H20. Constraints used during power system security directions

CONSTRAINT ID	HOURS	DESCRIPTION
#MSTUART1_E	1	#MSTUART1_E
@DL>=25	3	@DL>=25
#T-V-MNSP1_I	59	#T-V-MNSP1_I