AUSTRALIAN ENERGY REGULATOR

Indicators of the market impact of transmission congestion

Report for 2004–05

10 October 2006

Contents

Summary

On 13 June 2006 the Australian Energy Regulator released its decision to publish indicators of the impacts of transmission networks on the rest of the electricity market.[1] In this decision the AER 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 second annual report in response to that decision. As a second stage in early 2007, following the completion of all three reports, 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; and
- provide 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.

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

This report, for the period 2004–05, includes:

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

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 a major impact during 2004–05 and explains the circumstances that led to this impact.

On May 29, 2005 Tasmania joined the National Electricity Market. The report includes the impacts of congestion within Tasmania during the final month of the 2004-2005 financial year.

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, what reduction would result in the total cost of generating sufficient electricity to meet demand?

During 2004–05 the TCC was $45 million with around 70 per cent of this accumulated on just seven days.

Table 1 identifies for those seven days the location of the network congestion as identified by the MCC. Around $5 million of the TCC is attributable to the management by NEMMCO of negative settlement residues across the Victoria to Snowy interconnector. The causes of the negative settlements that led NEMMCO to intervene are explained in Appendix G.

Table 1—High TCC events

Date	Locations	TCC
13/10/2004	Queensland to New South Wales (Armidale SVC outage); Victoria to Snowy (outage); Western Sydney transmission ring New South Wales (system normal); South Australia to Victoria (Heywood and MurrayLink outages)	$7.9m
18/11/2004	Victoria to Snowy (negative residue management); Queensland to New South Wales (Armidale transformer outage)	$1.4m
30/11/2004	Victoria to Snowy (negative residue management); Queensland to New South Wales (System normal)	$7.5m
1/12/2004	Victoria to Snowy (negative residue management); Queensland to New South Wales (System normal);	$7.1m
9/12/2004	New South Wales (outage Sydney West to Regentville)	$1.9m
14/1/2005	Victoria to Snowy (negative residue management); Loss of Queensland to New South Wales interconnector	$4.2m
8/2/2005	Western Sydney transmission ring New South Wales (system normal); Victoria to Snowy (negative settlement management)	$1.1m

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?'

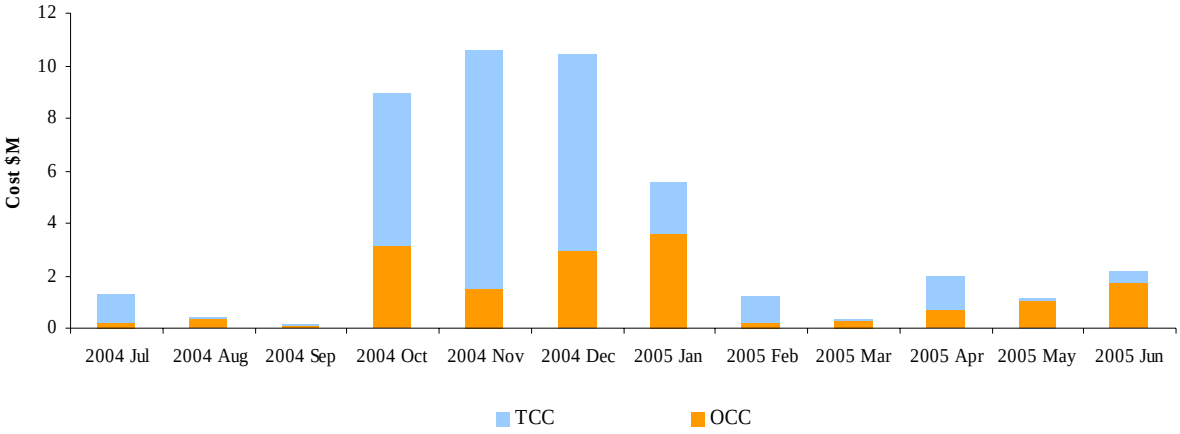
That is, the OCC is calculated by comparing the dispatch cost of the existing network (including network outages) with the network in its 'system normal' state.

The OCC, like the TCC 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 own costs.

The OCC for the period 2004–05 was $16 million or one third of the TCC for the period.

Figure 1 shows the monthly breakdown of the TCC with the proportion of the TCC attributed to the OCC overlayed. The six highest days, which accounted for two thirds of the annual total occurred 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 there were:

- 15 network locations that significantly affected interconnectors (compared to 5 in the previous year). All interconnectors were impacted; and
- 9 network locations that significantly affected market outcomes within regions. All regions were affected apart from South Australia.

Qualitative assessment

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

Inter-regional congestion occurred at significant levels between all regions during 2004-05. Flows into South Australia were constrained for 1900 hours or for more than a fifth of the time. The average marginal value of congestion was, however, relatively low. Around half of this congestion reflected the inherent limitations of the network and did not result from network outages. The other half occurred during the period 14 March to 1 June 2005. On 14 March, Northern Power Station (NPS) units 1 and 2 simultaneously tripped, resulting in an overload on the Victoria to South Australia Heywood interconnector which subsequently tripped. This caused interruptions to around half of the load in South Australia through automatic under frequency load shedding. As a result, the simultaneous loss of both units was reclassified as a credible contingency event by NEMMCO. This was reflected to the Victoria to South Australia interconnector and resulted in a lower import capability

into South Australia, affecting market outcomes for 918 hours. The reclassification was removed on 1 June.

The Snowy to New South Wales interconnector was constrained for around 40 hours. Flows at these times were typically close to the 3000 MW nominal limit. The marginal value of congestion was, on average, relatively high. 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 occurred for around 300 hours, similar to the previous year, with most of this congestion resulting from the inherent design of the network.

Significant market impacts were seen on the Victoria to Snowy interconnector primarily as a result of intervention by NEMMCO to manage the accumulation of negative settlement residues caused by counter-priced flows. NEMMCO intervened with discretionary constraints for 49 hours during the year - 34 hours to manage the accumulation of negative settlement residues[2]. A number of Rule changes have since been considered by the AEMC to address these counter-priced flows including: the Constraint Support Contracts and Constraint Support Pricing (CSC/CSP) trial that commenced in October 2005; a Rule change in September 2006 which alters the distribution of settlement residues between the two Snowy interconnectors; and a change to the funding of negative residues.

Network outages had significant impacts on the availability of Murraylink during the year. These outages included planned and unplanned outages of the interconnector itself. At times outages in south west New South Wales reduced the capability of flows into South Australia to zero.

The greatest intra-regional congestion occurred in Queensland, where the duration of congestion increased from around 50 hours the previous year to 339 hours. Constraints reflecting the inherent limitations of the network led to congestion in central Queensland and between central Queensland and the southern load centre for 230 hours. Network outages affected the dispatch of plant in far north Queensland and around Boyne Island in central Queensland for 109 hours in total.

Network outages affected market outcomes in New South Wales for around 108 hours during the year. Outages of the 81 line between Liddell and Newcastle and the 38 line between Regentville and Sydney West were the main contributors. This compared to around 39 hours the previous year. System normal limitations affected dispatch for around 40 hours. There were no significant system normal limitations during the previous financial year.

The Hazelwood transformers in the Latrobe Valley in Victoria led to intra-regional congestion for 101 hours, compared to 163 hours the previous year.

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[2] This is comparable in duration to the intervention by NEMMCO the previous year to manage loadings within the Snowy region associated with the physical limitations of the network.

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.

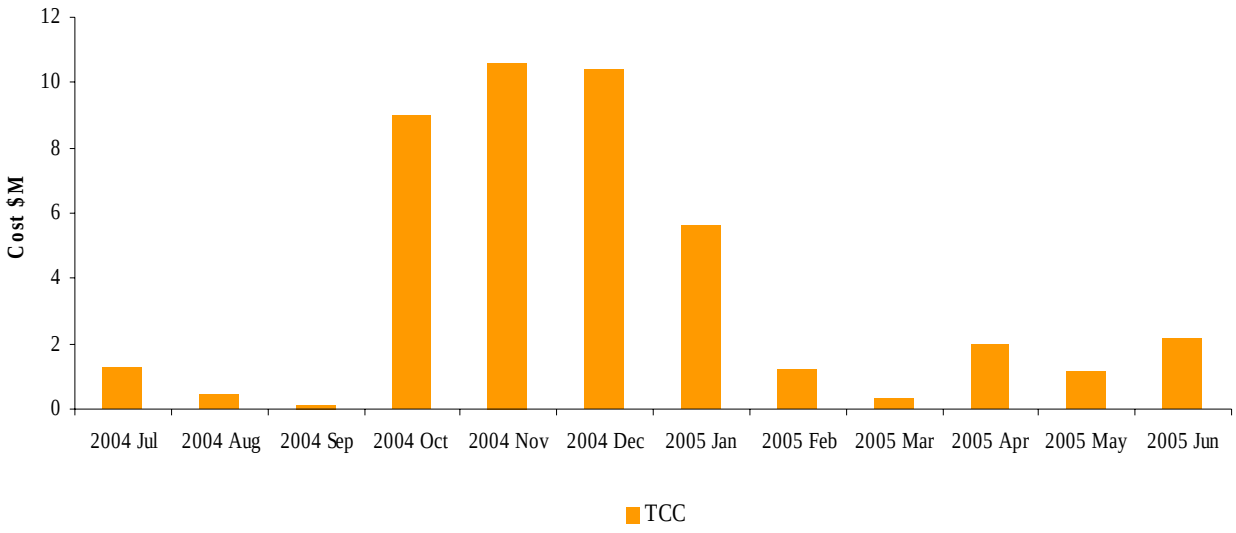
The TCC values the cost of generating electricity at the prices at which each generator offers its output to the market. Generators constrained by grid support arrangements do not have an incentive to offer their output at a price which reflects their costs. To prevent distortions to the TCC, if it could be identified that a generator was operating under a grid support agreement, the impact of that generator was removed from the TCC.

A detailed description of how the TCC is calculated is in the AER's decision, Indicators of the Market Impact of Transmission Congestion[3].

1.1 TCC results

The TCC for 2004–05 was $45m. Figure 2 shows the TCC for each month. Around 70 per cent of the total amount accumulated on just seven days of the year, (over the period October to February). Table 2 describes the circumstances for those seven 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
Wednesday 13/10/04	$7.9 million	***Record high October temperatures and extreme demands*** The temperature at Sydney's Observation Hill reached 38.2°C, its highest October level since recordings began in 1858. Demand marginally exceeded the MTPASA 10% probability of exceedance demand. Prices on this day reached $5000/MWh and stayed at this price for two and a half hours. Out of merit order dispatch occurred in New South Wales as a result of system normal limitations on the Western Sydney transmission ring constraining off around 400 MW at Mt Piper. Network limitations as a result of an outage of the Armidale SVC saw a reduced limit on exports between Queensland and New South Wales. Prices in Queensland separated from the extreme prices of New South Wales. NEMMCO applied discretionary constraints from 12.10pm to 3.40pm which reduced the export limit from Victoria to Snowy for a network outage in Victoria. Discretionary constraints were also applied from 1pm to 4.30pm that reduced output from the Southern Hydro generators by around 80MW to 320MW. A planned network outage in Victoria limited transfers across the Victoria to South Australia interconnector for most of the day. As a result, South Australia was insulated from the extreme prices occurring on the eastern seaboard. Following the return of the interconnector at around 3.30pm, exports from South Australia increased to the limit of 300MW.
Thursday 18/11/04	$1.4 million	***High demand in NSW*** Demand in New South Wales peaked at a new November high of just over 11,300MW, with prices reaching close to $1,000/MWh for around 4 hours. Counter price flows were forecast on the Victoria to Snowy interconnector. This saw NEMMCO invoke discretionary constraints, which limited flows to less than 200MW. Flows from Queensland into New South Wales increased from around 450 MW to 900MW following the early return of an Armidale transformer in New South Wales.

Date	TCC	Description
Tuesday 30/11/04	$7.5 million	***Record summer demand in NSW*** Prices in New South Wales were above $1000/MWh from 12.30 pm until 5 pm and peaked at $8455/MWh at 4 pm. Demand peaked at a new summer high of just over 12,800MW at 4pm. NEMMCO declared a lack of reserve level 1 (LOR1) between 10am and 7.30pm and LOR 2 between 3.30pm and 4pm (which means that reserves were less than 660 MW, the size of the largest generator). Prices in Queensland were aligned with New South Wales until 2pm. The Queensland to New South Wales interconnector was, for the most part, constrained between 2pm and 9pm. Network limitations in northern New South Wales saw import capability from Queensland reduced to as little as 650MW between 2.30pm and 4pm. The network limitations were the result of system normal conditions in the northern 132 kV network of New South Wales. Counter priced flows on the Victoria to Snowy interconnector were forecast from around midday. As a result, discretionary constraints were invoked by NEMMCO limiting flows north to less than 200MW. This did not, however, reduce the availability of imports into New South Wales from the southern regions.
Wednesday 1/12/04	$7.1 million	***High summer demand in NSW*** Extreme temperatures, as high as 41^0C in Sydney, led to near record summer demand. Demand was as much as 600MW greater than the 4 hour ahead forecast. Prices reached above $900/MWh between 11 am and 4 pm and peaked at $9909/MWh. At around 10am, following the declaration of an LOR level 1 condition, and without prior notice, NEMMCO revoked the Q>N-NIL_DF constraint. This allowed an increase in QNI's export limit, which improved the reserves in New South Wales. The constraint was returned at around 5pm. Following the trip of Vales Point unit 5 at around 2 pm, an LOR level 3 condition was declared in New South Wales and NEMMCO instructed TransGrid to shed 200 MW of load. Shortly after, a demand side response saw demand reduced by a further 300 MW NEMMCO invoked a discretionary constraint on the Victoria to Snowy interconnector, in order to manage negative settlement residues. This limited flows from Victoria into Snowy to 100MW for much of the afternoon. This did not, however, reduce the availability of imports into NSW.
Thursday 9/12/04	$1.9 million	***Line outages*** Prices for the day peaked at $91/MWh and were aligned across all regions except for Queensland. Prices in Queensland separated by as much as $55/MWh with a reduction in exports across the Queensland to New South Wales interconnector to 600 MW between 3 pm and 4 pm. An outage of the 38 line, between Regentville and Sydney West saw capacity across New South Wales constrained resulting in out of merit order dispatch for around 9 hours. The Liddell units in particular were constrained off almost 500 MW at times, with all of this capacity priced at $-1000/MWh. This had significant impacts on the TCC and OCC. At times, as much as 210 MW of capacity was also directly constrained on in New South Wales.

Date	TCC	Description
Friday 14/1/05	$4.2 million	***High NSW demand, loss of QNI*** Prices in New South Wales reached above $1000/MWh between 2.30 pm and 4.30 pm and peaked at $6277/MWh at 2.30 pm. Prices in Victoria and South Australia were less than $50/MWh and prices in Queensland reached $256/MWh. Demand in New South Wales peaked at more than 12,300MW. Southerly flows on the Queensland to New South Wales interconnector were at close to the limit of around 900MW until 2pm. At 2.05pm the loss of two transmission lines between Braemar and Tarong led to the separation of Queensland from the rest of the market. A single QNI circuit was reconnected from 2.48pm. An attempt to re-close the second circuit led to the loss of both lines at 3.58pm. A further single circuit reconnection was made at 4.21pm. At 7.30am the following morning the second circuit was successfully returned to service. Intra-regional constraints resulted in the out of merit dispatch of as much as 400MW of generation in New South Wales. Victoria and South Australia were separated from the extreme prices in New South Wales with discretionary constraints applied to exports on the Victoria to Snowy interconnector, to manage the accumulation of negative settlements, limiting flows north to as low as 100 MW.
Tuesday 8/2/05	$1.1 million	***High NSW demands, intra-regional congestion*** Demand was up to 450MW higher than the four hour ahead forecast and peaked at more than 12,600MW, which was only 400MW short of the all-time record. In Sydney the maximum temperature for the day reached 37^{o}C, 5^{o}C higher than forecast the previous evening. Intra-regional congestion within New South Wales occurred around the Western Transmission ring from at around 4 pm constraining off as much as 500 MW of capacity at Mount Piper. Flows north across the Victoria to Snowy interconnector were constrained by NEMMCO at between zero and 100 MW to manage the accumulation of negative settlement residues between Victoria and Snowy.

2 Outage cost of constraints

2.1 OCC results

More than one third of the TCC, or $16 million, is attributable to network outages (represented here as the outage cost of constraints or OCC). Figure 3 shows for each month during 2004-05 the summated TCC and the proportion that has been allocated as arising from network outages.

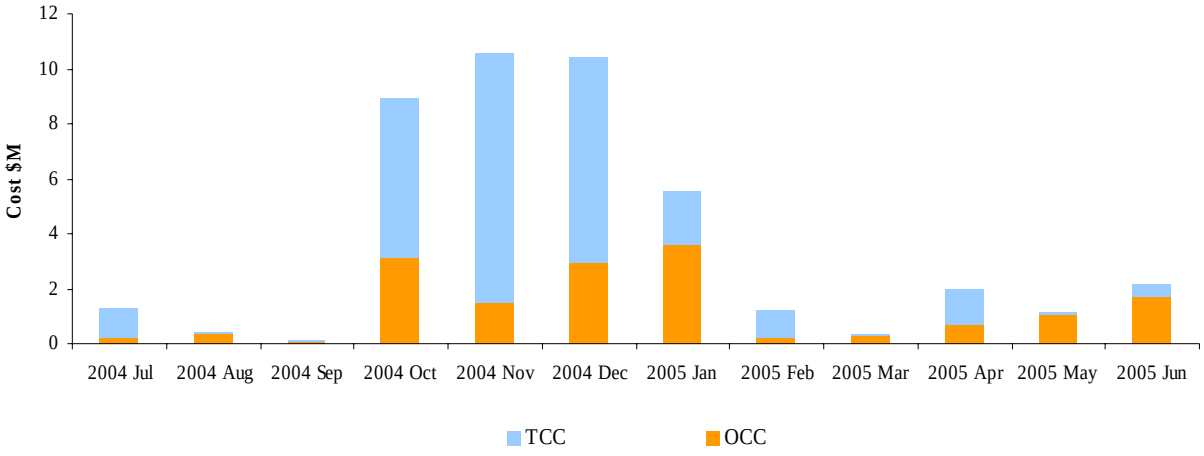
Network outages on 13 October 2004 led to significant levels of network congestion on the Queensland to New South Wales and the Victoria to Snowy interconnectors. An outage of the Armidale Static Var compensator in northern New South Wales restricted exports into New South Wales from Queensland. This outage was planned six days ahead. An outage in northern Victoria led to NEMMCO invoking discretionary constraints to limit imports from Victoria to New South Wales to less

than 650 MW. This outage was planned 5 days ahead. Temperatures on this day at Observation Hill in Sydney reached the highest levels ever recorded during October in Sydney. The combined impact of these two outages saw the OCC reach $3 million on this one day out of a total for the month of $3.1 million.

On 9 and 10 December 2004, an outage of the line between Sydney West and Regentville led to out of merit order dispatch in New South Wales. The OCC on these two days was $2.9 million, accounting for almost all of the OCC for December. Notification through the Network Outage Scheduler (NOS) of the need for the outage occurred 6 days prior.

An unplanned outage of the Queensland to New South Wales interconnector on 14 January 2005 saw the OCC on this day reach $2.5 million. The OCC for the month was $3.6 million. Planned outages around Boyne Island from 18 January to 20 January accounted for around $0.5 million of the remainder. An average of 6 days notice of the need to take this outage was provided.

Figure 3 –TCC and OCC by month



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 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's decision, Indicators of the market impact of transmission congestion[4].

3.1 MCC results

There are around 14 000 network constraints in the market systems. During 2004–05 there were generally between 150 and 250 constraints invoked at any one time. Most, however, do not affect market outcomes and therefore have a zero marginal value. During 2004–05 there were around 700 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 year. 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 15 inter-regional network limits or constraints with a cumulative marginal value over the year of more than $30 000/MWh. 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 ($)	Type—description
V-SN discretionary constraints	49	583 868	Discretionary constraints applied to the Victoria to Snowy interconnector - primarily for the management of negative settlements residues
VS_460	975	468 818	System normal - 460 MW limit on the Victoria to South Australia (Heywood) interconnector.
Q:N_NIL_A; Q:N_NIL_OSC	170	312 176	System normal - Queensland to New South Wales.
H>N-NIL_H_15M; H>N-NIL_C_15M; H>N-64_H_15M;	4	259 255	System normal - Snowy to New South Wales.
H>>H-64_B; H>>H-64_A; H>>H-64_2; H>>H-64_G	34	249 178	System normal – Snowy to New South Wales.
V^SML_X5TR	61	213 573	Outage – MurrayLink. Outage of X5 tripping scheme in NSW. Affects import capability into South Australia.

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

Constraint	Duration (hours)	CMV ($)	Type—description
Q>N-NIL_DF	5	193 613	System normal – Queensland to New South Wales
Q:N_AR_VC_1	4	133 764	Outage – Queensland to New South Wales. Outage of Armidale SVC
SVML_000 VSML_000	302	95 401	Outage – MurrayLink Restrict to zero flow in both directions, typically for outages of the interconnector.
N>Q_AR_TX	26	61 983	Outage – Queensland to New South Wales. Outage of Armidale transformer.
HN_2900 HN_3000	2	51 787	System normal –Snowy to New South Wales.
V:HHWSMC_C; V:HHWSMB_C	103	40 873	Outage –Victorian exports (Victoria to Snowy, Victoria to South Australia on both Heywood and MurrayLink) Outage of either Hazelwood to South Morang line.
VH>V3NIL; VH>V4NIL	93	38 919	System normal –Victorian exports (Victoria to Snowy and MurrayLink)
Q>N-81__1T	88	33 881	Outage – Queensland to New South Wales. Outage of 81 line between Liddell and Newcastle
VS_150	47	31 285	Outage – Victoria to South Australia. For outages during period of reclassification of both Northern power station units.

There were nine intra-regional network limits that bound for more than 10 hours. 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 4—High impact intra-regional constraints

Constraint ID	Duration (hours)	Type—Description
Q>PRE855_871CAL Q>PRE855_871GL_ST	190	System normal—to manage flows on 871 line (in central Queensland). Constrains Gladstone and Stanwell on and Callide B and C off.
V>V1NIL; V>V2NIL	101	System normal—Hazelwood transformer. Limits 2080 MW of Latrobe Valley generation behind the transformer. Yallourn unit 1 switched to either 220 kV or 500 kV network.
N>N-81__1T; N>N-81__19	94	Outage—primarily to manage overloads of the 82 line between Liddell and Tomago during outages of the 81 line between Liddell and Newcastle. Affects up to 11 000 MW of installed generation capacity in NSW.

Constraint ID	Duration (hours)	Type—Description
Q>TVTU7134_IHKA7135; Q>IHTV_7132; Q>IHKA7135; Q>KATU_7253	70	Outage – maintain thermal limits around Alan Sherrif and Townsville North Queensland outages.
Q_CS_1900	44	System normal – limits flow from central to south Queensland to 1900 MW. Around 5690 MW of Queensland generation is behind this constraint.
N>N-NIL_1U	41	System normal – avoid overload of 94Y (Mt Piper 132 kV to Mt Piper 330 kV)
Q>BI_1TX_865_GD460	39	Outage—constrains on Gladstone 3 and 4 Outage of a Boyne Island transformer or Boyne Island to Wurdong.
N>N-38_20A; N>N-38__19	14	Outage – to manage overloads of 81 and 82 lines between Liddell and Tomago and Liddell and Newcastle Outage of 38 line between Regentville and Sydney West. As much as 11 520 MW of New South Wales generation is affected.
T:T_NIL_2	12	System normal – constrains on Gordon in Tasmania to maintain transient stability.

3.2 Qualitative assessment

This section provides further information on individual constraints highlighted in tables 3 and 4 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.

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. In response NEMMCO intervened for 34 hours on the Victoria to Snowy interconnector through discretionary constraints. Although usually short in duration, this intervention often constrained exports from Victoria to low (sometimes zero) levels on days when the price in New South Wales was at extreme levels. Flows along the Snowy interconnector at the time of intervention were typically close to the 3000 MW nominal limit. The same constraints bound for a further 35 hours during the year on both the Victoria to Snowy interconnector and the Snowy to New South Wales interconnector (but did not lead to negative settlement residue issues). During the 2003-04 financial year, NEMMCO intervened with discretionary constraints affecting the Snowy region for around 30 hours to manage the inherent physical limitations of the network.

Discretionary constraints on the Victoria to Snowy interconnector were applied for an additional 15 hours to manage the loadings of the interconnector during network outages. The constraint invoked to manage an outage between Eildon and Mt Beauty in Victoria, had significant market impacts on Wednesday 13 October.

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

At times, combined Victorian export capability across the Heywood, Murraylink and Victoria to Snowy interconnectors, was limited either as a result of outages or system normal limitations around South Morang. These limits impacted on exports for more than 200 hours. Limits on the South Morang 500kV/330kV transformers limited dispatch for around 100 hours (compared to 163 hours the previous year). The market impact of these constraints is estimated at $39 000/MW or less than 10 per cent of that for the previous year. Outages of transmission elements around South Morang in Victoria affected exports for around 100 hours, this compares to around 63 hours the previous year.

Exports from Victoria to South Australia again saw high levels of network congestion. The nominal Heywood limit of 460 MW bound for 975 hours or 11 per cent of the year. This was down by around a quarter compared to the previous year.

On 14 March, Northern Power Station (NPS) units 1 and 2 simultaneously tripped, resulting in an overload on the Victoria to South Australia (Heywood) interconnector which subsequently tripped (as designed). This caused interruptions to around half of the load in South Australia through automatic under frequency load shedding. As a result, the simultaneous loss of both units was reclassified as a credible contingency

event. This saw the Victorian export capability across the Heywood interconnector reduced to an average of 160 MW. The reclassification was removed on 1 June 2005. Constraints managing the reclassifications bound for 928 hours or half the time in which they applied. One constraint in particular bound for the majority of this time at 878 hours. During this period, another constraint was used to manage a number of network outages and set a limit on flows into South Australia of 150 MW, which is lower than would otherwise have been the case had the loss of the Northern units not been reclassified as a single credible contingency.

Network congestion from Queensland to New South Wales decreased compared to the previous year. In November 2004, the design capability for northwards flows increased. The two constraints most frequently binding on flows south bound for 169 hours. These constraints reflect the inherent physical limitations of the network. Management of potential overloads of the 132kV network in northern New South Wales, which is parallel to the Queensland to New South Wales interconnector, at times impacted on the capability of Queensland exports. Whilst only impacting on dispatch for four hours, this constraint limited Queensland exports on 31 November and 1 December, days of extreme market outcomes in New South Wales. This constraint was revoked for a period on 1 December when reserves in New South Wales fell to low levels, allowing greater Queensland exports. The two constraints which manage outages of the Armidale SVC and transformer respectively, bound collectively for 30 hours and at times when Queensland exports were highly valued.

Network outages had significant impacts on the availability of Murraylink during the year. These outages included planned and unplanned outages on the interconnector itself, and outages in south western New South Wales, which removed from service a control scheme. When the scheme was out of service, the limit on flows into South Australia was reduced, at times to zero. Outages of this scheme occurred on 78 days or a fifth of the year.

Intra-regional congestion

This section describes the significant points of congestion internal to a single region as indicated by the MCC. Significant intra-regional congestion occurs when individual network limitations affect market outcomes for more than 10 hours.

Constraints in central Queensland to manage the flows along the 871 line between Calvale and Wurdong, for the unexpected loss of the 855 line between Calvale and Stanwell affected market outcomes for 190 hours. Two constraints managed this effect and combined to constrain on local generation at Gladstone and Stanwell and constrain off generation at Callide B and C. These constraints reflected the inherent physical limitations of the network and did not result from outages of network equipment.

In early 2005 the capability of the Yabulu generator increased from 160 MW to 230 MW. Following this upgrade, outages in far north Queensland saw Yabulu power station being constrained off for around 70 hours.

The constraint which manages flow from central Queensland to the load centre around Brisbane, affected the dispatch of plant in central and north Queensland for 44 hours during the year. This constraint did not have significant impacts the previous year.

Gladstone units 3 and 4 were constrained on for outages around Boyne Island for 39 hours during the year, which is around three times the duration for 2003-04.

The Hazelwood transformers in Victoria again had significant impacts on dispatch, affecting generation in the Latrobe Valley for more than 100 hours during the year. This compares to 163 hours the previous year.

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 94 hours during the year. Outages of the 38 line between Sydney West and Regentville affected dispatch for 14 hours. The constraint which manages flows along the western Sydney transmission ring also had significant impacts, affecting dispatch for 41 hours during the year. This constraint causes generation at Mount Piper to be constrained off and constraints on generation at Wallerawang. It typically bound on days when a Wallerawang unit was offline.

Directions

44 directions were issued during the year. The total cost of these directions for the year was $4.2 million.

NEMMCO directed generators in the south east of South Australia on 35 occasions. The majority of these directions occurred during March and April 2005. This arose following the commissioning of wind farms in the south east of South Australia in the summer of 2004-05, which led to changes to the network support arrangements in the vicinity. The need for these directions fell away following improvements to those arrangements during 2005.

NEMMCO directed a generator on seven occasions throughout the year to manage potential overloads in northern Queensland. A further direction occurred to manage potential overloads in the south east of Queensland.

The remaining direction followed the electrical separation of South Australia from the rest of the market, on 14 March 2005, to assist with frequency control.

Inter-regional Settlement Residues

Settlement residues for this period increased from $141 million the previous year to $232 million. Residues on the Snowy to New South Wales interconnector increased from $37 million to $118 million, whilst those for the Victoria to Snowy interconnector reduced from $45 million to $13 million.

Analysis shows that the Snowy to New South Wales interconnector's 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. The same was not seen on the Victoria to Snowy interconnector which was frequently limited by intervention by NEMMCO to manage the accumulation of negative settlements.

Appendix A Qualitative analysis

This section gives further information on individual constraints shown by the MCC indicator to have had a high market impact. This analysis aims to show what factors drove these constraints and led to significant congestion. The assessment includes comments on:

- 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 impact of network constraints on the cost of frequency control ancillary services (including the causes of the constraints) to reduce those impacts over time.
- other factors that may affect the MCC and TCC, for example, some constraints are invoked to manage power system directions by NEMMCO or grid support.

This analysis draws on information published by NEMMCO through its market systems and through its website. The Network Outage Scheduler (NOS) is used by the TNSPs to identify the requirement for outages of transmission equipment. The NOS is published on the NEMMCO website[5]. The requested outages are assessed by specialist staff within NEMMCO and progressed to a 'likely to proceed' (LTP) status if it is deemed that the outage will not materially affect system security. At this stage, NEMMCO will determine which constraints, if any, it will need to manage the security of the network during the outage. The constraint sets are then entered into the NOS and the market systems table 'GenConSetInvoke'. Once in the market systems, the impacts of the network outage will be modelled in NEMMCO's forecasts in pre-dispatch and short and medium-term PASA (projected assessment of system adequacy), which is up to two years in advance.

The constraints have been drawn from the list of constraints reported by the MCC as having had significant intra-regional or inter-regional impacts. Section A.1 details those constraints affecting interconnectors, while s.A.2 details constraints within regions.

[5] www.nemmco.com.au/transmission_distribution/NOS.htm.

A.1 Inter-regional constraints

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

Constraint: Q:N_NIL_A and Q:N_NIL_OSC

These two constraints have been grouped together as they define the nominal operating envelope on the Queensland to New South Wales interconnector. These two constraints bound for a total of 169 hours or two per cent of the year.

Constraint Q:N_NIL_A is a system normal limit that sets a dynamically calculated limit on southward flows across QNI. The constraints manage the flow for the loss of either the '8C' or '8E' lines (between Armidale and Dumaresq) in northern New South Wales.

This limit varies subject to the status of the two Millmerran units, the two Wivenhoe units and the demand in Queensland.

This constraint bound for a total of 49 hours, less than half of last year. When binding, this constraint set a limit on flows of between 846 MW and 950 MW with an average of 908 MW. This was consistent with the previous year (907 MW).

This constraint was revised in November increasing the limit to an average of 1100 MW. The constraint did not bind following this revision.

Constraint Q:N_NIL_OSC sets a system normal limit on flows south to maintain oscillatory stability in Queensland 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 on, the higher limit of 1078 MW is applied.

This constraint bound for 120 hours from November 2004 and always bound at the higher limit of 1078 MW.

Constraint: Q>N-NIL_DF

This constraint sets a system normal limit on exports from Queensland across both the Queensland to New South Wales and DirectLink interconnectors. These limits are set to avoid overloads in the northern New South Wales 132 kV network. In particular this constraint manages overloads of the 965 line between Armidale and Kempsey in northern New South Wales for a trip of the 9W3 line between Coffs Harbour and Nambucca. This 132 kV network is parallel to the 330 kV network that feeds into QNI and Directlink.

This constraint bound on just five hours over three days. Almost all of the CMV accumulated on the two days 30 November and 1 December.

On Tuesday 30 November, this network limitation saw exports from Queensland across QNI reduced to as low as 644 MW or more than 400 MW lower than the interconnector's typical operating capacity. The constraint bound for more than two hours on this day, between 1 pm and 5 pm.

On Wednesday 1 December this constraint bound for two hours. It first bound from around 10 am before being revoked from the market systems without notice at around

11 am. The constraint was revoked and reflected action taken following agreement between NEMMCO and TransGrid that in the event of an actual or imminent declaration of an LOR2 condition in New South Wales, TransGrid would radialise its north coast 132 kV transmission network. It was recognised that running some north coast load radially was acceptable in these circumstances as the amount of load exposed for a single (network) contingency was going to be less than the load exposed in NSW more generally in the event of a generator trip under LOR2 conditions. The transfer capability of the interconnector increased by around 300MW following this action.

Following this decision, and independent from it, a generator in New South Wales did trip, leading to a lack of reserve level three (imminent loading shedding) being declared in New South Wales between 1.55 pm and 4 pm on this day (refer to market notices 12293 and 12295). The constraint was returned to the system at 5 pm and bound for a further hour; the interconnector limit was reduced by almost 400 MW with the return of the constraint.

Constraint: Q:N_AR_VC_1

This constraint manages an outage of the Armidale SVC (static VAr compensator) and limits exports from Queensland to maintain transient stability following the loss of the Boyne Island Potline in Queensland.

This constraint bound for four hours during the year, almost all on Wednesday 13 October. The limit on exports across the Queensland to New South Wales interconnector was at 744 MW, around 200 MW lower than the nominal limit at the time. Prices in New South Wales on the day reached $5000/MWh for a number of hours.

The SVC was out of service on seven other days during the year, four of these occasions were for emergency outages; whilst three were for planned outages which occurred during mid October. The constraint bound during the planned outages on Wednesday 13 October and Thursday 14 October, with the majority of the CMV accruing on Wednesday. There was on average six days notice given through the Network Outage Scheduler (NOS) by Transgrid of the need to take the outage when this constraint bound. The outages were approved by NEMMCO and progressed to LTP status one day after notification was first received.

Constraint: Q>N_AR_TX

This constraint was used to manage outages of the Armidale 330/132kV transformers and the Armidale 132kV bus.

This constraint limits flows south into New South Wales across the Queensland to New South Wales interconnector and forces flows south along the DirectLink interconnector.

The majority of the market impacts (CMV) for this constraint occurred on 18 November. Flows south across the Queensland to New South Wales interconnector were limited from 8 am, and restricted to around 100 MW at midday. Flows increased to around 450 MW whilst the outage continued up until 2pm. Flows along DirectLink were forced south, at times as high as 110 MW increasing the limit on

flows across the QNI interconnector. The transformers were returned to service early and the import capability across QNI increased to around 900 MW. Three days notice was given by Transgrid through the NOS of the need to take the outages on this day.

Transgrid removed this line from service for 20 other days during the year. On those days when the constraint bound, on average five days notice was given through the NOS of the need to take the outages, ranging from less than one day on 3 June 2005 to 15 days on 21 October 2004. For all outages, nine days notification was received of the need to take the outages. The outages were approved by NEMMCO and progressed to LTP status on average one day after notification was first received.

Constraint: Q>N-81__1T

This constraint manages outages of the 81 line between Liddell and Newcastle. This outage is also managed by intra-regional constraints within New South Wales which is detailed in section A.2.2.

This constraint was apart of the set N-LDNC_81 from 26 October 2004 to 14 July 2005. Market notice 12145 stated that this constraint was developed; to improve the accuracy of forecast information on the Queensland to New South Wales interconnector. Prior to this constraint, outages of the 81 line were not being accurately modelled in predispatch.

This constraint was subsequently used in 41 of the 42 outages of this line during the year, and bound on 20 of those 41 days. When binding, there was on average 10 days notice given through the NOS of the need to take the outages. This notice ranged from four to 21 days. On average these constraints were progressed to LTP status by NEMMCO one day after notification was first received.

This constraint was replaced on 14 July 2005 by the fully co-optimised constraint N>>N-81__1T.

A.1.2 Snowy to New South Wales interconnector

Constraint: H>N-NIL_H_15M or H>N-NIL_C_15M or H>N-64_H_15M

These constraints manage overloads of the parallel 03 and 07 lines in southern New South Wales for the loss of the other. The 03 and 07 lines make up part of the Snowy to New South Wales interconnector. All of these constraints manage system normal conditions, with the outage of the 64 line which is normally out of service managed in the constraint H>N-64_H_15M.

The constraints bound for a total of less than four hours over the year. Constraint H>N-NIL_H_15M bound most frequently for a total of 3 hours over five days with high marginal values occurring over short periods on Friday 14 January and Thursday 23 June. High prices in New South Wales and relatively low prices in Snowy led to the high marginal values. Flows when binding were around 3000 MW across the interconnector.

Constraint: HN_2900 or HN_3000

These constraints are discretionary constraints which set an upper limit on flows into New South Wales across the Snowy to New South Wales interconnector. These

constraints are typically employed when dynamic stability analysis, performed by NEMMCO's on-line staff, indicates that the already invoked constraints are not accurately reflecting the network capability. When used, these constraints usually reduce the actual capability of the interconnector by 100 MW to 200 MW.

Both constraints were invoked on 13 October and bound for around two hours in total. At the time, prices in New South Wales reached $5000/MWh. Flows into New South Wales on the day were reduced by up to 250MW as a result of these constraints.

A.1.3 Victoria to Snowy interconnector

Constraint: Discretionary constraints of the form VH_*

There were 19 discretionary constraints applied to the Victoria to Snowy interconnector over the financial year which have been grouped together for analysis.

These constraints were typically used to manage the accumulation of negative settlements across the Victoria to Snowy interconnector and bound for 34 hours for this purpose. There was limited notification prior to the use of these constraints. On a number of instances NEMMCO identified that based on forecast conditions, the use of these constraints would be likely (see market notice 12274 for example). NEMMCO would wait until actual negative settlements began to accrue before invoking these constraints. Even if notification was given of the likely implementation, these constraints were not used in predispatch forecasts. The cumulative marginal values of these constraints used to manage negative settlement residues, was over $500 000, and represented the single greatest source of network congestion. This congestion is not reflective of the physical characteristics of the network, but results from the loop flow through the Snowy region resulting in negative residues. This is detailed in Appendix G.

These constraints were also used to manage network outages and bound for 15 hours for such purposes. The market impacts of these constraints, when used to manage network outages were less than when used to manage negative settlements. The most significant occurrence was constraint VH_0650 on Wednesday 13 October 2004. Market notice 12098 identified this constraint as being used to manage post contingent overloads in Victoria. There was an outage on this day between Eildon and Mt Beauty and discretionary constraints were also applied to Southern Hydro, limiting generation to less than 320 MW. The accumulated marginal value for this constraint was around $66 000/MWh on the day. Whilst the TCC on this day reached the highest daily levels for the year at $7.9 million, most of this accumulated at other locations during the day.

Most of the CMV accumulated for these constraints occurred on days which have been identified by the TCC as days of high network congestion, namely 18 November (TCC was $1.4 million) 30 November ($7.5 million), 1 December ($7.1 million), 14 January ($4.2 million) and 8 February ($1.1 million). Flows on the Victoria to Snowy interconnector, in the absence of all network constraints (as determined through the TCC calculation) would have reached as high as 1300 MW on 1 December. This compares to the actual flows of around 100 MW.

Constraint: V:HHWSMC_C or V:HHWSMB_C

These constraints manage outages of one of the lines between Hazelwood and South Morang, restricting exports from Victoria across the Victoria to Snowy, MurrayLink and Victoria to South Australia interconnectors.

The constraints were invoked to manage outages for 13 days and bound on seven of those days. The constraints were often operating in tandem on the export limits.

For outages which affected market outcomes, notification by SPAusNet through the NOS for the need to take the outages ranged from two days to 94 days notice with and average of 48 days notice. These outages were progressed by NEMMCO to LTP status on average seven days before the outage commenced.

for all outages, an average of 36 days notice was given for the need to take the outages with the outages progressed by NEMMCO to LTP status seven days before the commencement of the outages.

On 7 August, the outage led to counter price flows from Snowy into Victoria (see market notice 11894). The CMV for the constraints on this day was almost half of the total for the year. The TCC on this day was $257 000 whilst the OCC was $256 000. This outage accounted for all of the OCC on this day and the vast majority of the TCC.

Constraint: VH>V3NIL and VH>V4NIL

These two system normal constraints manage flows across the South Morang 500/330kV transformer by limiting flows out of Victoria across the MurrayLink and the Victoria to Snowy interconnectors.

In the formulation of the constraint, MurrayLink contributes with a factor of 0.626 and V-SN contributes with a factor of 1. That is, when these constraints are binding a reduction in Murraylink's limit by 1 MW allows for an increase in the V-SN limit by 0.626 MW.

These constraints bound for a total of 93 hours during the year. This compares to 162 hours for the previous year. Constraint VH>V3NIL accounted for the majority of this at 82 hours (down from 158 hours). The combined CMV was $39 000/MW, which was less than 10 per cent of the previous year of $440 000/MW.

A.1.4 Victoria to South Australia Heywood interconnector

Constraint: VS_460

This constraint manages the nominal rating of 460 MW maximum flows across the Heywood interconnector. Further details were provided in the 2003-04 MITC report (Appendix B section B.1.3).

The constraint bound on 240 days during the year for a total of 975 hours (a reduction from 1321 hours the previous year) with a CMV of $469 000 (a slight increase from $423 000 the previous year).

From 14 March until 1 June, the simultaneous loss of both units at Northern Power Station (NPS) were reclassified as a credible contingency event[6]. This reclassification was largely reflected to the Victoria to South Australia interconnector and saw an average import limit of 160 MW when the two units were in operation. As a result, VS_460 did not bind during this period. Constraints managing this reclassification bound for 928 hours during this 11 week period, or for half of the time. The constraint "V:S_NPS_SINGL_CONT_2 alone bound for 878 hours.

Constraint: VS_150

This constraint is a discretionary constraint that limits flow along the Victoria to South Australia interconnector to less than 150 MW. This constraint was used for network outages on the Heywood to South East line and equipment outages around Heywood on six days during May 2005, which was during the period when the simultaneous loss of the two Northern units was reclassified to a single credible contingency.

A.1.5 Victoria to South Australia MurrayLink interconnector

Constraint: V^SML_X5TR

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

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

This constraint bound for a total of 61 hours during the year over 21 days. On days when the constraint bound, an average 14 days notification of the need to take the outage was given through the NOS by Transgrid. This notification ranged from one day to 21 days notice. The outages were approved by NEMMCO and progressed to LTP status on average two days after notification was first received.

For all outages, this constraint was utilised for network outages on 78 days during the year. Transgrid gave on average 15 days notice through the NOS of the need to take these outages. The outages were approved by NEMMCO and progressed to LTP status on average two days after notification was first received.

When binding, the transfer limit on MurrayLink varied widely; from zero on 26 November to 138 MW on 23 May. The limit is heavily influenced by the flows on the 132 kV lines out of Wagga up to Finley and Yanco, which is related to local demand.

Constraint: SVML_000 or VSML_000

These constraints are applied on the MurrayLink interconnector and constrain the interconnector to zero in both directions. When planned, these constraints were used to manage outages of the MurrayLink cable or between MurrayLink and Redcliffs in

[6] This followed the loss of both units at NPS on 14 March and the consequent loss of the Heywood interconnector and interruption to large parts of South Australia.

Victoria. On two occasions these constraints were used for reasons other than network outages.

On 27 November 2004, ambient conditions in Victoria saw discretionary limits placed on the flow of MurrayLink into South Australia to prevent post contingent overloads in Victoria for two hours. For two dispatch intervals on this day, the constraint VSML_000 was used to manage these conditions.

On 23 December 2004, the constraint VSML_000 was invoked for a single dispatch interval. An unplanned outage of Victorian SCADA occurred at this time.

The MurrayLink interconnector was out of service on 36 days during the year. There were six planned outages over 13 days. Notification through the NOS of these outages ranged from three days to almost a year, with an average of 77 days. The remaining 23 days where outages occurred were unplanned.

Most of this CMV accumulated during a planned outage on 13 October where prices in South Australia were relatively low compared to the rest of the market. Prices in Victoria were around $1000/MWh reflecting the conditions in New South Wales where prices reached $5000/MWh for a number of hours. This outage was planned well in advance, first entering the NOS in November 2003, almost one year ahead.

A.2 Intra-regional constraints

A.2.1 Queensland

Constraint: Q>PRE855_871CAL or Q>PRE855_871GL_ST

These two constraints manage the overload of the 871 line between Calvale and Wurdong. The constraint Q>PRE855_871CAL constrains off generation at Callide B and C and the constraint Q>PRE855_871GL_ST constrains on generation at Stanwell and Gladstone. Each constraint bound for more than 140 hours, although the two constraints were often binding at the same time. In total the two constraints affected market outcomes for 190 hours.

At times, these constraints were affecting more than 500 MW of generation– some constrained on and others constrained off. During December these constraints had their biggest impacts. In particular, on Tuesday 28 December, Callide C units three and four were constrained off by almost 500 MW and Callide B constrained off by a further 100 MW during the morning load rise.

Whilst the duration and the amount of generation affected by these constraints were significant, the impacts on the CMV and the TCC were relatively minor. The CMV was only $17 000/MWh. The MCC measure for intra-regional constraints is based on the time duration that a constraint binds, not the CMV as the CMV can be skewed by bidding behaviour in response to intra-regional constraints where generators may offer this capacity at $-1000/MWh and is not accurately reflective of the true impacts of a constraint. The participants directly affected by these constraints, however, did not bid in this way. On Tuesday 28 December the TCC was relatively low totalling $14 000 despite almost 600 MW of capacity being constrained out of merit order.

Constraint: Q>TVTU7134_IHKA7135 and other constraints acting on Yabulu

In early 2005 the capability of the Yabulu generator increased from 160 MW to 230 MW. The operation of the unit altered from a normally off peaking plant to normally on. The unit was constrained off for around 70 hours during the year for outages around Townsville and Alan Sherriff in northern Queensland.

Constraints managing these outages bound on 9 days during the year. On average, Powerlink provided 12 days notice through the NOS prior to taking these outages, with the actual notice ranging between zero and 29 days, depending on the urgency of the outage. NEMMCO typically progressed these outages to LTP status the day they first received notice.

Constraint: Q_CS_1900

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

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

The constraint bound for a total of 44 hours over 24 days. On 17 May, the constraint bound for a total of eight hours. The TCC on this day was $30 000. Around 200 MW

of generation in Queensland was constrained off over the evening peak as a result of this constraint. Prices, however, peaked at less than $80/MWh for the day.

Constraint: Q>BI_1TX_865_GD460

This constraint manages power flows on remaining network components during outages of network elements around Boyne Island and Wurdong in central Queensland. The constraint affects generation at Gladstone with units three and four constrained on to a minimum loading level of 460 MW.

The constraint was active on 21 days during the year and affected dispatch on 14 of those days. In relation to the specific outages that affected dispatch, Powerlink provided an average of 11 days notice prior to the outages. Notification ranged from three days to 24 days on these occasions. The outages were progressed by NEMMCO to LTP status on average within one day of notification.

A.2.2 New South Wales/Snowy

Constraint: N>N-81__19 and other 81 line outage constraints

Outages of the 81 line between Liddell and Newcastle are managed by a number of different constraints with: N>N-81__1T; N>N-81__19; N>N-81__22; N>N-81__07; N>N-81__27 and N:N_LDNC_1 having the most significant impacts.

These constraints bound for a total of 94 hours during the year. The line came out of service on 42 days during the year, with these constraints binding on 19 days. When binding, there was on average 10 days notice given of the need to take the outages. This notice ranged from four to 21 days.

The constraint N>N-81__1T bound most frequently, affecting dispatch for 59 hours during the year. This constraint was created along with the intra-regional constraint Q>N-81__1T on 26 October 2004. Market notice 12145 identified the need for these two constraints; to improve the accuracy of forecast information on the Queensland to New South Wales interconnector. Prior to this constraint, outages of the 81 line were having impacts in dispatch that were not being accurately modelled in predispatch.

The constraints that manage these outages directly affect significant amounts of generation in New South Wales, varying from around 4500 MW for the constraints N>N-81__07 and N>N-81__22 to as much as 11 670 MW (or more than 95 per cent of the registered generation in NSW) for the constraint N>N-81__1T. As a result, when binding these constraints may dispatch hundreds of mega watts out of merit order. On 6 June, in particular, the constraint N>N-81__1T constrained on around 500 MW of generation for some hours, with almost 900 MW of generation constrained on across Eraring and Vales Point for one dispatch interval. The TCC for this day was relatively small at $325 000 indicating the total impact was not significant.

Constraint: N>N-NIL_1U

This constraint manages the loading on the Mt Piper 330/132 kV transformers for the loss of the 71 line between Mt Piper and Wallerawang. This constraint constrains off Mt Piper and constrains on Wallerawang.

This constraint bound for 41 hours during the year over 17 days. This constraint bound for almost seven hours on 13 October and for more than five hours on 19 and 28 November.

On 13 October the constraint had its largest market impacts when the price in New South Wales reached $3000/MWh for four hours, and peaked at $5000/MWh for two and a half hours. This constraint saw the two Mt Piper units constrained off by more than 300 MW, with all of this capacity priced at less than $20/MWh. There was considerable congestion on the network between most regions during this day however it is fair to say it was one of the most significant constraints on the day. The daily TCC was at its highest level for the year at $7.9 million.

This constraint bound for a combined total of more than 14 hours on six of the top seven TCC days during the year coinciding with planned and forced outages of Wallerawang units.

Constraints: N>N-38_20A and N>N-38__19

These constraints manage outages of the Regentville to Sydney West line in New South Wales to manage over loads of the 81 and 82 lines for the loss of the other. These constraints constraint on or off more than 10 000 MW of generation in New South Wales or 85 per cent of the registered load in New South Wales.

The line was taken out of service on five days during the year with an average of three days notice given through the NOS of the need to take the outage. The outages were progressed by NEMMCO to LTP status two days before the commencement of the outage.

The constraints bound on only two days during the year; on 9 and 10 December 2004. Notification through the NOS of these outages were given six and three days ahead respectively. Both outages were progressed to LTP status two days before the outages were scheduled to commence.

A.2.3 Victoria

Constraint: V>V1NIL and V>V2NIL

During 2004–05 this constraint bound on 30 days (down from 48 the previous year), for a total of 101 hours (down from 163 hours the previous year). For a detailed description of this network limitation, its impact and causes see the Market Impacts of Transmission Congestion for 2003 – 2004 (Appendix B section B.2.3).

A.2.4 Tasmania

Constraint: T:T_NIL_2

This is a system normal constraint which constrains on Gordon in Tasmania's south to maintain transient stability following the trip of a line between Palmerston and Liapootah or Chapel St and Liapootah. The constraint bound on 15 days over late May and June, binding for around 12 hours.

This constraint bound for a total of 5 hours on 30 and 31 May, constraining Gordon on to around 100 MW. On 18 July 2005, following advice from Transend, NEMMCO revoked this constraint from the market systems.

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 $232 million for the 2004–05 financial year with the majority accruing for imports into NSW across QNI and the Snowy to New South Wales interconnectors.

Indicative results, calculated from the market systems, identify that around 83 per cent of the inter-regional settlement residues for the year accumulated on 10 days. An estimate of the residues accruing for those days is 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 on these 10 days. Analysis shows that 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. The same was not seen on the Victoria to Snowy interconnector which was frequently limited by intervention by NEMMCO to manage the accumulation of negative settlements.

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

Date	Indicative settlement residues		TCC
18/07/2004	$3 million	1%	$308 212
19/07/2004	$6 million	2%	$591 046
13/10/2004	$37 million	16%	$7 875 648
18/11/2004	$4 million	2%	$1 384 677
26/11/2004	$7 million	3%	$512 179
30/11/2004	$29 million	13%	$7 522 332
01/12/2004	$54 million	24%	$7 076 996
14/01/2005	$21 million	9%	$4 208 642
08/02/2005	$20 million	9%	$1 088 991
23/06/2005	$8 million	3%	$24 385

Appendix C All network constraints

Table C1, sourced from the AEMC Reliability Panel 2004–05 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	Total
Total outages[2]	902	1146	1192	671	3911
Scheduled with less than four days notice	33%	27%	39%	29%	32%
Forced outages[3]	7%	7%	10%	11%	9%

[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.

Appendix D Frequency control ancillary services

The TCC and the MCC have not included 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 and hence does not have a significant impact on the TCC. For the same reasons, constraints associated with the FCAS markets have not been included in the constraints analysed in the MCC. 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 2004–05 was $26 million. Planned network outages on 85 days led to increased requirements for FCAS and accounted for an estimated $12 million of this cost.

Two unplanned outages accounted for a further $2.5 million.

On Friday 14 January 2005 the cost of ancillary services increased to a daily cost of almost $1 million. This increase followed the electrical separation of Queensland from the rest of the market.

On Monday 14 March 2005 the cost of ancillary services totalled around $1.6 million. This increase resulted from an event that saw the electrical separation of South Australia from the rest of the market. This followed the loss of a transmission line in South Australia following an unplanned reduction in the output of both Northern units in South Australia, leading to a requirement for locally sourced ancillary services.

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, generator's offers in these circumstances have been substituted with $300/MWh. This may not necessarily reflect the true cost of the directions.

There were 44 directions issued by NEMMCO to manage power system security as a result of transmission network issues.

NEMMCO directed a generator on seven occasions throughout the year to manage potential overloads in the northern Queensland. On one occasion a participant was directed to manage potential overloads in the south east of Queensland.

A further 36 were issued in South Australia, 35 of these were to manage network loading on the 132kV network in the state's south east. The remaining direction followed a separation from the rest of the market to assist with frequency control.

The compensation costs paid to the directed generators totalled $4.2 million.

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 2004-05 financial year.

Figure 1: 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 2004 – 2005 financial year, the AER reported on 399 such trading intervals.

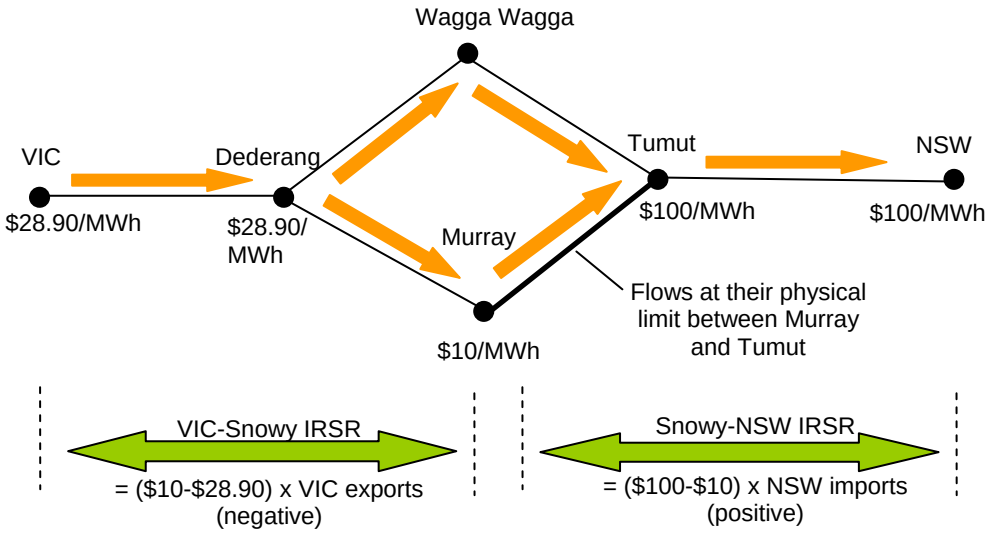
The table below identifies those 14 trading intervals which were greater than three times the weekly average and saw a variation in price from forecast with changes in network capability contributing.

Date	Region	No. of Trading Intervals	Reason
14-Jan-05	NSW	4	Trip of QNI. Prices increased as a result of the loss of almost 8000 MW of imports from Queensland.
26-Jan-05	SA	7	Lightning in the vicinity of the Heywood interconnector led to a reclassification and reduced import capability into SA
17-May-05	SA and Vic	1	Flows across the Snowy to Victoria interconnector were limited by a ramping constraint invoked ahead of a planned network outage in southern New South Wales. Predespatch did not reflect the use of these constraints for this trading interval.
30-May-05	SA	1	A planned network outage in New South Wales, reduced flows from Victoria along the MurrayLink interconnector into South Australia. A further planned network outage in South Australia, limited flows across the Victoria to South Australia interconnector.

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

H2 Queensland to New South Wales

H3. Snowy to New South Wales

H4. New South Wales to Snowy

H5. Victoria to Snowy

H6. Snowy to Victoria

H7. Victoria to South Australia

H8. South Australia to Victoria

H9. Queensland intra-regional constraints

H10. New South Wales intra-regional constraints

H11 Snowy intra-regional constraints

H12. Victoria intra-regional constraints

H13 South Australia intra-regional constraints

H14 Tasmania intra-regional constraints

H15 Constraints setting requirements for frequency control ancillary services

H16 Constraints used in grid support

H17 Constraints used in power system directions

H18 Constraints used to manage Northern reclassification

H1. NEW SOUTH WALES TO QUEENSLAND (QNI) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
N>Q+NIL_F7	9	21,454	201	System normal, limit on Queensland imports to avoid overloading the 86 line between Armidale and Tamworth on trip of 85 line between Armidale and Tamworth.
N^Q_NIL_B	6	10,870	165	System normal, limit on Queensland imports to avoid voltage collapse on trip of largest Queensland generator.
N:Q_NIL_B7	2	34	2	System normal, limit on Queensland imports to maintain transient stability.
NQ_075	0.2	14	7	Discretionary constraint limiting flows from New South Wales to Queensland to 75 MW

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
N^Q_MU_CPB	0.3	9,991	3,330	Outage of Muswellbrook Mvar capacitor bank. Limit Queensland imports to avoid voltage collapse on trip of the largest Queensland generator.
N:Q_ARDM	1	26	4	Outage of either 8C, 8E, 8L or 8M lines. Limit Queensland imports to maintain transient stability for the loss of a Callide C unit.

H2. QUEENSLAND TO NEW SOUTH WALES (QNI) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
QNI System normal limits	170	312,176	277	System normal, limit flows from Queensland to New South Wales to avoid oscillatory instability. Aggregation of the constraints Q:N_NIL_OSC and Q:N_NIL_A.
Q:N_NIL_OSC	120	250,978	174	System normal, limit flows from Queensland to New South Wales to avoid oscillatory instability .
Q>N-NIL_DF	5	193,613	3,073	System normal, limit on Queensland exports. Avoid overload of line 865 between Armidale and Kempsey for trip of 9W3 lint between Coffs Harbour and Nambucca.
Q:N_NIL_A	49	61,197	104	System normal, limit flows from Queensland to New South Wales to avoid oscillatory instability for trip of either lines 8C or 8E between Armidale and Dumaresq.
Q:N_BI_POT	84	16,798	17	System normal, limit flows from Queensland to New South Wales to avoid transient instability for trip of Boyne Island potline.
Q>N-NIL_DC	40	10,781	22	System normal, limit Queensland exports to avoid overload of 86 line between Armidale and Tamworth on trip of 85 line between Armidale and Tamworth.
Q>N-NIL_1T	7	6,798	82	System normal, limit Queensland to New South Wales to avoid overload of line 82 between Liddell and Tomago.
QN_950	20	1,045	4	System normal, physical limit on flows from Queensland to New South Wales of 950 MW.

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
Q:N_AR_VC_1	4	133,764	2,787	Outage of Armidale SVC. Limit Queensland to New South Wales to maintain transient stability on trip of Boyne Island potline.
N>Q_AR_TX	26	61,983	198	Outage of Armidale transformer. Limit Queensland to New South Wales to overload of last transformer on trip of other.
Q>N-81__1T	88	33,881	32	Outage of line 81 between Liddell and Newcastle to avoid overload on line 82 between Liddell and Tomago.
Q:N_BCBR_C	0	12,454	2,491	Outage of one Bulli Creek to Tarong line or Braemar transformer. Limit flows from Queensland to New South Wales to maintain oscillatory stability for the loss of a Boyne Island potline.
Q>N-38_20A	10	7,495	62	Outage line 38 between Regentville to Sydney West, limit Queensland to New South Wales to avoid overload of line 81 between Liddell and Newcastle on trip of line 82 between Liddell and Tomago.
Q>N-38_19A	6	5,282	79	Outage line 38 between Regentville to Sydney West to avoid overload of line 82 between Liddell and Tomago on trip of line 81 between Liddell and Newcastle.
Q>N-38_20A	5	5,219	82	Outage line 38 between Regentville to Sydney West to avoid overload of line 81 between Liddell and Newcastle on trip of line 82 between Liddell and Tomago.
Q>N-9W2_A	18	4,957	22	Outage of line 9W2 between Kempsey to Nambucca. Limit flows from Queensland to New South Wales to avoid overload of line 965 between Armidale and Kempsey on trip of line 96F between Kurri and Stroud.
Q>N-9W2+81	7	2,035	23	Outage of line 9W2 between Kempsey to Nambucca. Limit flows from Queensland to New South Wales to avoid overload of line 965 between Armidale and Kempsey on trip of line 963
Q:N_BR_VC_A	12	1,403	10	Outage of Braemar SVC. Limit flows from Queensland to New South Wales to maintain oscillatory stability for the trip of either 8C or 8E lines between Armidale and Dumaresq.
N>Q-ARCB5142	1	1,342	112	Outage of Armidale CB. Limit flows from Queensland to New South Wales to avoid overload of line 8C between Armidale and Dumaresq.
Q:N_ARDM_B	3	1,280	39	Outage of lines 8C or 8E between Armidale and Dumaresq. Limit flows from Queensland to New South Wales to maintain transient stability for trip of Boyne Island potline.

H3. SNOWY TO NEW SOUTH WALES INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
15 Minute ratings, 07 and 03 contingencies.	4	259,255	6,173	System normal limit on northern flow from Snowy to New South Wales. Avoid overload of 07 line between Lower Tumut and Canberra or 03 line between Lower Tumut and Yass for the trip of the the other. 15 minute line ratings apply. H>N-NIL_H_15M, H>N-NIL_C_15M, H>N-64_H_15M.
64 Line outage, 65, 66 line contingencies.	35	247,482	588	System normal limit on northern flow from Snowy to New South Wales. The 64 line between Lower Tumut and Upper Tumut out of service (normally out of service), avoid overloading 66 line between Murray and Lower Tumut or 65 line between Murray and Upper Tumut.
H>N-NIL_H_15M	3	215,391	5,821	System normal limit on northern flow from Snowy to New South Wales. Avoid overload of 07 line between Lower Tumut and Canberra for trip of 03 line between Lower Tumut and Yass. 15 minute line ratings apply.
H>>H-64_B	34	204,832	501	System normal limit on northern flow from Snowy to New South Wales. The 64 line between Lower Tumut and Upper Tumut out of service (normally out of service), avoid overloading 66 line between Murray and Lower Tumut on trip of 65 line between Murray and Upper Tumut.
Snowy upper limit, HN_2900, HN_3000	2	51,787	2,354	Discrectionary limits on northern transfers from Snowy to New South Wales of 2900MW and 3000MW.
H>>H-64_A	1	34,918	4,365	System normal limit on northern flow from Snowy to New South Wales. The 64 line between Lower Tumut and Upper Tumut out of service (normally out of service), avoid overloading 65 line between Murray and Upper Tumut on trip of 66 line between Murray and Lower Tumut.
HN_2900	1	31,358	2,851	Maximum transfer limit of 2900MW on northern flows from Snowy to New South Wales
H>N-NIL_C_15M	0.3	26,462	8,821	System normal limit on northern flow from Snowy to New South Wales. Avoid overload of 03 line between Lower Tumut and Yass for trip of 07 line between Lower Tumut and Canberra. 15 minute line ratings apply.
HN_3000	1	20,429	1,857	Maximum transfer limit of 3000MW on northern flows from Snowy to New South Wales

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
H>N-64_H_15M	0.2	17,402	8,701	System normal limit on northern flow from Snowy to New South Wales. Avoid overload of 07 line between Lower Tumut and Canberra for trip of 03 line between Lower Tumut and Yass. The line 64 between Lower Tumut and Upper Tumut out of service (normally out of service). 15 minute line ratings apply.
H>>H-64_2	0.2	7,704	3,852	System normal limit on northern flow from Snowy to New South Wales. The 64 line between Lower Tumut and Upper Tumut out of service (normally out of service), avoid overloading 66 line between Murray and Lower Tumut on trip of 65 line between Murray and Upper Tumut. 30 minute ratings apply.
H>>H-NIL_A	4	509	11	System normal limit on northern flows from Snowy to New South Wales, avoid overload on 65 line between Murray and Upper Tumut for the trip of the 66 line between Murray and Lower Tumut.
H>>H-NIL_C	1	438	26	System normal limit on northern flows from Snowy to New South Wales, avoid overload on 65 line between Murray and Upper Tumut for the trip of the 66 line between Murray and Lower Tumut.
H>>H-NIL_J	1	167	11	System normal limit on northern flows from Snowy to New South Wales avoid overload on 65 line between Murray and Upper Tumut.
H>>H-64_G	0.2	28	14	System normal limit on northern flow from Snowy to New South Wales. The 64 line between Lower Tumut and Upper Tumut out of service (normally out of service), avoid overloading 65 line between Murray and Upper Tumut.

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
H>>H-07+64_A	2	383	21	Outage of 07 line between Canberra and Lower Tumut as well as the 64 line between Lower Tumut and Upper Tumut (normally out of service). Limit on northern flow from Snowy to New South Wales, avoid overload of 65 line between Murray and Upper Tumut for the trip of 03 line between Yass and Lower Tumut.
N:H_MNYS	1	26	3	Outage of Marulan to Yass 04 or 05 line. Limit on northern flow from New South Wales to Snowy. Avoid loss of synchronism on a trip of Bayswater to Liddell lines 33 or 34.

H4. NEW SOUTH WALES TO SNOWY INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
H>>H-64_3	9	790	8	System normal limit on southern flow from New South Wales to Snowy. The 64 line between Lower Tumut and Upper Tumut out of service (normally out of service), avoid overloading 65 line between Murray and Upper Tumut for trip of line 66 between Murray and Lower Tumut. 30 minute line ratings.
H>>H-64_C	4	486	10	System normal limit on southern flow from New South Wales to Snowy. The 64 line between Lower Tumut and Upper Tumut out of service (normally out of service), avoid overloading 65 line between Murray and Upper Tumut for trip of line 66 between Murray and Lower Tumut.
H>>H-64_J	3	420	11	System normal limit on southern flow from New South Wales to Snowy. The 64 line between Lower Tumut and upper Tumut out of service (normally out of service), avoid see-saw action by constraint H>>H-64_G.
N:H_NIL	1	28	2	System normal limit on southern flow from New South Wales to Snowy to avoid transient instability.
N>HV-NIL_1	1	22	1	System normal limit on southern flow from New South Wales to Snowy. Avoid overload on 04 line between Yass and Marulan for trip of the 05 line also between Yass and Marulan.

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
N:H_MSUT	1	65	7	Outage of line 66 between Murray and Upper Tumut. Limit southern flows from New South Wales to Snowy.

H5. VICTORIA TO SNOWY INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
Victoria to Snowy discretionary constraints.	51	583,874	962	Summation of discretionary constraints (of the form VH_*) which limit flows from Victoria to Snowy. Primarily used for negative residue management.
VH_0100	12	239,436	1,735	Discretionary transfer limit of 100MW on flows from Victoria to Snowy.
H>>H-64_B	34	204,832	501	System normal limit on flow from Victoria into New South Wales. The 64 line between Lower Tumut and Upper Tumut out of service (normally out of service), avoid overloading the 66 line between Murray to Lower Tumut for the trip of the 65 line between Murray and Upper Tumut.
VH_0150	7	197,546	2,220	Discretionary transfer limit of 150MW on flows from Victoria to Snowy.
VH_0650	4	66,530	1,386	Discretionary transfer limit of 650MW on flows from Victoria to Snowy.
VH_0200	6	55,130	811	Discretionary transfer limit of 200MW on flows from Victoria to Snowy.
Hazelwood to South Morang 500 kV - Thermal	93	40,873	33	System normal, limit Victorian exports on V-SN and Murraylink to avoid overloading the South Morang 500/330 kV (F2) transformer. Aggregation of constraints VH>V3NIL and VH>V4NIL.
VH>V3NIL	82	32,726	33	System normal, limit Victorian exports on V-SN and Murraylink to avoid overloading the South Morang 500/330 kV (F2) transformer. Network in radial configuration.
Hazelwood to South Morang 500 kV - Transient stability	597	26,472	4	Limit Victorian exports to avoid voltage instability on trip of Hazelwood to South Morang
V:H_NILC_R	442	21,917	4	System normal. Limit Victorian exports for transient instability for loss of Hazelwood to South Morang 500 kV line.
VH_0050	4	16,405	315	Discretionary transfer limit of 50MW on flows from Victoria to Snowy.

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
@VH_0100_DS	3	8,929	218	Discretionary transfer limit of 100MW on flows from Victoria to Snowy.
H>>H-64_2	0.2	7,704	3,852	System normal limit on flow from Victoria into New South Wales. The 64 line between Lower Tumut and Upper Tumut out of service (normally out of service), avoid overloading the 66 line between Murray to Lower Tumut for the trip of the 65 line between Murray and Upper Tumut.
VH>V4NIL	10	6,193	50	System normal, limit Victorian exports on V-SN and Murraylink to avoid overloading the South Morang 500/330 kV (F2) transformer. Network in parallel configuration.
V:H_NILB_R	155	4,555	2	System normal. Limit Victoria exports to maintain transient stability on trip of Hazelwood to South Morang 500 kV
VH_0250	1	3,666	524	Discretionary transfer limit of 250MW on flows from Victoria to Snowy.
VH_0000	3	1,435	46	Discretionary transfer limit of 0MW on flows from Victoria to Snowy.

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
Outage of Hazelwood to South Morang,	103	48,255	26	Outage of Hazelwood to South Morang 500 kV line, limit Victorian exports to avoid transient instability for trip of a remaining Hazelwood to South Morang line. Aggregation of constraints V:HHWSMC_C and V:HHWSMB_C
V:HHWSMC_C	48	33,492	58	Outage of Hazelwood to South Morang 500 kV line, limit Victorian exports to avoid transient instability for trip of a remaining Hazelwood to South Morang line
V:HHWSMB_C	54	7,382	11	Outage of Hazelwood to South Morang 500 kV line, limit Victorian exports to avoid transient instability for trip of a remaining Hazelwood to South Morang line
VH:DDSMQ1	2	1,850	69	Outage of Dederang to South Morang 330 kV line, limit Victorian exports across V-SN and Murraylink to avoid transient instability for a trip of a remaining Dederang to South Morang line.

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
V:HEPTTC_R	34	1,243	3	Outage of Eildon to Thomastown 220 kV line, limit Victorian exports to avoid transient instability for a trip of Hazelwood to South Morang 500 kV line. Network in radial configuration
V:H2RPC_R	6	415	6	Outage of dynamic reactive plant in Victorian metropolitan area or South East SVC. Limit Victorian exports to prevent transient instability.
V:HEPMBC_P	4	68	2	Outage of Eildon to Mt Beauty 220 kV line, limit Victoria exports to avoid transient instability for trip of Hazelwood to South Morang 500 kV line.
V:HEPTTC_P	1	55	3	Outage of Eildon to Thomastown 220 kV line, limit Victorian exports to avoid transient instability for a trip of Hazelwood to South Morang 500 kV line. Network in parallel configuration
V:HEPMBB_P	1	12	1	Outage of Eildon to Mt Beauty 220 kV line, limit Victoria exports to avoid transient instability for trip of Hazelwood to South Morang 500 kV line. Limit Victorian exports to prevent transient instability for trip of Hazelwood to South Morang 500 kV.

H6. SNOWY TO VICTORIA INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
H>V_NIL1A	7	2,246	29	System normal. Limit transfers from Snowy to Victoria to avoid overloading a Dederang to Murray 330kV lint for loss of the other.
HV_1600	2	533	25	System normal, discretionary limit close to the nominal transfer limit of 1900MW on transfers from Snowy to Victoria. Used on 28 February 2005.

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
HV_0200	1	15,465	1,031	Discretionary constraint, used to manage negative settlement residues during a network outage on 7 August 2004
HV_0300	0.3	7,664	1,916	Discretionary constraint, used to manage negative settlement residues during a network outage on 7 August 2004
HV_0100	4	3,351	68	Discretionary constraint, used to manage negative settlement residues during a network outage on 7 and 8 August 2004
HV_0900	8	1,105	12	Discretionary constraint, used to manage a network outage on 5 and 6 April 2004
HV_0800	1	27	2	Discretionary constraint, used to manage a network outage on 9 September 2004
H^V_EPMB	0.2	11	6	Outage of Eildon to Mt Beauty 220 kV line, limit Snowy to Victoria transfers to avoid voltage collapse for trip of the largest Victorian generating unit.

H7. VICTORIA TO SOUTH AUSTRALIA (HEYWOOD) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
VS_460	975	468,818	40	460MW limit on flows into South Australia from Victoria across the Heywood interconnector.
Hazelwood to South Morang 500 kV - Transient stability	460	28,287	5	System normal. Limit Victoria exports maintain transient stability on trip of Hazelwood to South Morang 500 kV line. Aggregation of constraint V:H_NILC_R and V:HNIL_B_P
V:H_NILC_R	442	21,917	4	System normal. Limit Victoria exports maintain transient stability on trip of Hazelwood to South Morang 500 kV line.
VS_250	12	9,941	71	Discretionary limit of 250 MW on flows into South Australia from Victoria. Most frequently used when lightning is within 80 km of the interconnector.
VS_380	1	9,609	565	Discretionary limit of 380 MW on flows into South Australia from Victoria.
V:H_NILB_R	155	4,555	2	System normal. Limit Victoria exports maintain transient stability on trip of Hazelwood to South Morang 500 kV line.
V>S_NIL	26	3,425	11	System normal. Limit flows from Victoria to South Australia to manage thermal limits on Heywood interconnector.
VSS_400	1	1,193	92	Discretionary limit of 400 MW on flows from Victoria to South Australia across Heywood and Murraylink interconnectors.

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
Outage of Hazelwood to South Morang	103	40,873	33	Outage of Hazelwood to South Morang 500 kV line, limit Vic. exports to avoid transient instability for trip of a remaining Hazelwood to South Morang line. Aggregation of constraints V:HHWSMC_C and V:HHWSMB_C
V:HHWSMC_C	48	33,492	58	Outage of Hazelwood to South Morang 500 kV line, limit Victorian exports to avoid transient instablility for trip of a remaining Hazelwood to South Morang line
VS_150	47	31,285	55	Discretionary constraint. Outage of network elements affecting Heywood interconnector. Limits flow from Victoria to South Australia to 150 MW.
V>S_SETB	38	13,340	29	Outage of South East to Tailem Bend, limit Heywood to avoid overload of 132 kV parallel network for loss of remaining South East to Tailem Bend line.
V:HHWSMB_C	54	7,382	11	Outage of Hazelwood to South Morang 500 kV line, limit Victorian exports to avoid transient instablility for trip of a remaining Hazelwood to South Morang line
V>S_PATB	18	6,370	29	Outage of Para to Tailem Bend line. Limit flows into South Australia to Victoria to avoid overload of Mannum to Mannum Pumping station on trip of Mobilong to Tailem Bend.
V>S_TB_CB6536	75	5,896	7	Outage of Tailem Bend CB. Limit flows into South Australia.
I:VS-250	58	5,346	8	Discretionary constraint. Limit flow into South Australia from Victoria for outages affecting the Heywood interconnector.
V>S_TB_TX	55	3,228	5	Outage of Tailem Bend transformer. Limit flows into South Australia from Victoria to avoid overload of 132 kV network for a trip of Tailem Bend to South East.
V>S_MBMO	12	2,574	18	Outage of Mt Barker to Mobilong. Limit flows into South Australia from Victoria to avoid overload of Mannum to Mannum pumping station on trip of Northern unit.
V:HEPTTC_R	34	1,243	3	Outage of Eildon to Thomastown. Limit Victorian exports to avoid transient instability for trip of Hazelwood to South Morang.
SA_HYSE2	0.1	1,001	1,001	Separation of AC interconnection between South Australia and Victoria between Heywood and South East.
V>S_SETB	16	1,865	10	Outage of South East to Tailem Bend, limit flows into South Australia from Victoria to avoid overload of Blanche to Snuggery; Blanche to Mt Gambier or Keith to Tailem Bend on trip of the remaining South East to Tailem Bend line.

H8. SOUTH AUSTRALIA TO VICTORIA (HEYWOOD) INTERCONNECTOR

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
SV_300	6	10,217	152	Discretionary limit reflecting nominal transmission limit on flows from South Australia to Victoria.
N:H_NIL	1	28	2	System normal limit on flows from South Australia to Victoria to maintain transient stability.

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
S>V_MBMO	8	454	5	Outage of Mt Barker to Mobilong. Limit flows from South Australia to Victoria to avoid overload of Angas Creek to Mannum on trip of Para to Tailem Bend
S>V_PATB	2	57	3	Outage of Para Tailem Bend line. Limit flows from South Australia to Victoria to avoid overload of Angas Creek to Mannum on trip of Para to Tailem Bend.
N:H_MNYS	1	26	3	Outage of 04 or 05 lines between Marulan and Yass. Limit flow from South Australia to Victoria to retain synchronism on trip of line 33 or 34 between Bayswater and Liddell.
S>V_TB_TX	0	5	2	Outage of Tailem Bend 275 to 132 transformer. Limit flows from South Australia to Victoria to avoid overload of Angas Creek to Mannum on trip of Tailem Bend to South East.

H9. QUEENSLAND INTRA-REGIONAL CONSTRAINTS

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	DESCRIPTION
Precontingent transfers on 871 line in central Qld	292	System normal. Limits transfers across line 871 between Curvale and Wurdong for the trip of line 855 Stanwell and Calvale.
Q>PRE855_871CAL	149	System normal. Limits transfers across line 871 between Curvale and Wurdong for the trip of line 855 Stanwell and Calvale. Constrains off generation at Callide B and C.
Q>PRE855_871GL_ST	142	System normal. Limits transfers across line 871 between Curvale and Wurdong for the trip of line 855 Stanwell and Calvale. Constrains on generation at Stanwell and Gladstone.
Q_CS_1900	44	System normal limitation of 1900 MW on flows from north and central Queensland to the southern load centre.
Q>IHKA7135	15	Outage of Ingham to Kareeya 7135. Thermal limit for Townsville to Alan Sherriff line 7276 or 7277for trip of the other. Constrains off Yabulu.
Q_MK_33BUS	10	Outage of line T38 Mackay 33kV C Bus. Constrains Mackay GT to zero.
Q_MSPTS_7243	10	Outage of line 7243 Mt Stuart to Townsville South 132 kV line. Constrains Mt Stuart 1 to zero
Q>KATU_7253	10	Outage of Kareeya to Tully132kV line 7253. Thermal limit for Townsville to Alan Sherriff line 7276 or 7277 for trip of the other. Constrains off Yabulu
Q>GD_BT_XFMR	6	Outage of H7/T5 Bus Tie Transformer. Maintain remaining BTT within 2 hour rating post contingent. Constrains Gladstone 3 and 4 to above 450
Q:NIL_CN1	5	System normal. Central Qld to North Qld transient stability limit for loss of either Nebo to Strathmore (822 or 840) 275kV line. Constrains on 884 MW of north Queensland
Q_KMBG_7143	3	Outage of line 7143 Kamerunga to Barron Gorge PS 132 kV line. Constrains off Barron Gorge
@Q_GLD910	3	constrains on Gladstone, "Network support for Gladstone"
Q_CNRM_7164	3	Outage of 7164 Chincilla to Roma 132 kV line. Constrains off Roma 8

CONSTRAINT ID	HOURS	DESCRIPTION
Q>BKSB_8819_SB2	2	Out=275kV Fdr 8819 , Post contingent loading for BKSB fdr 803 for outage of Fdr 817. Control on SB Min Loading
@Q_GLD1161	1	constrains on Gladstone, "Network support agreement"
Q:CN930	1	Qld Central to North upper transfer limit of 930 MW (discretionary)
Q>TVTU_7134	1	Out=Townsville PS -Tully132kV line 7134. Thermal limit for Townsville-Alan Sherriff 7276 or 7277for next contingency being either 7277 or 7276. Constrains off Yabulu.
Q>TVAS_7276	0.3	Out=Townsville-Alan Sherriff 132kV line, 7276 or 7277. Thermal limit for Townsville-Alan Sherriff line, 7276 or 7277for next contingency being either one of the Ingham T'ville 132kV lines, 7132 or 7133. Constrains off Yabulu
Q^NIL_1CS	0.3	Central to south limit. Out=Nil , CQ-SQ Transfer System Normal<=voltage stability calculation(1277.2+f(units on;MW,kV)-50CalcMarg),calc below 1750, 1900 washout applied ; Gladstone Q margin
Q>GD_BT_XFMR_400	0.3	Outage of H7/T5 Bus tie transformer. Constrains on generation at Gladstone 3 and 4 to greater than 450 MW.
Q>IHTV_7133	0.2	Outage of line 7133 between Ingham and Townsville. Constrains off Yabulu
Q>TV_TYP	0.2	Outage of line 7241 between Townsville and Townsville PS or switch yard bus. Constrains Yabulu to zero.

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	DESCRIPTION
Q_STSTN_862	853	Long term outage of line 862, constrains Stanwell 2 to zero
Q_CLCB_851	821	Long term outage of line 851, constrains Callide B 1 to zero
Q_CLCB_852	723	Long term outage of line 852, constrains Callide B 2 to zero.
Q_MIMPP_9905	350	Long term outage of line 9905, constrains Millmerran to zero.

CONSTRAINT ID	HOURS	DESCRIPTION
Q_KMBG_7184	106	Network outage of line 7184, constrains Barron Gorge to zero.
Constrains off Yabulu	70	Collection of constraints which manage network outages in northern Queensland around Alan Sherrif which limits generation at Yabulu.
Q>BI_1TX_865_GD460	39	Outage of Boyne Island transformer or line 865 between Wurdong and Gladstone. Constraints generation at Gladstone units 3 and 4 above 460 MW.
Q>TVTU7134_IHKA7135	27	Outage of line 7134 between Townsville and Tully and line 7135 between Ingham and Kareeya. Thermal limit for line 7276 or 7277 between Townsville and Alan Sherriff for loss of other.
Q_CV_CB4232	25	Network outage of Collinsville CB, constrains Collinsville 3 to zero
Q_CV_CB4242	24	Network outage of Collinsville CB, constrains Collinsville 4 to zero
Q_OKTA_7246	21	Network outage of line 7246. Constrains Oakey to zero
Q>IHTV_7132	18	Outage of Ingham to Townsville 132kV line 7132 or 7133. Thermal limit for Townsville to Alan Sherriff line 7276 or 7277, for trip of the other.
Q_OKTA_7247	18	Outage of Ingham to Kareeya line 7135. Thermal limit for Townsville to Alan Sherriff line 7276 or 7277 trip of the other. Constrains Oakey to zero
Q_MSPTS_7242	11	Outage of line 742 Mt Stuart to Townsville south 132 kV line. Constrains Mt Stuart 2 to zero
Q:NE_SVC	3	Outage=Nebo SVC, (Offset -90), Central Qld to North Qld transient stability limit for loss of either Nebo to Strathmore (822 or 840) 275kV line. Limit is a function of NQLD GTs on/off . Outage of Nebo SVC
QLD_BCTR	1	Separation between Bulli Creek and Tarong, allow Millmerran to flow into NSW
Q_LVDS	1	Out=Lilyvale Dysart 7150 132kV line, 275kV flow into Nebo <= 820MW. Constrains on north Queensland

H10. NEW SOUTH WALES INTRA-REGIONAL CONSTRAINTS

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	DESCRIPTION
N>N-NIL_1U	41	Outage=Nil, avoid overloading Mt Piper 330 to Mt Piper 132 (94Y) 132kV line on loss of Mt Piper to Wallerawang (71) 330kV line, Feedback
N>N-NIL_28	5	Out= NIL, avoid Marulan->Dapto(8) overload on Marulan-Avon(16) trip;Fb;Scaled
N>N-NIL_1T	5	Out= NIL, avoid Liddell->Tomago(82) overload on NIL trip; intra-; FBk
N>N-NIL__K	3	System normal, avoid Wallerawang->Ingleburn(77) overload on Wallerawang –Sydney South(76) trip; FBk
N>N-NIL__U	3	Out= NIL, avoid Kangaroo Valley->Dapto (18) overload on NIL trip; Fb
N>N-NIL_04	1	NSW internal, Outage of NIL, load on 4 on trip of 5
N>N-NIL_1N	0.4	Out= NIL, avoid Liddell->Tomago(82) overload on Liddell-Newcastle(81) trip; intra-; FBk
N>N-NIL_1G	0.3	Out=Nil, avoid overload Vales Point to Munmorah (23) line on loss of Vales Point to Sydney North (22) line, Feedback
N>N-NIL_1E	0.1	NSW internal, Outage of NIL, load on 81 on trip of 82

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	DESCRIPTION
81 line outage constraints.	94	Constraints managing outages of the 81 line between Liddell and Newcastle. Aggregation of constraints N>N-81* and N:N_LDNC_1
N>N-81__1T	59	Out= Liddell-Newcastle(81); avoid Liddell->Tomago(82) overload on Nil trip; Opt3_intra,Fb
N>N-81__19	15	Out= Liddell-Newcastle(81), avoid Liddell->Tomago(82) overload on 32 trip; FbRdf
38 line outage constraints.	14	Constraints managing outages of the 38 line between Regentville and Sydney West. Aggregation of constraints of the form N>N-38*

CONSTRAINT ID	HOURS	DESCRIPTION
N>N-38_20A	10	Out= Regentville-Sydney West (38), avoid Liddell->Newcastle(81) overload on Liddell-Tomago(82) trip; intra-; FBk
N_X_CB5012_CB5272	9	Network outages of CBs 5012 and 5272. WW07 set to zero.
N>N-81__22	8	NSW internal, Outage of 81 , loading of 82 on trip of 31
N:N_LDNC_1	8	Out= Liddell-Newcastle(81), avoid Synch.loss(N:N) on Liddell-Tomago(82) fault
N_X_6_18	7	Multiple outage of Canberra to Kangaroo Valley (6) and Dapto to Kangaroo Valley (18) 330 kV lines. Shoalhaven generation set to zero.
N>N-81__07	4	Out= Liddell-Newcastle(81); avoid Eraring->Newcastle(93) overload on Liddell-Tomago(82) trip; Fb
N>N-38__19	4	NSW internal, Outage of 38, loading of 82 on trip of 81
N_X_CB5042_CB5242	3	Network outages of CBs 5042 and 5242. MM04 set to zero
N>N-29__07	2	Out= NIL, avoid Kangaroo Valley->Dapto (18) overload on NIL trip; Fb
N>N-LOTG_1	1	Out= Bayswater-Liddell(34)+5012+5022; avoid 5032 overload on Bayswater to Sydney West (32) trip
N>N-38__20	1	NSW internal, Outage of 38, loading of 81 on trip of 82.
N>N-31__03	0.3	NSW internal, Outage of 31, loading of 23 on trip of 22.
N>N-38_19A	0.2	Out= Regentville-Sydney West (38), avoid Liddell->Tomago(82) overload on Liddell-Newcastle(81) trip; intra-; FBk
N>N-81__27	0.2	NSW internal, Outage of 81, loading of 82 on trip of NIL

H11. SNOWY INTRA-REGIONAL CONSTRAINTS

Constraints modelling nominal transmission conditions

Nil.

Constraints modelling transmission outages

Nil.

H12. VICTORIA INTRA-REGIONAL CONSTRAINTS

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	DESCRIPTION
Hazelwood transformers.	101	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	97	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, around 2079 MW of installed capacity.
V>V2NIL	3	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, around 1719 MW of installed capacity.

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	DESCRIPTION
V>V_XEPMB	9	Outage = Both Eildon to Mt Beauty 220kV lines, limit Southern Hydro generation to avoid overloading either Dederang to Mt Beauty 220kV line for trip of one the lines
V_APPT	3	Network outage of Anglesea to Port Henry line. Constraints Anglesea to zero.
V>EPTT	3	Outage =Eildon to Thomastown 220kV line, limit Southern Hydro generation to avoid overloading either Dederang to Mt Beauty 220kV line for trip of one the lines
Latrobe Valley discretionary limits.	2	Discretionary constraints to manage network outages and limits from Latrobe Valley to Melbourne. Aggregation of constraints of the form V>LV2*
V>LV2_1900	1	Discretionary upper limit on Latrobe Valley generation (except Yallourn)
V>V_HWSM_R	1	Outage of Hazelwood to South Morang 500kV line, limit Latrobe Valley generation except Yallourn to avoid overloading the remaining Hazelwood to South Morang 500kV line for trip of the Hazelwood to Rowville No.4 500kV line, Radial
V>V_EPMB	1	Out = Eildon to Mt Beauty 220kV line, Mt Beauty 220kV Bustie CB closed, limit Southern Hydro generation to avoid overloading of Dederang to Mt Beauty 220kV line for loss of the other Dederang to Mt Beauty 220kV line
V>LV2_1750	1	Discretionary upper limit on Latrobe Valley generation (except Yallourn)
@LV080704	1	Discretionary upper limit of 2841 MW on Latrobe Valley generation. Affects 5619 MW of installed capacity.
V>V10NIL	0.1	Out = Mt Beauty 220kV Bustie CB open, limit Southern Hydro generation to avoid overloading of Dederang to Mt Beauty No.2 220kV line for loss of Dederang to Mt Beauty No.1 220kV line

H13. SOUTH AUSTRALIA INTRA-REGIONAL CONSTRAINTS

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	DESCRIPTION
@S-NPS_PLAY<530	1	Discretionary constraints reclassifying Northern as a single contingency. Limits dispatch of Northern power station. Used on 11 June, no market notices.
@S-NPS_PLAY<560	0.1	Discretionary constraints reclassifying Northern as a single contingency. Limits dispatch of Northern power station. Used on 11 June, no market notices.

Constraints modelling transmission outages

Nil.

H14. TASMANIA INTRA-REGIONAL CONSTRAINTS

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	DESCRIPTION
T:T_NIL_2	12	Out = Nil, constrain Gordon generation on to avoid transient instability for fault and trip of a Liapootah to Chapel St line or a Liapootah to Palmerston line
T>T_NIL_110_8	3	Out = Nil, avoid overload the New Norfolk to Creek Road line for loss of the New Norfolk to Chapel St line
T>T_NIL_220_13	2	Out = Nil, avoid overload a Chapel Street 220/110kV transformer for loss of a parallel transformer, Feedback
T:T_NIL_1	1	Out = Nil, Basslink importing only, avoid transient instability for fault and trip of a Farrell to Sheffield line
T>T_NIL_110_8_PM	0.2	Out = Nil, Palmerston 110kV bus split, avoid overload the New Norfolk to Creek Road line for loss of the New Norfolk to Chapel St line
T>T_NIL_220_12B	0.1	Out = Nil, avoid overload the Burnie 220/110kV No.3 transformer for loss of one of the Burnie 220/110kV No.2 transformer, Feedback
T>T_NIL_220_12A	0.1	Out = Nil, avoid overload the Burnie 220/110kV No.2 transformer for loss of one of the Burnie 220/110kV No.3 transformer, Feedback
T>T_NIL_220_6B	0.1	Out = Nil, avoid overload the Palmerston to Sheffield line (flow to South) for loss of a Sheffield to Georgetown line, Feedback

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	DESCRIPTION
T>T_LE_T_WA_2_3	3	Out = Lake Echo Tee to Waddamana No.2 110kV line, avoid O/L the Waddamana to Lake Echo No.1 line for loss of the Meadowbank to New Norfolk line
T>T_CS_TX3	2	Outage of chapel street transformer, constrains off Gordon and constrains on southern Tasmanian generation.
T>CS_TX3_RI_TRIP_PM	2	Out = Chapel St No.3 220/110kV transformer, Chapel St Transformer overload guard armed, Palmerston 110kV bus split, avoid overloading a Chapel St 220/110kV transformer for loss of a parallel transformer, Feedback
T>T_BUSH1_220	1	Out = Burnie to Sheffield 220kV line, Hampshire link open, avoid O/L a Sheffield 220/110kV transformer for loss of the other Sheffield 220/110kV transformer
T_SHDG	1	Outage of Sheffield to Devils Gate. Constrain Devils Gate to zero.
T>T_HA_TX	1	Out = Hadspen 220/110kV transformer, avoid O/L Palmerston 220/110kV transformer for loss of the remaining Hadspen 220/110kV transformer
T>CS_TX3_RI_TRIP	1	Out = Chapel St No.3 220/110kV transformer, Chapel St Transformer overload guard armed, avoid overloading a Chapel St 220/110kV transformer for loss of a parallel transformer, Feedback
T_PO110_MIN_60	1	Minimum loading level of Poatina 110 of 60 MW.
T>T_CS_TX3_PM_SPLIT	1	Out = Chapel St No.3 220/110kV transformer, Palmerston 110kV bus split, avoid overloading a Chapel St 220/110kV transformer for loss of a parallel transformer, Feedback
T>T_TULE_T2_WA_2	0.2	Out = Tungatinah to Lake Echo Tee to Waddamana No.2 110kV line, avoid O/L the Waddamana to Lake Echo No.1 line for loss of the Meadowbank to New Norfolk line
T>T_HA_GT_220_3B	0.1	Out = Hadspen to Georgetown 220kV line, avoid O/L the Sheffield to Palmerston No.1 line (flow to South) for loss of the Hadspen to Georgetown No.2 line

H15. CONSTRAINTS SETTING REQUIREMENTS FOR FREQUENCY CONTROL ANCILLARY SERVICES

Constraints modelling nominal transmission conditions

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
F_I+NIL_MG_R6	8678	252,507	2	Outage=Nil, Raise 6 sec Service Requirement for a NEM Generation Event
F_I+NIL_MG_R5	8636	132,420	1	Outage=Nil, Raise 5 min Service Requirement for a NEM Generation Event
F_I+LREG_0150	6575	98,748	1	NEM Lower Regulation Requirement greater than 150 MW
F_I+NIL_MG_R60	8636	94,797	1	Outage=Nil, Raise 60 sec Service Requirement for a NEM Generation Event
F_I+TL_L5_0600	1004	94,541	8	Lower 5 min Service Requirement for a NEM Network Event, TL = 600
F_I+RREG_0150	6566	89,924	1	NEM Raise Regulation Requirement greater than 150 MW
F_I+MLOAD_L5_0370	7484	73,471	1	Outage=Nil, Lower 5 min Service Requirement for a NEM Load Event, ML = 370
F_I+LREG_0140	2184	39,556	2	NEM Lower Regulation Requirement greater than 140 MW
F_T+TL_L60_0200	1020	16,714	1	Lower 60 sec requirement for a Tasmania Network Event, TL = 200, 1% load relief
F_I+MLOAD_L6_0370	6997	12,684	0	Outage=Nil, Lower 6 sec Service Requirement for a NEM Load Event, ML = 370
F_I+MLOAD_L60_0370	6253	12,193	0	Outage=Nil, Lower 60 sec Service Requirement for a NEM Load Event, ML = 370

Constraints modelling transmission outages

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
F_S+V_HYML_L5	22	50,511	191	Outage = one Heywood to Moorabool (HYTS-MLTS) 500kV line or one Moorabool to Sydneham (MLTS-SYTS) 500kV line, SA Lower 5 min Requirement
F_SA_ISLE+MG_R60	0.5	40,597	6,766	Raise 60 sec Service Requirement for Islanded SA Generation Event
F_SA_ISLE_L5_0100	0.5	40,569	6,762	Lower 5 min Service Requirement for Islanded SA Load Event, ML = 100
F_SA_ISLE_L6_0100	0.5	40,000	6,667	Lower 6 sec Service Requirement for Islanded SA Load Event, ML = 100
F_SA_ISLE+MG_R6	0.5	40,000	6,667	Raise 6 sec Service Requirement for Islanded SA Generation Event
F_SA_ISLE+MG_R5	0.5	39,999	6,667	Raise 5 min Service Requirement for Islanded SA Generation Event
F_SA_ISLE_L60_0100	0.5	30,040	5,007	Lower 60 sec Service Requirement for Islanded SA Load Event, ML = 100
F_I+TL_L60_0600	998	20,233	2	Lower 60 sec Service Requirement for a NEM Network Event, TL = 600
F_SA_ISLE+RREG_0070	0.5	16,000	2,667	Islanded SA Raise Regulation Requirement greater than 70 MW
F_SA_ISLE+LREG_0070	0.5	16,000	2,667	Islanded SA Lower Regulation Requirement greater than 70 MW
F_Q+N_BCBR_L5	12	15,384	107	Outage = one Bulli Creek (R3) to Braemar (R2) (9901 or 9902) 330kV line or one Braemar (R2) 330/275kV transformer or one Braemar (R2) to Tarong (H18) (8814 or 8815) 275kV line, Qld Lower 5 min Requirement
F_V+S_HYML_L5	176	12,500	6	Outage = one Heywood to Moorabool (HYTS-MLTS) 500kV line or one Moorabool to Sydneham (MLTS-SYTS) 500kV line, Eastern Lower 5 min Requirement

H16. Constraints used for Grid Support

CONSTRAINT ID	HOURS	DESCRIPTION
@POR01_10	13	Port Lincoln Network Support Agreement
Q_CN_QCVL_60 - 100	3	Powerlink Network Support Agrreement
Q:CN1QMSP1	115	Powerlink Network Support Agrreement
Q:CN1QMSP2	124	Powerlink Network Support Agrreement
Q_CN_QCVL_050 - 150	113	Powerlink Network Support Agrreement
Q_DL_030 - 70	3	Directlink Network Support Agreement
S_SNUG1_05	1	Snuggery Network Support Agreement
V_BDL_20	0.2	Bairnsdale Network Support Agreement
V_BDL01_20 - 40	1	Bairnsdale Network Support Agreement

H17. Constraints used in power system directions

CONSTRAINT ID	HOURS	DESCRIPTION
#MSTUART1_E	9	Has the affect of constraining on Mount Stuart 1
#MSTUART2_E	14	Has the affect of constraining on Mount Stuart 2
#SNUG1_E	113	Has the affect of constraining on Snuggery
@Q-CVL>=120	1	Has the affect of constraining on Collinsville

H18. CONSTRAINTS MANAGING NORTHERN RECLASSIFICATION

Constraints affecting the Victoria to South Australia Heywood interconnector.

CONSTRAINT ID	HOURS	CMV ($)	AVG MV	DESCRIPTION
V:S_NPS_SINGL_CONT_2	878	110,838	11	Vic-SA Stability limit for single credible contingency = Loss of two Northern Power Station units.
V:S_NPS_SIN_COT_2_HY	25	3,162	10	Vic-SA Stab Lmt,SingleCredible Contingency=Loss of 2 Northern PS units
V:S_NPS_SIN_COT_1_HY	15	1,117	6	V-SA transf Lmt<=150MW, NPS<2units.
V:S_NPS_SINGL_CONT_1	0.1	3	3	V-SA transf Lmt<=360MW, NPS<2units.

Constraints affecting Northern generation.

CONSTRAINT ID	HOURS	DESCRIPTION
S:NPS_SINGL_CONT	103	Limit on Northern power station generation whilst loss of both units is declared as a single credible contingency.
S:NPS_SINGL_CONT_HY	49	Limit on Northern power station generation whilst loss of both units is declared as a single credible contingency.
V:S_NPS2=180	46	Maintain NPS Unit 2 = 180 MW with HYTS-SESS line out
V:S_NPS1=180	41	Maintain NPS Unit 1 = 180 MW with HYTS-SESS line out
@NPS1>=180	5	Maintain NPS Unit 1 >minimum load in association with use of S-NPS_SINGLE_CONT
@NPS500	5	Discretionary constraint which forces a fixed load of 500 MW on Northern power station
@NPS<=515	2	Discretionary constraint which limits Northern power station to 515 MW.
@NPS2>=180	2	Maintain NPS Unit 2 >minimum load in association with use of S-NPS_SINGLE_CONT