FINAL REPORT

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Last resort planning power 2012 comparison report

Prepared for Australian Energy Market Commission

SW Advisory

MARSDEN JACOB ASSOCIATES

SW Advisory MARSDEN JACOB ASSOCIATES

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Executive Summary

Marsden Jacob Associates (MJA) in association with SW Advisory undertook a review of the 2012 Annual Planning Reviews (APRs) and 2011 National Transmission Network Development Plan (NTNDP) and previous planning reports for the prime purpose of determining whether there were any apparent inter-regional planning shortfalls.

A planning shortfall might warrant the exercise of the Last Resort Planning Power (LRPP) under the National Electricity Rules.

The review found that the NTNDP has been continually evolving with changes in format and presentation each year that recognised the needs of and feedback from the market. The 'static' nature of the market since 2010 meant that the 2011 NTNDP found that the findings of 2010 NTNDP remain valid, and as a consequence, the 2011 NTNDP did not present revised analysis and modelling from that presented in the 2010 NTNDP.

This meant that the 2010 NTNDP supported by the 2011 NTNDP and Constraints Report formed the basis of ascertaining whether or not the 2012 APRs fully addressed the identified and potential interregional constraint issues.

The 2010 NTNDP and supported by the 2011 NTNDP rated the potential benefits in upgrading interconnectors via the rankings "early attention", "preparatory work" and "monitor". The recommendations of that report were:

- QNI: early attention;
- Vic to NSW preparatory work (two projects considered); and
- SA – Vic nothing given.

The 2012 APRs described the work being done to address these identified opportunities. A summary of work being undertaken as described in the 2012 APRs is presented in Table ES1 overleaf.

The review of the 2012 APR's showed that respective planning bodies had fully accounted for potential interregional projects identified in the 2010 and 2011 NTNDPs. This finding was also consistent with the finding of the 2011 NTNDP which was that the 2011 APRs had addressed the issues identified in the 2010 NTNDP.

Thus we concluded that the jurisdictional planning bodies have fully met their obligations in relation to addressing interregional constraint issues identified in the 2010 and 2011 NTNDPs and observed trends.

Table ES1: Overview of Interconnector Investigations

Inter-connector	Nominal Maximum Capacity	Finding	Timeframe
QNI	NSW-Qld: 400 MW Qld-NSW: 1078 MW	Work being undertaken to address uneconomic constraints on this interconnector. In June 2012 Powerlink and TransGrid published a Project Specification Consultation Report that presented a range of possible options.	Assessment draft report in mid-2013.
Vic to NSW	Vic-NSW: 3200 MW - Tumut Generation NSW-Vic: 1900 MW - Murray Generation	Various projects are being considered by TransGrid and AEMO and a preliminary feasibility study has commenced. A RIT-T has commenced to address increased NCAS to support greater transfers between NSW and Victoria.	Preliminary feasibility study being undertaken.
Heywood	Vic-SA: 460 MW SA-Vic: 460MW	A RIT-T was initiated by ElectraNet and AEMO in June 2011 and a Project Specification Consultation Report was published in October 2011 that presents a range of options	RIT-T commenced June 2011 and PSCR published Oct 2011.
Murraylink	Vic-SA: 220 MW SA-Vic: 188 MW	Work is being undertaken examining options to increase capacity. NSW is to be included in the Murraylink Runback System.	RIT-T assessment by AEMO is pending.
Basslink	Vic-Tas: 478 MW Tas-Vic: 594 MW	The NTNDP did not signal any requirement to upgrade Basslink	N.A.

1. Introduction

The Last Resort Planning Power (LRPP) is an oversight mechanism which allows the Australian Energy Market Commission (AEMC) to direct parties to apply the Regulatory Investment Test – Transmission (RIT-T) to specific projects. Specifically, the AEMC has the authority under the National Electricity Rules to direct Registered Participants (generally Jurisdictional Planning Bodies or TNSPs) to undertake a RIT-T. A direction notice can be issued if the Commission considers that there has not been due consideration of an inter-regional transmission constraint. This power is intended to ensure that there is efficient inter-regional transmission investment across the National Electricity Market (NEM). The AEMC is required to report annually on the matters it has considered, in deciding whether or not to exercise the LRPP in that year.

The AEMC contracted Marsden Jacob Associates (MJA) in association with SW Advisory to provide a report comparing AEMO planning proposals as expressed in the 2011 National Transmission Network Development Plan (NTNDP) against Transmission Network Service Provider (TNSP) responses as provided in their 2012 Annual Planning Reviews (APRs).

The primary objective of the consultancy is to determine whether any apparent planning shortfall exists regarding inter-regional transmission which might warrant the exercise of the Last Resort Planning Power (LRPP) under the National Electricity Rules.

1.1 Terms of reference

The Terms of Reference require the consultant to write a report that provides::

- a brief commentary on the nature of congestion in the NEM in general and specifically how constraints relating to transmission elements deep within a region can affect the flows on interconnectors; and
- a review of transmission planning documents in order to identify if there are any interregional planning gaps.

In this report these two aspects have been respectively labelled:

- Part 1: Nature of Congestion; and
- Part 2: APR Planning Completeness.

The primary purpose of this report is to identify whether there are any apparent transmission planning shortfalls related to interconnectors which might warrant the exercise of the LRPP. In particular, the analysis undertaken for the report was aimed at analysing the various AEMO and TNSP transmission planning and constraint documents to see whether there were any inter-regional constraints identified where TNSPs did not appear to have undertaken an appropriate level of transmission planning to investigate whether they could be economically relieved.

The specific Terms of Reference for the assignment were as follows.

Part 1 – Nature of congestion

The AEMC is seeking commentary on the nature of congestion in the National Electricity Market (NEM). This introductory commentary will provide:

- a brief overview of congestion in the NEM and how constraints affect dispatch;
- a description of how many constraint equations contain interconnector terms in the NEM; and
- an explanation of how constraint equations with an interconnector term can influence inter-connector flows, including a constraint which exists deep within a region and does not reflect physical limits on parts of the network that cross region boundaries.

Part 2 – Planning completeness

The analytical component of the comparative report will:

- summarise AEMO's 2011 and 2010 NTNDPs (National Transmission Network Development Plan), including a detailed summary of all proposed inter-regional planning opportunities described in those documents as well as accounting for the 2011 AEMO Congestion Report;
- review and consider all the relevant TNSP Annual Planning Reports (APRs) for 2011 and 2012;
- review and consider any other relevant TNSP planning initiatives which relate to inter-regional network development;
- provide a detailed summary of how each of the TNSPs have responded to planning opportunities expressed in the NTNDPs, whether in the APRs or in any other relevant planning initiatives;
- identify if there is any 'gap' where a TNSP has not responded adequately to planning opportunities identified by AEMO; and
- if a gap is identified, make a recommendation as to whether there is any need for the AEMC to undertake further analysis.

For all parts of this assignment the required deliverables are to consist of (but may not be limited to):

- the preparation of a draft comparative report;
- consideration of any staff comments and incorporation of these comments; and
- the preparation of a final report to be published on the AEMC's website.

2. Approach to this assignment

This chapter presents the approach proposed for the primary Part 2 of the assignment. This is done by presenting an overview of transmission planning in the NEM, the key reports reviewed and how the approach was modified from the previous year.

Part 1 (nature of congestion) is an explanation of constraint management with a focus on interregional constraints.

2.1 Transmission planning in the NEM

Transmission planning in the NEM involves the jurisdiction planning bodies and AEMO (in its national planning role) providing planning support from a whole of market perspective. The jurisdictional planning bodies are:

- ElectraNet in South Australia;
- Transend in Tasmania;
- AEMO in Victoria;
- TransGrid in New South Wales; and
- Powerlink in Queensland;

The National Electricity Rules (NER) specifies that on an annual basis, the jurisdictional planning bodies are required to publish Annual Planning Reports (APRs) and that AEMO is to undertake a National Transmission Network Development Plan (NTNDP).

The APRs cover the development of the relevant transmission network and generally encompasses issues associated with connection assets (new or existing), shared network issues and development options, and interconnectors (proposals to maintain or increase capacity). The format of the respective APR's has been different as is the approach taken to the explanations and descriptions provided. The outlook in these reports is normally limited to about 10 years;

The NTNDP has a greater strategic focus than that contained the APR's as it considers a wider range of scenarios with a longer term focus on how the electricity market may develop. Consequently options presented in the NTNDP are usually quite conceptual in nature, whereas the APRs generally focus on more concrete options.

To assist the market in understanding the performance of the transmission system, AEMO also produces a Constraints Report that presents details of constraints that impacted the market over the previous year.

2.2 Key reports reviewed in this assignment

The key documents which were reviewed for this assignment were as follows:

- AEMO NTNDP 2010
  - Published before 31 December 2010
- AEMO NTNDP 2011
  - Published before 31 December 2011
  - Inputs include:
    - Constraints published in 2010 Constraints Report
    - Jurisdictional 2011 APR's released by 31 June 2011
- 2011 AEMO Constraints Report
  - Dated 16 February 2012
  - Reports on constraints observed in calendar year 2011
- Jurisdictional planning bodies 2012 APRs
  - Must be released before 30 June 2012
  - Strategic reference is the 2011 NTNDP

2.3 Modified approach

In 2011 the approach adopted by IES to this assignment entailed a comparison of the TNSP planning responses as provided in their 2011 APRs to the identified transmission constraint issues and planning proposals expressed in the 2010 NTNDP developed by AEMO. The review found that the planning responses contained in the respective APR's satisfactorily addressed the issues and proposals contained in the NTNDP.

However the 2011 NTNDP did not present revised analysis and modelling from that presented in the 2010 NTNDP. The 2011 NTNDP stated that the findings of the 2010 NTNDP remain valid.

This meant that the reference by which the 2012 APR's were measured against was necessarily translated to that of the 2010 NTND and any commentary contained in the 2011 NTNDP. The assessment of whether or not there was any planning gaps also required consideration of constraints and trends identified in the 2011 Constraints Report.

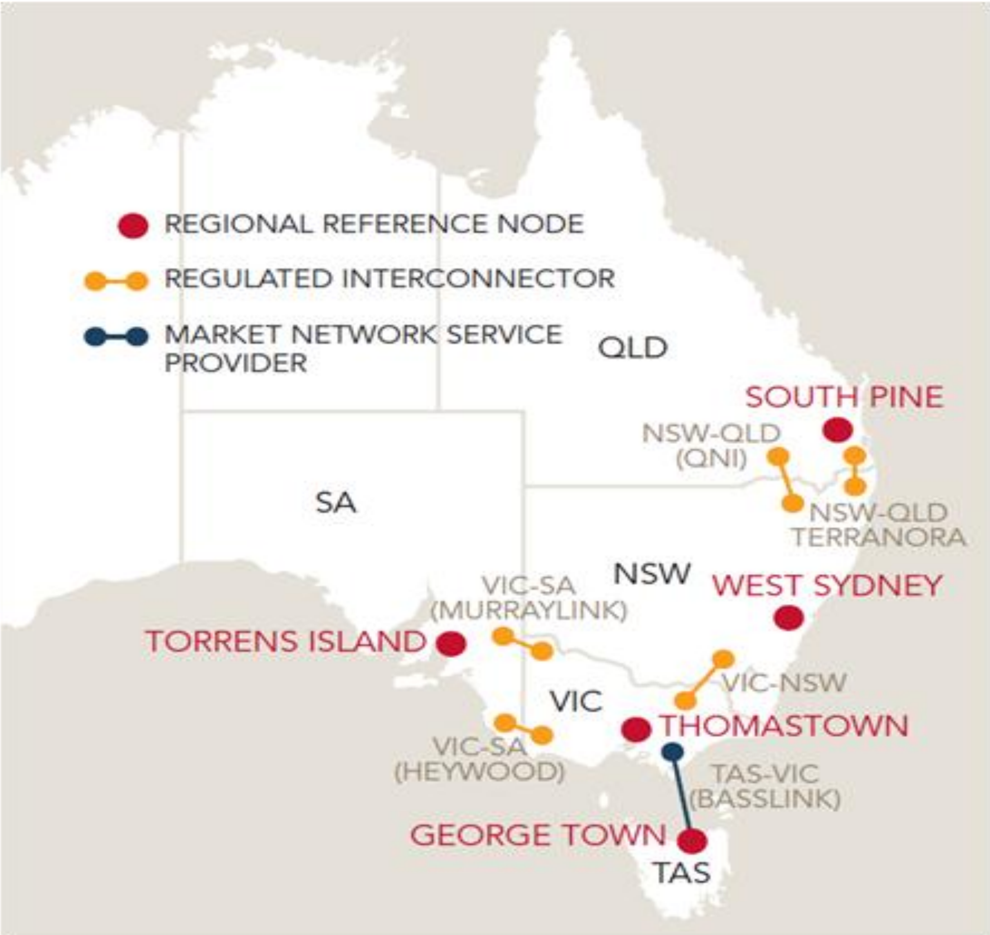
3. The nature of congestion in the NEM

3.1 Regions and interconnectors

The National Electricity Market is a regionally based market design. It has five regions: Queensland, New South Wales, Victoria, South Australia and Tasmania. The regions are largely based on state boundaries but the NSW region includes the ACT. The regions are connected by six notional interconnectors: QNI, Terranora, Vic-NSW, Heywood, Murraylink and Basslink, these are presented in Figure 1 and Table 2. QNI, Vic-NSW and Heywood interconnectors are HVAC links while Terranora, Murraylink and Basslink are HVDC links.

An interconnector between two regions in the NEM notionally connects the regional reference node of the exporting region to the regional reference node of the importing region. The interconnector can effectively be made up of many physical transmission lines or network elements.

Figure 1: National Electricity Market Interconnectors



Source: Introduction to Australia's National Electricity Market July 2010, AEMO.

Table 1: Interconnectors in the NEM

Name	From region	To region
QNI	New South Wales	Queensland
Terranora[1]	New South Wales	Queensland
Vic – NSW	Victoria	New South Wales
Heywood	Victoria	South Australia
Murraylink	Victoria	South Australia
Basslink[2]	Tasmania	Victoria

3.2 Congestion

Transmission line congestion occurs when the power flows along one or more transmission lines are constrained to be less than what would be desirable if the cheapest generation were dispatched first, in order to meet the NEM's regional demands, allowing for losses. Congestion generally results in the dispatch of more expensive generation than otherwise would have been the case and very occasionally, curtailment of loads.

Power system security in the NEM is managed by AEMO controlling the dispatch of generators, dispatchable loads and DC transmission lines so that the power system remains in a secure state. This involves ensuring that the power system remains within its technical limits. The technical limits may correspond to such things as the maximum flows on one or more power lines and minimum and maximum voltages at points in the network.

The technical limits for power flows are calculated such that pre-contingent flows will be maintained below the continuous ratings of the relevant network elements and post-contingent flows will be maintained below the emergency ratings of the relevant equipment. These limits are called thermal limits. Other limits may correspond to managing transient stability, steady state stability or voltage stability.

3.3 System security and the NEM's network model

Although the NEM market design is a regional model with 5 regions and 6 interconnectors the actual physical transmission network has over 2,000 nodes (connection points and busses) and around 3,000 lines, including three DC interconnections. Unlike some markets which have explicit dispatch models of the underlying physical transmission system, the NEM has a regional model which uses an implicit network model.

The NEM dispatch engine (NEMDE) explicitly models generator, load, MNSP and interconnector dispatches. Network and power system security issues are managed via the use of "generic constraints" which limit generator dispatches and interconnector flows in order to maintain the power system in a secure state. The "generic constraints" essentially provide an implicit network model of the NEM.

Generic constraints are used to manage all network limits and system security requirements including:

[1] Formerly Directlink.

[2] Note that Basslink is the only market network service provider (MNSP), an unregulated interconnector.

- frequency control ancillary service (FCAS) requirements;
- thermal, voltage stability and transient stability limits;
- network support and network control ancillary services (NCAS);
- ramping of network flows to enable outages; and
- other power system management issues.

Because the NEM interconnectors are notional interconnectors and are effectively made up of a large number of physical network elements, congestion in any one of these physical network elements can cause congestion in the interconnector. This in turn means that there are many "generic constraints" that can affect the flows on interconnectors. In fact about 70% of constraints which are used to manage network limits affect interconnector flows.

3.4 NEM Dispatch Engine (NEMDE)

The NEM dispatch engine, NEMDE, is a linear programming (LP) optimisation that maximises the value of spot market trade. In practical terms, NEMDE effectively minimises the dispatch costs based on generator offers for energy and load and generator offers for frequency control ancillary services (FCAS), subject to meeting the regional demands and satisfying network and security constraints. NEMDE runs every five minutes and produces as outputs:

- the dispatches of energy and FCAS for generators and dispatchable loads;
- interconnector flows and losses;
- regional energy prices; and
- shadow prices or marginal costs of constraints.

3.5 Impact of constraints on dispatch

If there were no constraints used in NEMDE that limited the dispatch of generators then the generator dispatch outcomes would be based on the least cost generation which could be used to meet the regional loads once marginal transmission losses had been taken into account. The impact of including transmission and security constraints into the dispatch process is that the dispatch of some cheaper generation will be reduced and the dispatch of some higher cost generation will be increased to meet the actual demands. When this occurs, one or more constraints will be said to be binding, that is, the constraint is affecting the dispatch. The impact that a binding constraint is having on dispatch costs can be determined from its shadow price. A constraint's shadow price is a measure of how much the dispatch costs could be reduced if the constraint were relaxed by say one MW. Thus when analysing the impact of constraints there are two quite useful measures: the amount of time a constraint is binding and the constraint's average marginal cost (average shadow price).

3.6 Constraint equations

NEMDE manages the dispatches generation so that the power flows stay within the thermal, voltage, and stability limits of the transmission network. These limits are managed by constraint equations in the dispatch process. A constraint equation may contain a linear combination of generator and interconnector terms which represent generator dispatches of energy and FCAS and interconnector flows. As well a constraint equation may contain terms which represent non dispatchable inputs such as electricity demand in various locations, thermal limits of transmission lines, current flows in the network and availability of reactor and capacitor banks.

Each constraint equation or set of constraint equations represents a particular type of power system limitation or requirement. Constraint equations can also exist for specific configurations of the power system such as system normal or plant outages. These power system limitations include the following types:[3]

Network

- Thermal – for managing the power flow on a transmission element so that it does not exceed a rating (either continuous or short term) under normal conditions or following a credible contingency.
- Voltage Stability – for managing transmission voltages so that they remain at acceptable levels after a credible contingency.
- Transient Stability – for managing network flows to ensure the continued synchronism of all generators on the power system following a credible contingency.
- Oscillatory Stability – for managing network flows to ensure the damping of power system oscillations is adequate following a credible contingency.
- Network Control Schemes – the modelling of generator control schemes or reactive control devices on generator output.

Frequency control

- Frequency Control Ancillary Services – for maintaining the frequency within the Reliability Panel standards.

Other

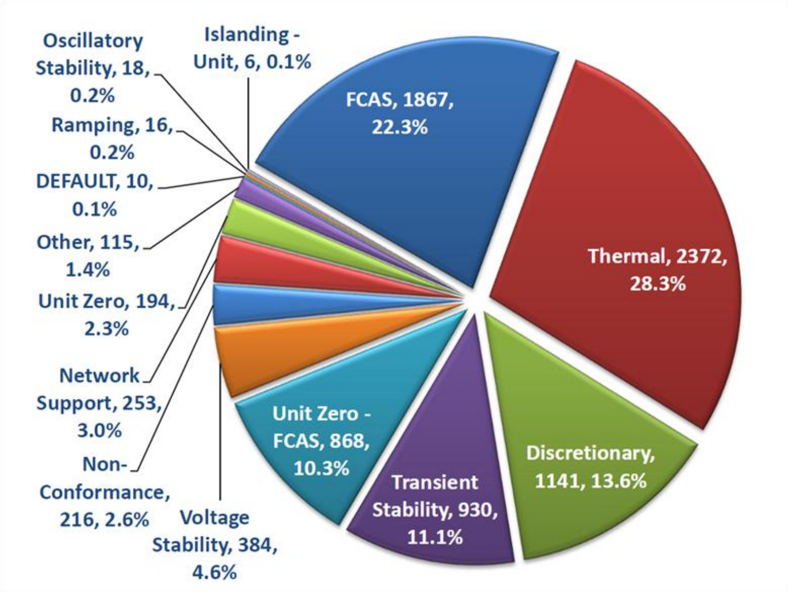
- For managing negative residues.
- For managing ramping and rate of change of interconnector flows and generator dispatches.
- For managing non-conformance of generators to dispatch instructions.
- For managing network support agreements.
- Unit Zero: for managing a generating unit that is unable to generate, but is not bid in as unavailable (this may be the case when a generating unit is connected to a transmission element or group of transmission elements that are removed from service),
- For allowing system operators to impose a discretionary limit on generators and/or interconnectors.

AEMO reports that as of 31st December 2011 there were approximately 9523 constraint equations.[4] Figure 2 shows a breakdown of the constraint equations by the type of limit they manage.

[3] Constraint Formulation Guidelines, Document Ref: 170-0040, Version: 10, 6 July 2010, AEMO.

[4] The NEM Constraint Report 2011, 16 February 2012, AEMO (Ben Blake).

Figure 2: Breakdown of the constraint equations by type of limit



Source: NEM Constraint Report 2011, AEMO.

3.7 Inter-regional constraints

Within the NEM there is often a perception that interconnectors are just a bit of transmission system connecting two regions and inter-regional flows could be substantially increased by removing a few inter-regional blockages or "pinch points". This perceptions stems from the NEM's market model where there are just regions and interconnectors connecting regions. However this is not the physical reality. For a meshed network, the flow in any part of the network will be related to flows in other parts of the network. Thus, due to the meshed nature of the NEM's transmission system the flow between two regional reference nodes can be limited by sections of the physical network distant from the regional boundary. Basically any line in the meshed part of the network between regions can affect the inter-regional flows between the regions. This leads to the definition of an inter-regional constraint being one that can affect the dispatch of flow between two regional reference nodes. In practical terms this equates to an inter-regional constraint being one that contains an interconnector term in the constraint equation.

Approximately 70% of network constraint equations contain an interconnector term and hence impact interconnector flows and approximately 36% of FCAS constraints contain an interconnector term and hence affect interconnector flows. The FCAS constraints that affect interconnector flows a predominately related to Basslink.

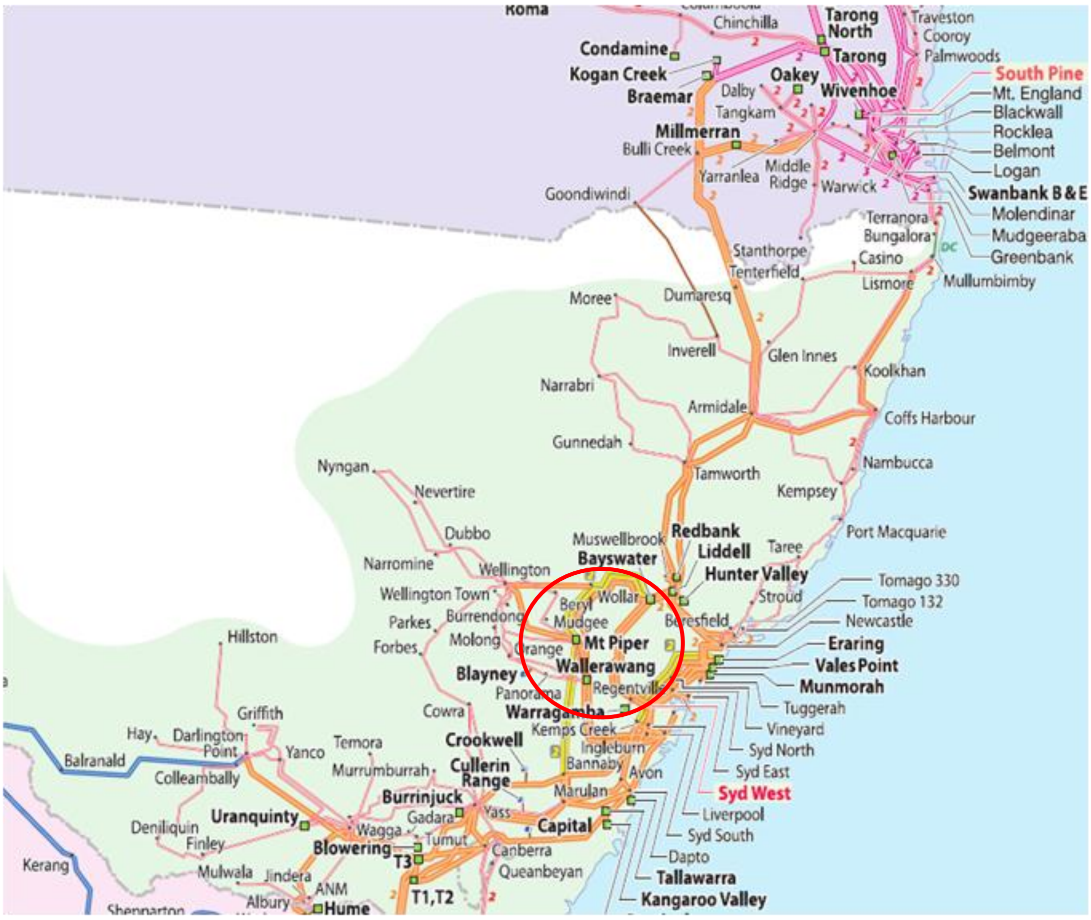
3.8 Example of Constraint Distant from Regional Boundary

As discussed earlier constraints which manage the loading on network elements well away from a regional boundary can substantially affect interconnector flows. How this can occur is nicely illustrated in AEMO's "Constraint Master Class – 70 and 71 limit" presentation.[5] The following is a rough summary of the key points of the presentation.

[5] http://www.aemo.com.au/en/Electricity/Congestion-Information-Resource/Constraint-Master-Class-and-limit

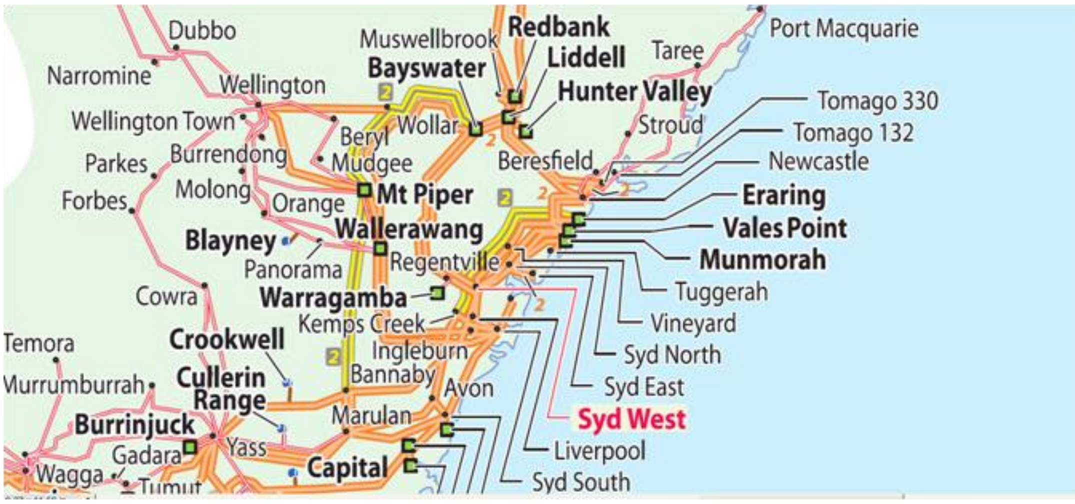
The constraint “N>>N-NIL__S” is a system normal constraint associated with the 70 and 71 lines between Mt Piper and Wallerawang in New South Wales. Figure 3 and Figure 4 are diagrams of the physical transmission network in the area surrounding these lines.

Figure 3: Schematic of transmission network in NSW and southern QLD



Source: AEMO.

Figure 4: Transmission network map of Sydney area in NSW



Source: AEMO.

The constraint N>>N-NIL__S is used to avoid an overload on the Mt Piper to Wallerawang line (line 70) on a trip of the Mt Piper to Wallerawang line (line 71). This is a system normal constraint with feedback which is used to manage a thermal limit.

Even though lines 70 and 71 are a long way from the boundary between the NSW and QLD, regions flows on QNI can affect flows on these lines, and hence managing a potential overload on line 70 will affect the dispatch of QNI. In fact, the dispatchable terms of this constraint equation (terms in the left hand side of the equation) include interconnector flows for not only QNI but also Vic-NSW and Terranora interconnectors as well. The constraint equation also includes terms for a number of New South Wales generators (Uranquinty, Mt Piper, Redbank, Liddell, Bayswater and Snowy). Thus when/if the constraint N>>N-NIL__S is binding, it has an impact upon both New South Wales generation and three interconnectors: QNI, Terranora, and Vic-NSW.

The AEMO's 2011NEM Constraint Report does not identify this constraint equation as being in the top 20 constraint equations in terms of binding hours or constraint costs. However, the 2010 NTNDP lists it as being one of the network constraint equations which bound more than 100 hours in the 2009/10 year. During this period, it impacted on southerly flow on the QNI and Terranora interconnectors as well as northerly flow on the Vic-NSW interconnector.

4. Review of NTNDP 2010 and 2011

This chapter presents a review of the 2010 and then 2011 NTNDP reports developed by AEMO. The 2011 NTNDP report was published prior to the release of the 2011 Constraints Report and the 2012 APRs.

4.1 Review the 2010 NTNDP

The 2010 NTNDP presented a change in approach from the earlier ANTS and NTS reports. The report introduced and described five long term “strategic” scenarios for the industry and two carbon price scenarios giving a total of 10 different scenarios. These 10 different scenarios were used to provide the potential drivers of upgrade options to be explored in the modelling of transmission congestion and upgrade solutions. In addition to the transmission modelling, the 2010 NTNDP report also outlined the number of hours each interconnector was constrained and the related constraint equations which were binding for more than 100 hours in the 2009-10 year. The report did not outline the associated market costs (marginal dispatch costs) of the binding interconnector constraints, though these are outlined in AEMO’s 2010 NEM Constraint Report.

Chapter 3 of the 2010 NTNDP presents the modelling outcomes of a 20 year optimised generation and transmission development plan for each scenario. The modelling outcomes are based on a least cost modelling approach, in which fuel costs differ only marginally between the regions and new generation is usually selected to meet regional capacity requirements.

The 2010 NTNDP report makes the distinction between projects addressing intraregional and interregional flows very clear. The report uses a nomenclature of region and project number if the project is addressing intra-regional flow constraints and it uses from and to regions and project number if the project is addressing inter-regional constraints. The letters S, V, N, Q are used to stand for SA, Victoria, NSW, Queensland and Tasmania respectively. Some examples of constraints impacting flow within and between regions are illustrated below:

- Q1 stands for Queensland Project No 1;
- N3 stands for NSW Project No 3; and
- SV1 stands for SA to Victoria Project No 1.

The report presented changes in generation by technology on a NEM wide basis followed by transmission developments, including increased interconnection, likely to be required. The transmission developments that occurred in at least one of the scenarios were identified. The interconnection upgrades that occurred in at least one of the scenarios are presented in Table 2 overleaf.

The key findings of the 2010 NTNDP report included:

- between $40 billion and $30 billion in investment is required to augment the shared transmission network and develop new generation assets across the NEM;
- augmentation of the Queensland to New South Wales (QNI) interconnector proceeds in five out of ten of the scenarios; and
- in two of the scenarios an incremental upgrade of the Victoria-South Australia interconnector (Heywood) proceeds in the final years of the 20-year outlook period.

Table 2: Potential Interconnector Upgrades Identified in the 2010 NTNDP

Inter-connector	Option	NTNDP 2010 recommendation	Suggested augmentation	Drivers
QNI	QN1	Early attention	Series compensation on the 330 kV Armidale-Dumaresq circuits and 330 kV Dumaresq-Bulli Creek 330 kV circuits	NSW exporting to QLD during high demand, QLD exporting to NSW during lower demand
Vic-NSW	NV1	Preparatory work	A new 220 kV, 250 MVA phase angle regulator on 220 kV Buronga-Red Cliffs interconnection	High power exports from Vic to SA over Murraylink
Vic-NSW	NV2	Preparatory work	Installation of a fourth 330/220 kV Dederang transformer and a third 700 MVA 330/220 kV South Morang transformer, a phase angle regulator on the 330 kV Jindera-Wodonga circuit, up-rating of the 220 kV Eildon-Thomastown and 330 kV South Morang-Dederang circuits, a cut-in of the 220 kV Rowville-Thomastown circuit at South Morang, and series capacitors on the 220 kV Eildon-Thomastown and 330 kV Wodonga-Dederang circuits.	Increased NSW to Vic exports during low demand
Vic-SA	VS1	None given	A third Heywood 500/275 kV transformer, a 100 MVAr capacitor bank at South East Substation, 275 kV series compensation between the South East Substation and Tailem Bend Substation, a SVC at Tailem Bend, increase of the relevant circuit ratings to line design ratings by protection and selected plant modifications.	Increased renewable generation in SA exporting to Vic during non peak load conditions
Vic-SA	VS2	None given	A third Heywood 500/275 kV transformer, a 100 MVAr capacitor bank at South East Substation, a third South East 275/132 kV transformer, increase of the relevant circuit ratings to line design ratings by protection and selected plant modifications	Increased renewable generation in SA exporting to Vic during non peak load conditions

4.2 Review the 2011 NTNDP

The format and information presented in the 2011 NTNDP differed substantially from that of the 2010 NTNDP.

Arising from feedback associated with the consultative process regarding the 2011 NTNDP, AEMO concluded (Section 1.1.4):

> *A key conclusion stemming from these responses is that annual updates and revisions for the 2010 NTNDP's 20-year outlook are not a priority, particularly given current levels of demand growth, which remain stable, and the now legislated price on carbon, which falls within the range of possible carbon price trajectories first examined in 2010. Alternatively, the NTNDP should challenge the energy industry (and the electricity transmission sector in particular) to find appropriate technical and structural solutions to efficiently deliver Australia's future power system.*

The 2011 NTND also concluded (Section 1.1.5):

> *The 2010 NTNDP's network plans provided a series of efficient network development outlooks for a range of scenarios, which remain valid because, while there were small movements in demand projections since 2010, load levels and project timings have remained consistent with the 2010 scenarios.*

Noting the above, the structure and focus of the 2011 NTNDP appeared to reflect these conclusions in so far as the level of detail regarding transmission developments was largely confined to a comparison of the transmission developments identified in the 2010 NTNDP with the 2011 APRs for each region. The 2011 NTNDP did not present any updated modelling undertaken by AEMO.

The comparison used the same numbering for transmission developments used in the 2010 NTNDP (which made for easy comparison).

Table 3 presents AEMO's 2011 NTNDP comparison of the interconnector developments recommended in the 2010 NTNDP and their corresponding statuses as reported in the 2011APR reports. The 2011 NTNDP notes that the status and timing of projects listed in the 2011 APR's generally correspond with developments identified by the 2010 NTDP as occurring in the first 10 years. A summary of the key points is presented below.

Augmentations classified as requiring early attention

- QNI:
  - Upgrade benefits being investigated by Powerlink and TransGrid.
- NV1 (phase angle regulator):
  - Transgrid and AEMO to investigate this upgrade.
  - The 2011 Victorian APR has not assessed this upgrade in detail.
  - ElectraNet and AEMO in consultation with TransGrid in 2011/12 intend to proceed with joint planning of this upgrade.

Augmentations classified as requiring preparatory work

- NV2 (upgrading the New South Wales–Victoria interconnector):
  - Transgrid and AEMO to investigate this upgrade.
  - The 2011 Victorian APR has not assessed this upgrade in detail.

Augmentations classified as having no timing listed

The interconnector upgrades SV1 and SV2 between Victoria and SA were not identified in the 2010 NTNDP for development over the next 10 years (as either "Early Attention", Preparatory Work" or "Monitoring"). However, work on the SA-Victorian interconnection included:

- NSW sites being included in the Murraylink Runback Control System;
- AEMO and Electranet jointly undertaking a RIT-T application on options that increase the Victoria - SA (Heywood) interconnector capability.

Table 3: 2011 NTNDP comparison of 2010 NTNDP interconnector recommendations and status reported in 2011 APRs

APR	Option	Rating / Timing	Status of Investigation	Cost $M	Consistency
Powerlink TransGrid	QN1	Early attention	Powerlink and TransGrid are actively investigating upgrade impacts and benefits, and outcomes will be released in 2011. Powerlink 2011 APR, Section 5.2.2. TransGrid 2011 APR Section 3.3 Section 6.2.3	120	The 2011 APR assessment is consistent with the 2010 NTNDP.
Transgrid	NV1	Early attention	The feasibility of a phase angle regulator installation is under investigation. TransGrid and AEMO will investigate the impacts on the power systems in New South Wales and Victoria from increasing Murraylink power transfer capabilities. TransGrid 2011 APR, Section 3.3, Section 6.3.8.	Not listed	The 2011 APR assessment is consistent with the 2010 NTNDP.
AEMO Victoria	NV1	Early attention	The 2011 VAPR has not assessed the need for this augmentation in detail. AEMO will continue to work with ElectraNet and TransGrid on potential augmentations as part of the NTNDP.	Not listed	-
Transgrid	NV2	Preparatory work	TransGrid and AEMO would jointly undertake this work. TransGrid 2011 APR, Section 3.3, Section 6.3.1, and Section 6.3.8	Not listed	The 2011 APR assessment is consistent with the 2010 NTNDP.
AEMO Victoria	NV2	Preparatory work	AEMO has not assessed the benefits of upgrading the New South Wales–Victoria interconnector in detail for the 2011 VAPR. AEMO will continue to work with TransGrid on potential augmentations as part of the NTNDP	Not listed	The 2011 APR assessment is consistent with the 2010 NTNDP.
ElectraNet	NV1	Early attention	EletraNet and AEMO intend to proceed with joint planning to develop augmentation options and undertake preliminary market simulation studies, in consultation with TransGrid, during 2011-12. ElectraNet 2011 APR, Section 10.2 and Appendix A.	Not listed	-

5. Review of interconnector constraints in 2011

This chapter presents a review of interconnector transmission constraints for calendar year 2011 as presented in the NEM Constraints Report 2011 dated 16 February 2012. This report is produced by AEMO to provide information about constraint equation trends and performance. The emphasis of the report is on the number of hours constraint equations were binding in 2011 and how this changed from 2010.

Included in the report are the following:

- changes to constraint equations from the previous year;
- the composition of constraint equations (FCAS, outage, system normal, quick, automation etc);
- the 20 most binding constraint equations (in terms of hours binding);
- trends in binding constraints by region, limit type (FCAS, thermal, network support etc), and system normal/outage conditions; and
- the market impact of constraint equations (defined as the sum of marginal constraint costs from the marginal constraint cost dispatch rerun).

5.1 Overview of interconnector constraint statistics

The report presents, in Chapter 9, statistics on constraint equations setting interconnector limits, which is the focus of this review. Chapter 9 notes that the reporting of interconnector binding hours and associated binding constraints is complicated by the fact that more than one constraint equation can be binding at any one time. When more than one constraint equation is setting the import limit, AEMO's market systems software selects a constraint equation based on the following priority:

- single interconnector on the LHS;
- multiple interconnectors and generators (energy) on the LHS; and
- multiple interconnectors, FCAS requirements and generators (FCAS) on the LHS.

Based on the above, the report presents statistics on recorded constraints that limited interconnector flow in 2011 and compares this with 2010. In particular, the report presents binding hours per month in each direction on each interconnector categorised by the constraint in terms of whether the constraint is a system normal, outage, FACS, automated thermal limit (constraint automation) or a quick constraint.

Table 4 and Table 5 overleaf present a summary tabulation of the statistics presented in the AEMO 2011 Constraints Report. For each interconnector Table 4 presents the number of hours flow was constrained in each direction, while Table 5 translates these hours into a percentage of the total time the interconnector was constrained in either direction.

Table 4: Cause of interconnector constraints in 2011 – hours of constraints

	Reverse Flow					Forward Flow				
	Quick	Constraint Automation	FCAS	Outage	System Normal	Quick	Constraint Automation	FCAS	Outage	System Normal
Terranora (NSWto Qld)	14	18	251	1112	105	45	0	0	586	98
QNI (NSW to to Qld)	18	0	290	87	698	0	0	18	99	321
Basslink (Tas to Vic)	0	0	2366	197	1089	0	187	2408	12	0
Vic - NSW (to NSW)	0	12	0	92	475	12	0	0	444	1495
Heywood (Vic to SA)	0	12	161	78	417	0	0	120	835	1971
Murraylink (Vic to SA)	0	0	0	111	113	0	0	0	383	1505
Outage Submit Times	278	803	998	1281	0	0	0	0	0	0
Constraint Automation Usage	44	183	131	92	0	0	0	0	0	0

Note: *Developed from the graphs presented in the AEMO 2011 Constraints Report.*

Table 5: Cause of interconnector constraints in 2011 - % of time of constraints

	Reverse Flow					Forward Flow				
	Quick	Constraint Automation	FCAS	Outage	System Normal	Quick	Constraint Automation	FCAS	Outage	System Normal
Terranora (NSWto Qld)	0.6%	0.8%	11.3%	49.9%	4.7%	2.0%	0.0%	0.0%	26.3%	4.4%
QNI (NSW to to Qld)	1.2%	0.0%	18.9%	5.7%	45.6%	0.0%	0.0%	1.2%	6.5%	21.0%
Basslink (Tas to Vic)	0.0%	0.0%	37.8%	3.1%	17.4%	0.0%	3.0%	38.5%	0.2%	0.0%
Vic - NSW (to NSW)	0.0%	0.5%	0.0%	3.6%	18.8%	0.5%	0.0%	0.0%	17.5%	59.1%
Heywood (Vic to SA)	0.0%	0.3%	4.5%	2.2%	11.6%	0.0%	0.0%	3.3%	23.2%	54.8%
Murraylink (Vic to SA)	0.0%	0.0%	0.0%	5.3%	5.4%	0.0%	0.0%	0.0%	18.1%	71.3%

Notes: *Developed from the graphs presented in the AEMO 2011 Constraints Report.*
The percentages sum to 100% across reverse and forward flows for each interconnector.

5.2 Interconnector constraints

This section presents a review of the constraints and associated constraint equations that limited interconnector flows in 2011, and how this changed from 2010. These are related to constraints identified in the APR's where these are included.

5.2.1 Terranora interconnector

This comprises two 110 kV lines from Terranora in NSW to Mudgeeraba in Queensland, with the controllable element being the 180 MW DC link (3 separate DC lines). Constraints on this line are usually thermal limits in northern NSW and it may constrain at the same time as QNI.

In both directions the vast majority of binding constraints are outage constraints. In 2011 system normal constraints represented 7% of binding hours for flows to Qld and 80% for flows to NSW.

5.2.2 Queensland to NSW interconnector (NSW1 – QLD1)

QNI is the AC interconnector between Dumaresq in NSW and Bulli Creek in Queensland which was commissioned in 2001 as a pair of 330kV lines between Armidale and Braemar and as a pair of 275kV lines between Braemar and Tarong.

Flow limits are usually as follows:

- NSW to Qld – system normal thermal limits on Calvale to Wudond (871) and voltage collapse on loss of the largest Qld unit (depending on Kogan Creek generation); and
- Qld to NSW – oscillatory stability and transient stability for loss of a Boyne smelter or fault on a Bulli Creek to Dumaresq line.

In 2011 flow was normally to NSW within a range of 200 to 700 MW, unlike 2010 where the flow to NSW was more strongly biased with flows usually being greater than 700 MW.

New South Wales to Queensland

Three of the top four binding constraints were system normal constraints. System normal constraints represented 73% of constraint hours in 2011. The main system normal constraints are shown in Table 6 below.

Table 6: Binding constraint equations: NSW to Queensland flow

Equation ID	2011 Hours (2010 Hours)	Description
Q>>NIL_855_871	215.6 (466.0)	Out = Nil, avoid overload on Calvale to Wurdong (871) 275 kV line on trip of Calvale to Stanwell (855) 275 kV line See Table 3 for comments
N^^Q_NIL_B1, 2, 3, 4, 5, 6 & N^Q_NIL_B	80.3 (60.2)	Out = Nil, avoid voltage collapse for loss of the largest Queensland generator See Table 7 for comments
Q>>NIL_871_855	35.3 (3.8)	Out = Nil, avoid overload on Calvale to Stanwell (855) 275 kV line on trip of Calvale to Wurdong (871) 275 kV line See comment on Q>>NIL_855_871 in Table 3 for comments

5.2.3 Queensland to New South Wales

Four of the top six binding constraints were system normal constraints and system normal constraints represented 64% of the hours this interconnector was binding in 2011. The total hours when these constraints were binding were far greater in 2010 when the flow distribution had higher flows to NSW. The three most binding system normal constraints are shown in the table below.

Table 7: Constraint equations: Queensland to NSW flow

Equation ID	2011 Hours (2010 Hours)	Description
V::N_NILVxxx & V::N_NILQxxx	501.0 (381.4)	Out = Nil, avoid transient instability for fault and trip of a Hazelwood to South Morang 500 kV line See Table 3 for comments
Q:N_NIL_BI_POT	87.3 (226.3)	Out = Nil, avoid transient instability for a trip of a Boyne Island potline (400 MW) See Table 3 for comments
Q:N_NIL_BCK2L-G	37.5 (599.3)	Out = Nil, avoid transient instability for a 2 phase to ground fault on a Bulli Creek to Dumaresq 330 kV line at Bulli Creek See Table 6 for comments

5.2.4 Basslink (T-V-MNSP1)

The flow and binding hours were very similar in 2010 and 2011. 2011 had fewer hours of flows at 450 MW from Victoria.

Basslink is mainly limited by FCAS or the Frequency control system protection scheme FCSPS constraint equations which in 2011 comprised the majority of constraint hours (65% of the hours for flows to Victoria and 93% of the hours for flows to Tasmania). The FCAS constraints represented the top five constraints for flow to Victoria and were seven of the top 10 constraint equations for flow to Tasmania.

5.2.5 Victoria to New South Wales (VIC1-NSW1)

This interconnector can bind in either direction for high demand in either region:

- flow to NSW is mainly limited by transient stability for fault of a Hazelwood to South Morang line; and
- flow to Victoria is mainly limited by voltage collapse for loss of a large Victorian generator or thermal limits on the Murray to Dederang or Wagga to Lower Tumut (051) lines.

The hours of binding constraints were similar in 2010 and 2011.

Most constraints were system normal constraints that comprised 77% of the time for flows to NSW and 82% of the time for flows to Victoria. Periods of binding outage constraints were mostly outside of the potential high demand summer period.

Flow to New South Wales

The top four constraints for flow to NSW are shown below.

Table 8: Binding constraint equations: Victoria to NSW flow

Equation ID	2011 Hours (2010 Hours)	Description
V::N_NILVxxx & V::N_NILQxxx	993.8 (496.8)	Out = Nil, avoid transient instability for fault and trip of a Hazelwood to South Morang 500 kV line See Table 3 for comments
V>>V_NIL_2A_R & V>>V_NIL_2B_R & V>>V_NIL_2_P	189.7 (293.3)	Out = Nil, avoid overloading the South Morang 500/330 kV (F2) transformer for no contingencies, for radial/parallel modes and Yallourn W1 on the 500 or 220 kV See Table 3 for comments
V>>V_NIL1A_R	151.3 (6.8)	Out = Nil, avoid overloading a South Morang to Dederang 330 kV line for trip of the parallel line See Table 3 for comments
V>>N-NIL_HA	92.0 (445.8)	Out = Nil, avoid overload on Murray to Upper Tumut (65) 330 kV line on trip of Murray to Lower Tumut (66) 330 kV line

Flow to Victoria

The top two constraints for flow to Victoria are shown below.

Table 9: Binding constraint equations: NSW to Victoria flow

Equation ID	2011 Hours (2010 Hours)	Description
N^^V_NIL_1	86.2 (93.7)	Out = Nil, avoid voltage collapse for loss of the largest Victorian generating unit This constraint equation bound and set the interconnector limit for periods from late April through to early September. It is expected to bind for a similar number of hours in 2012.
V>>V_NIL_1B	27.8 (72.9)	Out = Nil, avoid overloading Dederang to Murray #2 330 kV line for trip of the Dederang to Murray #1 330 kV line This constraint equation bound from mid May through to early June 2011.

5.2.6 Heywood interconnector

Until about 2010 the majority of flows across Heywood were to SA, however the level of wind generation in SA has meant that flows across Heywood are now mostly to Victoria. Flows in 2011 were similar to 2010 except that 2011 had more periods of high flows into SA.

In 2010 the limit to Victoria was increased from 300 MW to 460 MW and in January 2011 the combined limit Heywood + Murraylink was increased to 580 MW. In December 2011 the limit to SA was increased by 50 MW on revision of the voltage collapse constraint.

The majority of binding constraints are system normal, although binding outage constraints comprised 47% of these in the 2011 period October to November.

Flow to South Australia

The two most binding constraints shown below, dominated the binding hours for flow to SA.

Table 10: Binding constraint equations: Heywood interconnector - Victoria to SA flow

Equation ID	2011 Hours (2010 Hours)	Description
V^^S_NIL_NPS_xxx & V^^S_TBCP_NPS_xxx & V^^S_NIL_MAXG_xxx	1026.7 (542.0)	Out = Nil, Victoria to SA long term voltage stability limit for loss of the largest credible generation contingency in SA, South East capacitor bank on / off, Tailem Bend capacitor bank on/off See Table 3 for comments
V::N_NILVxxx & V::N_NILQxxx	863.8 (429.9)	Out = Nil, avoid transient instability for fault and trip of a Hazelwood to South Morang 500 kV line See Table 3 for comments

Flow to Victoria

The main constraints for flows to Victoria are shown in Table 11 below.

Table 11: Binding constraint equations: Heywood interconnector - SA to Victoria flow

Equation ID	2011 Hours (2010 Hours)	Description
V>>V_NIL_2A_R & V>>V_NIL_2B_R & V>>V_NIL_2_P	195.7 (287.1)	Out = Nil, avoid overloading the South Morang 500/330 kV (F2) transformer for no contingencies, for radial/parallel modes and Yallourn W1 on the 500 or 220 kV
S>>V_NIL_SETX_SETX	195.3 (203.6)	Out = Nil, avoid overloading a South East 275/132 kV transformer on trip of the remaining South East 275/132 kV transformer See Table 3 for comments
F_S++HYML_L60	77.4 (52.0)	Out = one Heywood to Moorabool 500 kV line or one Moorabool to Sydenham 500 kV line, SA lower 60 second requirement

5.2.7 Murraylink

Transfers to SA via Murraylink have been mainly limited by constraint equations that affect export from Victoria as a whole (South Morang F2 transformer or transient stability). Many of the thermal limits close to Murraylink are dealt with by the Murraylink runback scheme. Flows to Victoria are limited by the 132 kV Roberstown to Monash and Waterloo lines and Roberstown 275/132 kV transformers.

Most binding constraints were system normal constraints that comprised 78% of the hours for flows to SA and 50% of the hours for flows to Victoria. Periods of binding outage constraints were mostly outside of the potential high demand summer period.

The main constraints for flows to SA and to Victoria respectively are shown below.

Flow to South Australia

Table 12: Binding constraint equations: Murraylink - Victoria to SA flow

Equation ID	2011 Hours (2010 Hours)	Description
V::N_NILVxxx & V::N_NILQxxx	968.3 (495.5)	Out = Nil, avoid transient instability for fault and trip of a Hazelwood to South Morang 500 kV line See Table 3 for comments
V>>V_NIL_2A_R & V>>V_NIL_2B_R & V>>V_NIL_2_P	184.7 (294.5)	Out = Nil, avoid overloading the South Morang 500/330 kV (F2) transformer for no contingencies, for radial/parallel modes and Yallourn W1 on the 500 or 220 kV See Table 3 for comments
V>>V_NIL1A_R	151.4 (6.8)	Out = Nil, avoid overloading a South Morang to Dederang 330 kV line for trip of the parallel line

Flow to Victoria

Table 13: Binding constraint equations: Murraylink - SA to Victoria flow

Equation ID	2011 Hours (2010 Hours)	Description
S>V_NIL_NIL_RBNW	174.0 (136.9)	Out = Nil, avoid overloading the North West Bend to Robertstown 132 kV line on no line trips See Table 3 for comments
S>>V_NIL_WTTP_WEMW4	127.8 (21.9)	Out = Nil, avoid overloading the Waterloo East to Morgan Whyalla pump 4 132 kV line on trip of the Waterloo to Templers 132 kV line See Table 3 for comments
S>>V_NIL_RBTXW_RBTX1	123.7 (0)	Out = Nil, avoid overloading Robertstown #1 275/132 kV transformer on trip of the Robertstown #2 275/132 kV transformer

6. Review of annual planning review reports

This chapter reviews the 2012 Annual Panning Reviews (APRs) published by the respective jurisdictional planning bodies (by 30 June 2012). The 2011 APRs are also referred to in this chapter.

6.1 Queensland

6.1.1 Review of 2012 APR

The APR developed by Powerlink provides a clear description of the projected loads, committed and commissioned network developments. Looking forward, it presents a clear summary of forecast network limitations and the reasons for the limitation and refers to the Powerlink website for information on proposed developments.

Chapter 6 contains a section on interconnectors and potential upgrades. The key points made are as follows:

- in October 2008 Powerlink and TransGrid published a joint Final Report relating to the potential upgrade of QNI. This report identified that it may be economic to upgrade the capability of the interconnection (series compensation with an estimated cost of around $120M) but the optimum timing, under the most plausible scenario, was not until 2015/16;
- based on that timing, TransGrid and Powerlink considered it premature to recommend an upgrade option. Powerlink and TransGrid committed to monitor the NEM and regulatory environment for changes that may influence this outcome;
- since that time there have been a number of developments such as new generation, expanded renewable energy target and the implementation of the RIT-T;
- in June 2012 Powerlink and TransGrid published a joint Project Specification Consultation Report (PSCR) in accordance with the principles and methodology of the RIT-T, relating to the potential upgrade of QNI. The PSCR considers the preliminary analysis on the load forecast and generation outlook commenced in late 2011. The PSCR describes:
  - the existing supply arrangements and limitations of the interconnector,
  - outlines the credible upgrade options and technical characteristics of non-network solutions, and
  - discusses which market benefits may be material to the assessment of the credible options under the RIT-T; and
- since that time, there has been a revision of the load forecasts within the Queensland Region and other regions of the NEM. The impact that these may have on the optimal timing of any of the QNI upgrade options will be assessed, and communicated to interested parties.

6.1.2 Joint project specification consultation report (PSCR)

The key points from The Joint Project Specification Consultation Report (PSCR) and associated description is on Powerlink's website are as follows:

- the PSCR is not dated and only refers to the 2010 NTNDP;

- the PSCR was prepared to provide a basis for TransGrid and Powerlink to consult with AEMO, registered participants and interested parties to identify options for the development of QNI and that will be included in an application of the RIT-T. Submissions are due 30 November 2012; and
- the options identified in the PSCR are shown in Table 14 below. The table also shows if these options were identified in the 2010 NTNDP;

Table 14: QNI upgrade options identified in the Powerlink / TransGrid PSCR

Option	Description	Increase in Limit	Cost ($M)	2010 NTNDP
1a	Series compensation	To NSW: 470-640 MW To Qld: 210 – 250 MW	150	Covered
1b	Series Compensation with Second Armidale SVC	To NSW: 590-800 MW To Qld: 230-380 MW	200	Not covered
2	Second Armidale SVC	To NSW: 70-80 MW To Qld: 100-130 MW	70	Not covered
3	System Protection Scheme – Fast Fault Clearing Times	To NSW: - To Qld: 40-90 MW	3	Not mentioned
4a	Second High Voltage AC (HVAC) Interconnector at 330kV	To NSW: 1,300 MW To Qld: 1,070 MW	1,300	Directly addressed
4a	New Armidale – Bulli Creek HVAC Interconnector at 330 kV	To NSW: 1,040 MW To Qld: 500 MW	500	Not covered
4c	500 kV High Voltage AC	To NSW: 2,200 MW To Qld: 1,600 MW	2,300	Part of NEMLink
5	High Voltage DC	To NSW: 1,400 MW To Qld: 1,400 MW	500	Mentioned
6	Braking Resistor	To NSW: 100 MW To Qld: 10 MW	10	Not mentioned

TransGrid and Powerlink plan to publish a Project Assessment Draft Report in mid to late 2013 containing the results from a full analysis of the QNI upgrade options, and a preliminary decision on the preferred option identified through the RIT-T.

6.1.3 Constraint equations

The Powerlink's APR does not present any details of proposed upgrade works or constraint equation performance and changes.

6.2 New South Wales

6.2.1 2012 APR

The Transgrid 2012 APR is a comprehensive report that presents a substantial amount of technical detail. In relation to interconnection and the NTNDP reports:

- section 3.3 addresses the status of transmission augmentations including interconnection upgrades with NSW identified in the 2010 NTNDP; and

- all augmentations are treated on an equal basis meaning that there is no separate consideration given for those augmentations referred to as interregional augmentations.

The statuses of interconnection augmentations with NSW presented in the TransGrid 2012 APR are presented below.

QNI

The status of this project is discussed in Section 3.3 which states the following:

"The first review of the QNI upgrade was completed by TransGrid and Powerlink in 2008. The impact and benefits of upgrade options are presently under active investigation by TransGrid and Powerlink. The outcomes of the present investigation will be released to the market in 2012."

Section 6.2.4 presents additional detail on the recent history (since 2008) and status of the joint planning work being undertaken by Powerlink and TransGrid on this matter. It concluded by noting that the PSCR was published by TransGrid and Powerlink in June 2012. The upgrade options in that report were listed.

The comments on that report discussed above on the Powerlink 2012 APR are applicable here.

Victoria – NSW Interconnection Upgrade

Section 3.3 of the TransGrid APR presents this project which was identified in the 2010 NTNDP as NSW works including a phase shifting transformer in the Jindera – Wodonga circuit. The report states:

"there are a number of options for upgrading the interconnection and joint work would be undertaken by TransGrid and AEMO."

Section 6.3.6 provides additional detail. Here the report briefly describes the purpose, options and long term plan. In relation to the 2010 NTNDP which identified this option for "early attention", the report states that "TransGrid is undertaking a preliminary feasibility study and will continue to work with AEMO on this option".

Murraylink Runback Scheme

Section 6.1.8 describes the Murraylink Runback Control System and the proposal to include NSW in the scheme[6]. It is proposed that these runback controls be completed and the owners of Murraylink will then acquire the communication links.

NSW - SA

The 2012 TransGrid APR also addressed interconnection between NSW and SA. It notes that:

- there is potential for the development of a direct interconnection between South Australia and NSW which could be developed as a 500 kV AC link or a HVDC link or a combination of both; and
- ElectraNet and AEMO have undertaken a joint feasibility study into the transmission development options between SA and other NEM load centres and that a number of options have been considered.

[6] The capability of Murraylink to transmit power from Victoria into South Australia is partly governed by the power transfer capacities of the NSW 220 kV system between Darlington Point and Buronga and the Victorian north west 220 kV system. Various runback control schemes have been implemented in the Victorian 220 kV system to enable Murraylink to be operated at a relatively high level prior to a critical contingency. The power transfer over Murraylink is then run back following a contingency. Similar controls were also installed at sites in NSW by TransGrid but the communication links between the sites and Murraylink have not been completed.

The APR states that:

> *"TransGrid has been involved in providing options analysis to this process and is continuing to investigate these options and the connection into the NSW 500 kV system".*

6.3 Victoria

Unlike the Queensland and NSW (and to a lesser extent SA) APR's, the 2012 Victorian APR (VAPR) does not present demand growth forecasts. It is assumed here that this is because the VAPR is produced by AEMO which has undertaken such forecasts as part of the NTNDP process.

The VAPR presents the top 20 binding constraints for Victoria in 2010 and 2011. Here 'top' is based on the summation of Marginal Constraint Cost (MCC) as opposed to the AEMO Constraints Report where "top" is based on the summation of binding hours. Because of this there is little correlation in the ranking of constraints reported.

The VAPR identifies six constraint equations as presenting persistent market impacts (being in the top 20 during both 2010 and 2011). From these six constraints, the constraints associated with interregional transfers are as follows:

- V^SML_NSWRB_2 (Voltage collapse Vic to SA Murraylink);
- V>>SML_NIL_7A (Thermal Vic to SA Murraylink : Ballarat North- Buangor 66 kV);
- V>>N-NIL_HA (Thermal Vic to NSW : Murray-Upper Tumut); and
- V>>SML_NIL_1 (Vic to SA Murraylink : Ballarat-Moorabool No1).

Chapter 3 of the VAPR lists the network limitations for each Victorian region. Interconnector related constraints and the planning status are listed in Table 15 below.

Table 15: 2012 VAPR: Victorian related constraints and possible solutions

Limitation	Possible Network Solution	Drivers	Status
Vic – SA Interconnector congestion	A third Heywood transformer and supporting network augmentations in SA.	New wind generation in SA's south east.	Current joint RIT-T with ElectraNet
Dederang-South Morang 330kV line loading	Upgrading station control equipment and/or a new Dederang-South Morang 330kV line installation	Increased NSW import/export	Priority assessment
Murray-Dederang 330kV line loading	Installation of a new Murray-Dederang 330kV line or a new Jindera-Dederang 330kV line	Increased NSW import/export	Monitoring
the Eildon-Thomastown 220kV line loading	Installing wind monitoring or line up-rating of the Eildon-Thomastown 220kV line	Increased NSW import/export	Monitoring
Dederang 330/220kV transformer loading	A new 330/220kV transformer installation at Dederang Terminal Station	Increased NSW import/export	Monitoring
Voltage collapse	Capacitor bank installation and controlled series compensation at Dederang Terminal Station	Increased NSW import/export	Monitoring
South Morang 500/330kV transformer loading	A new 500/330kV or 500/220kV transformer at South Morang Terminal Station	Increased export to NSW	Monitoring

The status of planning work on interconnection limitations identified above and as discussed in the VAPR is discussed below.

6.3.1 South Australia–Victoria (Heywood) interconnector congestion.

This limitation is associated with uneven Heywood 500/275/22 kV transformer loadings and voltage instability (collapse) in the vicinity of Heywood and the Portland Alcoa plant. Credible options discussed include the following:

- a third Heywood transformer, with other network augmentations in South Australia and Victoria at an estimated cost of $80 to $130M;
- a new Krongart–Heywood 500 kV interconnector at an estimated cost of $500 million to $800M;
- demand-side management; and
- installing a control scheme.

The PSCR was published on 31 October 2011. The Project Assessment Draft report (PADR) is scheduled to be published in August 2012 and the PACR is scheduled to be published in December 2012.

6.3.2 Victorian reliability support : Murray–Dederang 330 kV line Loading

AEMO currently procures a network loading control ancillary service (NLCAS) on the Murray–Dederang 330 kV line that provides for greater use of inter-regional network capabilities between NSW and Victoria. The contract for this NLCAS expires on 30 June 2012. Without this NLCAS, pre-contingent flows will need to be limited. In the 2011 NTNDP, AEMO identified that this NLCAS or its equivalent will be required for the next five years.

A RIT-T is being undertaken to address a NLCAS gap for improving reliability / increased power transfer capability between NSW and Victoria. It is focusing on the benefits to be gained in the short term and credible options have been limited to developments that can be implemented within 1 or 2 years. The preferred solution is a non-network option with lower implementation costs than market benefits. Options include:

- a load reduction control scheme to allow the Murray–Dederang 330 kV line to be operated at a higher short-term rating (5 minute); and
- a demand-side response option to voluntarily curtail load at a lower cost than the cost of involuntary load reduction.

The status of the RIT-T is as follows:

- the PSCR was published on 19 December 2011 and was open for consultation until 16 March 2012. In the PSCR AEMO, noted its exemption from publishing a PADR as it met the conditions under clause 5.6.6 (y) of the NER;
- no submissions were received in response to the PSCR; and
- AEMO published the PACR on 3 May 2012. To take account of the 2012 energy and maximum demand forecasts AEMO will reassess the date when investment is required before services are procured.

6.4 South Australia

The format of the 2012 South Australian APR (SAAPR) is similar to that of the 2012 VAPR in that only a brief review is presented on demand projections. The planning period is stated as 20 years which is longer than the other jurisdictional APR planning horizons which are more focussed on the next 10 years.

Similar to the 2012 VAPR, the 2012 SAAPR presents an assessment of the top 20 network constraints that were experienced during the 2011 calendar year. These are based on the summation of Marginal Constraint Cost (MCC) as opposed to the AEMO Constraint Report where this is based on the summation of binding hours. Because of this there is little correlation in the top constraints reported.

Two of the four grouping of these constraints were:

- Heywood Interconnector import and export limits; and
- Murraylink Interconnector export limits.

The 2012 SAAPR presents a detailed description of these interconnectors and associated limits (Heywood - Section 3.2.1 and Murraylink – Section 3.2.2).

6.4.1 Heywood interconnection

Electranet and AEMO undertook a South Australian Interconnector Feasibility Study in 2010. The final report dated February 2011 is available on the Electranet website (www.electranet.com.au/network/transmission-planning/interconnection-studies).

Following this, ElectraNet and AEMO initiated a RIT-T in June 2011 to investigate options for the augmentation of the Heywood Interconnector. A Project Specification Consultation Report (PSCR) was published in October 2011 and stakeholder feedback has been received in response to the PSCR.

The components of the network options being considered include:

- a third 500/275 kV transformer at the Heywood 500 kV terminal station;
- reactive compensation in the South Australian network (shunt or series compensation);
- additional 275/132 kV transformer capacity in the South East region of South Australia;
- reconfiguration of existing 132 kV transmission system (decisions such as decommissioning of the lines are also driven by the condition of the transmission line assets);
- a new high capacity inter-connector involving Krongart to Heywood 500 kV lines along with associated support augmentations in South Australia; and
- common to all options will be the development of weather stations and application of dynamic line ratings to the 275 kV and 132 kV lines in South Australia.

6.4.2 Murraylink

The 2011 VAPR identified that the Moorabool-Ballarat No. 1 220 kV line and the Ballarat-Bendigo 220 kV lines have thermal loading issues at times of high Victorian demand from 2011/12, and that these become exacerbated with power transfers to SA across Murraylink. However Murraylink imports to SA are required to avoid a potential loading issue on the Robertstown - North West Bend No.1 132 kV line under high demand conditions.

This situation prompted a joint investigation by AEMO and ElectraNet in 2011 on credible short term solutions (network and non-network) and staged long-term solutions to this supply issue (maintain supply to Regional Victoria and the South Australian Riverland under N-1 conditions).

The 2012 SAAPR stated the following:

> *"On 18 April 2012, AEMO published the report "Regional Victorian Thermal Capacity* - *Ballarat Supply* - *Project Specification Consultation Report" which is the first report required by the RIT-T process for consultation on options to resolve constraints on the Moorabool-Ballarat No. 1 220 kV line. The report includes discussion of issues related to forecast constraints on the ability of Murraylink to export from Victoria to South Australia at Victorian peak load times."*
>
> *"The final outcome of AEMO's assessment of Murraylink capacity will be published as part of the RIT-T process referred to above."*

7. Conclusions - planning gaps

As described in the approach to this review, the methodology used to assess the likelihood of any planning gaps was to cross check the planning responses presented in the respective APRs against the issues and recommendations in the 2010 and 2011 NTNDP reports and any observed constraint trends identified in the 2011 Constraints Report.

The 2011 Constraints Report was reviewed to identify the key constraint equations and to assess if there were any trends in increasing hours of interconnector related constraints. For each interconnector, the total hours of constraints in both directions in 2011 are shown in the table below. The total hours of constrained operation were similar to those in 2010.

Table 16: Hours of interconnector constraint in 2011 (Hours)

	Reverse	Forward	Total
Terranora (NSW to Qld)	1,500	729	2,229
QNI (NSW to Qld)	1,093	438	1,531
Basslink (Tas to Vic)	3652	2,607	6,259
Vic – NSW (to NSW)	579	1,951	2,530
Heywood (Vic to SA)	668	2,,926	3,594
Murraylink (Vic to SA)	224	1888	2,112

The NTNDP 2011 did not undertake any new modelling from that undertaken in 2010. The executive summary of the NTNDP 2011, under the heading "NTNDP and APR alignment", states:

> *"The status and timing of projects listed in the 2011 APRs generally correspond with developments identified by the 2010 NTNDP as occurring in the first 10 years.*
>
> *Cases where a proposed project or its timing differs from the NTNDP, however, are mainly due to APRs providing a more detailed consideration of local reliability issues, where the NTNDP takes a higher-level approach focussed on long-term national transmission network development. Other factors that led to differences included changes in load forecasts and near-term assumptions about the location of new generation."*

The approach of the various jurisdictional planning bodies to the presentations in their respective APR's varied. The approach of NSW and Queensland was not to include reference to specific constraint equations in their respective APR's but to reference limitations on specific transmission elements and describe works and economic assessments being undertaken. This provided for a clear understanding of why flows may be limiting and the solutions. However it meant that a connection between the binding constraints identified in the Constraints Report was not easily done.

The Victorian and SA APRs did provide reference to specific binding constraint equations, the level of binding hours and marginal constraint costs that were giving rise to augmentation assessments. These constraints covered many (but not all) of those identified in the 2011 Constraints Report.

A summary of the findings from the APR's for each interconnector is as follows:

- QNI
  - Identified in the 2010 and 2011 NTNDP and discussed in the NSW and Queensland APR's,
  - Work is actively being undertaken to address uneconomic constraints affecting this interconnector.
- SA - Victoria
  - Although the 2010 and 2011 NTNDPs did not recommend a timing to increase the capability of flows between SA and Victoria, a substantial amount of work is being done to investigate augmentations. This is a result of assessments and modelling by the both ElectraNet and AEMO (Victorian planning body) on this matter.
  - Work being undertake includes:
    - Heywood: investigation being undertaken on upgrade options and a RIT-T evaluation
    - Murraylink: continued improvements, runback scheme currently being extended into NSW.
- Victoria - NSW
  - The 2012 Victorian and NSW APRs discuss this constraint in terms of the constraint points, the status of work being undertaken and the consistency with the NTNDP,
  - While an RIT-T assessment is not pending, work is being undertaken by AEMO, TransGrid and ElectraNet to investigate the NV1 and NV2 options.

As a result of the above, this review concludes that the jurisdictional planning bodies have:

- demonstrated a depth and clarity of analysis commensurate with their respective planning responsibilities;
- shown consistency in their APRs reflecting cooperation in their interregional planning roles; and
- addressed the issues identified in the 2010 and 2011NTNDP report.

On this basis the review, we conclude that there are no interregional planning gaps. Hence MJA and SW Advisory consider that there is no indication of any planning shortfall regarding inter-regional transmission which might require the exercise of the Last Resort Planning Power (LRPP).