2010

New South Wales Annual Planning Report 2010

TransGrid

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Executive Summary

Executive Summary

The National Electricity Market (NEM) and the regulatory framework continue to evolve with the creation of Australian Energy Market Operator (AEMO) which takes over from the National Electricity Market Management Company (NEMMCO) with the added responsibility for gas markets. TransGrid is committed to work with the NSW jurisdiction, the Australian Energy Regulator (AER), AEMO and the Australian Energy Market Commission (AEMC) in order to enhance the NEM and its operation and yield continuing economic benefits to the customers.

A number of reviews of the NEM and its regulation are being undertaken by the AEMC from the perspective of the climate change policies and the directions from the Ministerial Council of Energy (MCE). TransGrid continues to proactively participate in these reviews providing considered inputs by working with Grid Australia as well as on its own accord where appropriate.

The NSW Annual Planning Report (APR) 2010 reflects recent changes to the National Electricity Rules (NER) relating to the planning framework and the dissemination of information in the APR, in particular changes to Chapter 5 of the NER.

Purpose of the APR

The primary purpose of the Annual Planning Report is to provide advance information to market participants and interested parties on the nature and location of emerging constraints in the NSW electricity transmission network. The advance information on emerging constraints facilitates the development and implementation of appropriate and timely network and non-network solutions.

TransGrid Takes a Holistic Approach to Network Planning

Publication of the Annual Planning Report is one aspect of a comprehensive framework TransGrid has implemented in its planning processes to deliver on reliability obligations in New South Wales. This framework consists of, inter alia:

i. in depth analysis of the interconnected power system;

ii. sophisticated load forecasting techniques;

iii. proactive sourcing of network support from non-network alternatives such as demand side response (DSR) and embedded generation based on alternative fuel sources and renewables;

iv. joint planning with connected customers; and

v. asset replacement strategy based on condition monitoring, not age, which is holistically taken into account in planning the NSW transmission network.

TransGrid Leads in Non-Network Alternatives - Demand Management and Local Generation

TransGrid has taken a leadership position in encouraging and implementing non-network alternatives and has completed a number of demand management (DM) and local generation projects.

TransGrid adopts a multi-faceted approach to encouraging DM and local generation options to reduce the need for capital investment in the transmission network that would otherwise be necessary to meet the growing electricity demand in NSW.

In the summer of 2008/09, TransGrid implemented the largest ever network support in the National Electricity Market from non-network sources. A total of 350 MW of network support was contracted in the Newcastle – Sydney – Wollongong load area from a portfolio consisting of an embedded generator, a large industrial load and an aggregator. This allowed deferral of the Western 500 kV Upgrade project by one year to summer 2009/10 while meeting our reliability obligations to our customers. The net saving of over $14 million was returned to customers by way of reduced transmission charges.

The Demand Management and Planning Project was carried out with EnergyAustralia from 2003 to 2008. It has resulted in a comprehensive knowledge base of DM technologies and practices with the potential to reduce electricity demand in the Sydney inner metropolitan area.

Currently, TransGrid is negotiating network support for Sydney Metropolitan area. Recently, a Request for Proposal (RfP) for network support in the far North Coast area of NSW has been issued.

A number of other DM and local generation projects are being actively pursued.

In addition, to promote market maturity, awareness and commercial approach to non-network alternatives, TransGrid has entered into agreements with all NSW and ACT distributors to jointly undertake and financially support innovation projects in Demand Management, Demand Side Response and embedded generation area.

TransGrid's joint planning with NSW Distributors provides a mechanism to identify opportunities for DM and local generation options. TransGrid, with the relevant Distributors, has conducted specialist DM and local generation studies. Over the years, specific Requests for Proposals for DM and local generation alternatives have been issued for a number of areas.

The information in the Annual Planning Report ensures that interested parties are kept informed in advance of emerging network constraints so that feasible DM and local generation options may be formulated to reduce the demand growth rate and therefore defer or avoid the need for new transmission or distribution network investment.

TransGrid Works With Proponents of Alternative Generation to Provide Access to its Network

TransGrid has developed a negotiating framework approved by the AER to provide access to its network to the proponents of the alternative generation such as wind, gas and solar. TransGrid adopts a transparent approach to these negotiations while maintaining complete commercial confidentiality. Where appropriate and agreed, specialist technical studies and investigations are also undertaken on behalf of the proponents on an agreed basis.

Load and Energy Growth

Native energy use in NSW has increased at about 1310 GWh per annum over the past ten years.

Over a similar period peak summer demand has increased by an average of about 340 MW per annum and peak winter demand by an average of about 190 MW per annum. This level of growth has continued despite concerted efforts to curb demand through DM initiatives. Although a substantial policy change is proposed that may dampen future load growth, options still need to be developed to meet the expected demand growth to ensure reliability of supply to support the expected economic and population growth of New South Wales.

The 2010 energy projections are 3,034 GWh, or 3.8 per cent, on average higher than last year's projections. The 10% Probability of Exceedence (POE) summer demand projections are 163 MW or 1.0 per cent on average above last year's projections. Similarly, the 10% POE winter projections are 232 MW or 1.4 per cent on average higher than last year's projections.

TransGrid's plans for the future development of the transmission network in NSW are detailed in this Annual Planning Report.

Structure of the Annual Planning Report

The Annual Planning Report follows a structure that has been approved by the Ministerial Council on Energy:

- Section 1 is the table of contents;
- Section 2 contains a summary of the outcomes of the Annual Planning Review and a discussion of supply reliability in NSW;
- Section 3 contains a summary of relevant National Transmission Network Developments;
- Section 4 contains a summary of the latest NSW energy and demand projections;
- Section 5 provides descriptions of committed augmentations, augmentations that have satisfied the regulatory process and some recently completed augmentations;
- Section 6 contains details of emerging constraints in NSW within a five year planning horizon. It includes details of all proposed network augmentations as required by the National Electricity Rules;
- Section 7 contains a discussion of other relevant transmission planning issues in NSW including sustainability; and
- Section 8 contains various appendices. This material includes details of Distributors' load forecasts as required by the National Electricity Rules.

1 Table of Contents

Introduction

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2 Introduction

TransGrid is the owner, operator and manager of one of the largest high voltage transmission networks in Australia, connecting generators, distributors and major end users in New South Wales.

TransGrid's network is interconnected to Queensland and Victoria, providing a robust electricity system which facilitates interstate energy trading. The NSW high voltage transmission network is the hub of the National Electricity Market (NEM), serving the largest state in the market.

2.1 Outcomes of the Annual Planning Review for 2010

The 2010 New South Wales Annual Planning Report (APR 2010) documents process and outcomes of the New South Wales Annual Planning Review carried out since the publication of the APR 2009. The purpose of the Planning Review and the APR is to:

- Identify emerging constraints in New South Wales transmission networks over appropriate planning horizons;
- Provide advance information on the nature, quantification and location of the constraints. The level of information included in this document is intended to be sufficient to encourage market participants and interested parties to formulate and propose options to relieve the constraints, including those that may include components of demand management (DM) and local generation or other options that may provide economically efficient outcomes;
- Discuss options that have been identified for relieving each constraint including network, local generation, DM and other options;
- Indicate, where possible, if and when TransGrid intends to issue a request for proposal for non-network alternatives to relieve a constraint;
- Comply with National Electricity Rules (NER) requirements in respect of preparation of a Transmission Network Service Provider's Annual Planning Report and the associated consultation on proposed new small transmission network assets;
- Provide further details on the load forecast data that has been provided for input to the Electricity Statement of Opportunities (ESOO); and
- Provide a basis for annual reporting to the New South Wales Minister for Energy, (the Minister) on the outcome of the Annual Planning Review.

The Annual Planning Review for 2010 included:

- An update of TransGrid's NSW load forecast that took account of actual peak loads for winter 2009;
- Provision of load forecast data for inclusion in AEMO's 2010 ESOO and National Transmission Statement (NTS);
- Ongoing planning analysis and identification of network constraints and assessment of feasible options for relieving these constraints; and
- Publication of this APR 2010.

It is intended that the APR 2010 will provide electricity market participants and interested parties with information that will help them contribute to the optimum and economically efficient development of transmission networks in New South Wales.

The timely identification of emerging constraints allows the market to identify potential non-network alternatives and TransGrid to develop and implement appropriate and timely measures.

2.2 Context of the Annual Planning Report

The New South Wales Annual Planning Report is one of a number of documents that disseminate information pertinent to transmission and distribution planning in the National Electricity Market (NEM). These documents cover the broad range of areas such as supply demand balance, transmission networks planning and distribution networks planning. Some of these documents are mandated through a variety of legislative and policy directives and therefore overlap to some extent. Nevertheless they form an effective framework for the dissemination of network planning information throughout the NEM. The main documents related to transmission and distribution planning are summarised in the following table.

Summary Information for Annual Planning Documents

Document	Published by	Covers
Electricity Statement of Opportunities for the National Electricity Market (ESOO)	AEMO	Supply demand balance and outlooks in the NEM
National Transmission Network Development Plan (NTNDP)	AEMO (from 2010)	National transmission planning
National Transmission Statement (NTS)	AEMO (2009 only)	Potential developments of National Transmission Flow Paths in the NEM (previously ANTS and transitional to NTNDP)
Annual Planning Reports	TNSPs	Regional transmission planning
Electricity System Development Reviews	NSW DNSPs	Distribution planning in NSW

Contact information relating to TransGrid's APR 2010 appears in Appendix 7.

2.3 Supply Reliability in New South Wales

Within the NEM planning framework the focus of the NSW Annual Planning Report is on supply reliability in NSW. The following sections detail TransGrid's approach to this responsibility.

2.3.1. TransGrid's Obligations

TransGrid is responsible for the planning and development of transmission networks in New South Wales in two interrelated roles.

Firstly, it has been nominated by the Minister to be the Jurisdictional Planning Body (JPB) for NSW in the NEM.

In this role it:

- Provides jurisdictional information for input to the ESOO and NTNDP;
- Carries out an Annual Planning Review during which it:
  - Prepares an APR for NSW;
  - Holds a public forum that considers the APR and related transmission planning matters;
  - Reports to the Minister on matters arising from the Annual Planning Review; and
  - Reports to the Minister on matters arising from the ESOO and NTNDP.

Secondly, it is registered as a TNSP in the NSW region of the NEM. In relation to a TNSP's responsibilities for planning and development of networks the NER require a TNSP to:

- Analyse the future operation of its transmission network to determine the extent of any future network constraints;
- Conduct annual planning reviews with Distributors to determine the extent of any emerging constraints at points of connection between the TNSP's network and the Distributors' networks;
- Carry out joint planning with Distributors to determine options for the relief of constraints that can be considered by Registered Participants and interested parties;
- Coordinate a consultative process for consideration and economic analysis of the options in accordance with the AER's regulatory test if required;
- On the basis of the consultative process and economic analysis determine the recommended option for network augmentation if required;
- After resolution of any disputes concerning the recommended option arrange for its implementation in a timely manner; and
- Prepare and publish an Annual Planning Report by June 30 of each year.

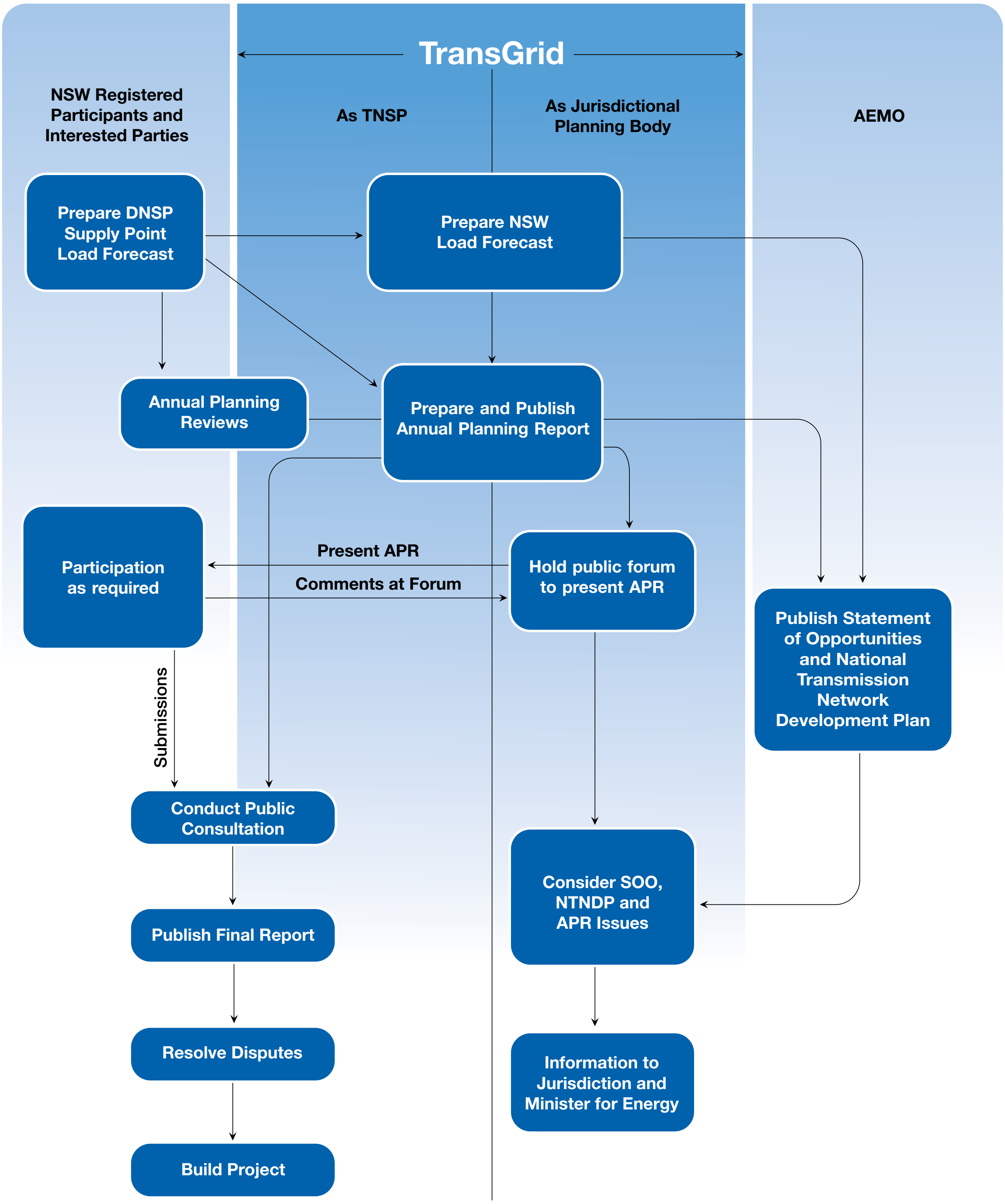
The NER require that the Annual Planning Report must include:

- Results of annual planning reviews with Distributors during the present year;
- Load forecasts submitted by Distributors;
- Planning proposals for future connection points;
- Forecast and quantification of constraints over 1, 3 and 5 years;
- Plans and dates to issue a request for proposal for a non-network alternative;
- Summary information for proposed augmentations;
- Summary information for proposed replacement transmission network assets; and
- Consultation reports on proposed new small transmission network assets.

These obligations are described more fully in Chapter 5.6 of the NER and the AER's regulatory test.

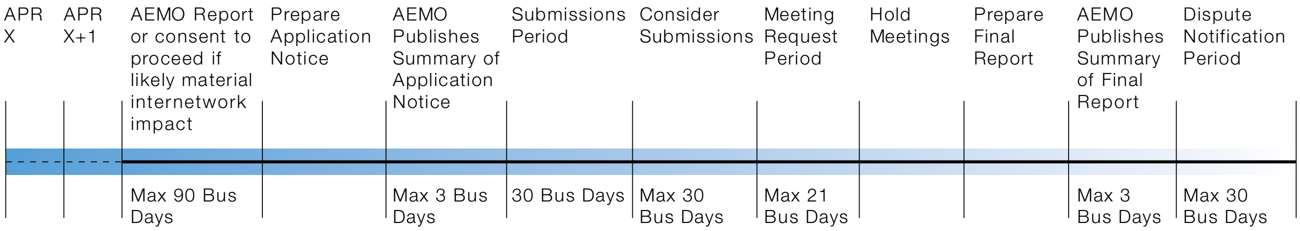
Figure 2.1 on the next page illustrates the main tasks and interrelationship of TransGrid's dual roles.

Figure 2.1 TransGrid's Planning Roles

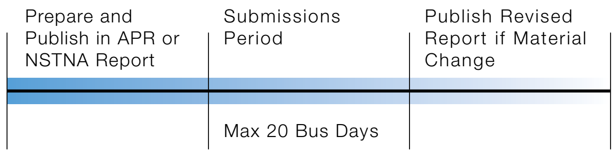


The NER distinguish between the planning consultation processes that should be followed when applying the AER's regulatory test depending on whether the proposed augmentation would be a new small transmission network asset (asset cost between $5 million and $20 million) or a new large transmission network asset (asset cost greater than $20 million) or a funded augmentation. This is illustrated in Figure 2.2 on the next page. This process will change with the introduction of the Regulatory Investment Test for Transmission (RIT-T).

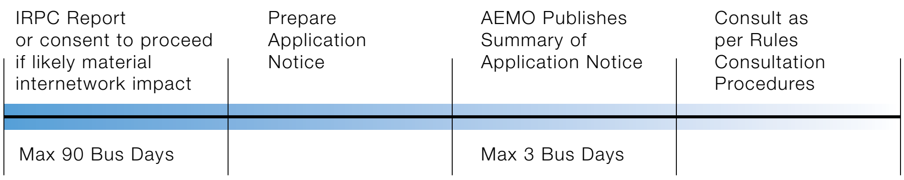
Figure 2.2 NER Planning Consultation Processes



(a) Proposed New Large Transmission Network Asset



(b) Proposed New Small Transmission Network Asset



(c) Proposed Funded Augmentation

2.3.2. Network Planning Approach

TransGrid's approach to planning of the NSW transmission network is derived from its planning obligations under the NER and NSW legislation. This is detailed in Appendix 1.

2.3.3. Annual Planning Review with Distributors

In accordance with NER requirements TransGrid conducts an annual planning review with each Distributor connected to its network. The purpose of these reviews is to:

- Identify emerging network constraints at points of connection between TransGrid's and the Distributors' networks and elsewhere in TransGrid's network or the Distributors' networks;
- Carry out joint planning to determine options for the relief of network constraints; and
- Review the load forecasts provided by the Distributors.

TransGrid also conducts planning meetings and reviews with major customers.

2.3.4. Annual Planning Review for New South Wales

TransGrid carries out an annual planning review of its transmission network in New South Wales. The purpose of the Review is to focus on an optimum level of investment by encouraging interested parties to propose options for the relief of constraints that may involve components of DM and local generation. The NER underpin this by requiring all TNSPs to carry out annual planning reviews with Distributors and publish the results in an Annual Planning Report.

The Annual Planning Review for 2010 commenced in October 2009 with a request by TransGrid to Distributors for their updated load forecasts. These forecasts take into account electrical loads experienced during summer and winter 2009. TransGrid has provided a revised NSW load forecast for inclusion in AEMO's 2010 SOO and NTNDP. Based on these revised load forecasts TransGrid has updated its short term (1, 3 and 5 years) and longer term (5 to 20 years) analyses of present and emerging network constraints and has summarised the results in this APR.

2.3.5. NSW Government Directive on Reliability Standards

In 2005 the NSW Government introduced mandatory licence conditions on DNSPs which set out certain reliability standards for sub-transmission and distribution networks. The licence conditions specify "n-1[1], 1 minute" reliability standards for sub-transmission lines and zone substations supplying loads greater than or equal to specified minimums, e.g. 15 MVA in urban and non-urban areas.

These requirements imply a requirement on TransGrid to provide a commensurate level of reliability in its network supplying NSW DNSPs.

2.4 Regulatory Test Thresholds and Information Disclosure on Network Replacements

In October 2008 the AEMC gave effect to a NER Rule change based on a proposal put forward by Grid Australia (representing the NEM TNSPs). The rule change related to augmentation asset thresholds under the regulatory test and information disclosure requirements for network replacements.

The changes to the Rules were as follows:

- The new small transmission network asset threshold was increased from $1 million to $5 million;
- The new large transmission network asset threshold was increased from $10 million to $20 million;
- A new "replacement transmission network asset" category was defined for network replacement projects whose costs are expected to exceed a threshold of $5 million. For this proposal category there is a requirement to disclose information in Annual Planning Reports that is similar to the information required for augmentation proposals that are not new small network assets; and
- A procedure was defined for the review of the thresholds every three years.

1 An "n-1" reliability standard allows for maximum forecast demand to be supplied when any one of the n elements of a network is out of service. An "n-1, 1 minute" standard allows for a risk that there will be some loss of supply for up to 1 minute to allow, for example, automatic switching to alternative supply arrangements.

2.5 TEC Rule Change

In April 2009 an NER rule change was introduced with effect from July 2009. The rule change was based on a proposal put forward by the Total Environment Centre (TEC) in the interest of providing DM and non-network alternative proponents more detail and allowing more time to respond.

The changes to the Rules included requirements to indicate the following:

- When a constraint is occurring and the MW reduction at a connection point required to relieve the constraint for 12 months; and
- Plans and dates to issue a request for proposal for a non-network alternative.

This information is included in APR 2010 in Chapters 5 and 6.

2.5.1. Clarification of Constraint Information in this APR

The magnitudes and timing of the constraint information are indicative only.

It should be noted that:

- The magnitudes are based on forecast maximum demands. The actual amount of support required would depend on the actual demand at the time, which may differ from the forecast demand;
- As further information becomes available and forecasts are refined, the magnitudes and timings may change;
- The magnitudes are for support at the optimal location. If the support was to be provided at a less than optimal location, the magnitude required would be higher;
- TransGrid sources network support via a competitive process. There is no guarantee that:
  - sufficient support will be able to be secured;
  - network support will be cost effective; or
  - any particular proponent's offer will be accepted;
- In some circumstances the amount of support required depends on factors beyond TransGrid's control, such as generation patterns. In these cases an indicative level of support has been provided; and
- Typically the loading on transmission networks is highest during summer and winter. Within those periods, the timing of the highest demands (at which times support may be required) depends on a number of factors including actual weather conditions. Consequently it is not possible to predict the month(s) during which support may be required. Rather, the season in which support is expected to be required is given. Summer is taken to be December to February (although in some cases it is possible that support may be required in late November or early March). Winter is taken to be June, July and August.

TransGrid's requirements of network support and the providers of that support include that the network support must:

- be cost effective;
- meet the size and location of support required. This can be by a single provider or in aggregate by more than one providers;
- meet the requirement during the time of year specified;
- meet reliability requirements; and
- be able to be delivered by the needs date.

A network support proponent or proponents must be able and willing to enter into binding contracts to provide the support.

2.5.2. Criteria to Issue a Request for Proposal

Clause 5.6.2A (b) (3a) (iv) requires TransGrid to indicate in the APR if it is expecting to issue a request for proposal (RfP) for augmentation or non-network alternative, and if so, the expected date the RfP will be issued.

In addition to the need to comply with the NER requirements, TransGrid has statutory, social, environmental and commercial objectives set out in the Energy Services Corporations Act 1995. These combine to mean that TransGrid should undertake to minimise the impact of its network where it can otherwise meet its transmission services obligations, including through the use of non-network alternatives.

Currently TransGrid uses a process taking into account the size and location of the DM required and the feasibility of delivering non-network alternatives in time and within budget to assess if an RfP is to be issued. With the introduction of the new Rules requirement to indicate in the APR if and when RfPs are to be issued, TransGrid has developed a list of criteria to assist this decision making process.

Factors for consideration in developing the criteria include:

- Outcomes of the joint planning process with DNSPs and directly connected customers on initial assessment of the potential and feasibility of non-network alternatives to meet an identified need or relieve an emerging constraint.
- The amount of capital investment able to be deferred and its commercial value to TransGrid.
- Length of deferral that is possible/feasible.
- The amount of work required to issue and respond to an RfP. This is not inconsiderable in terms of defining the constraint, preparation of the RfP, preparation and submission of an offer by proponents, assessment of offers by proponents, commercial considerations and the administration of the agreements with the network support providers.
- Size and location of expected DM required. This also takes into account the materiality and usefulness of the information and the degree to which there are feasible DM projects likely to come forward.

- The time horizon. How long does TransGrid have to make the decision to commit to a solution? Sufficient time must be allowed from the decision as to whether to issue an RfP or not, to the time of a system support investment decision having to be made.

When considering the feasibility of implementing non-network alternatives over network alternatives, the following factors are taken into account:

- Economic efficiency as in the Regulatory Test (Regulatory Investment Test for Transmission, RIT-T, from 1st August 2010);
- Technical performance of the non-network alternative to ensure applicable reliability standards of reliability are met;
- Risks associated with non-network alternatives vis-à-vis network alternatives and some quantification of those risks in terms of impact on TransGrid's financial performance; and
- Commercial assessment of potential network support arrangements, including financial analysis and impact on TransGrid's financial position.

3

National Transmission Network Developments

3 National Transmission Network Developments

2009 National Transmission Statement

The 2009 National Transmission Statement (NTS) was the outcome of AEMO's annual national transmission review and was a transitional step towards the National Transmission Network Development Plan. The NTS evolved from previous Annual National Transmission Statements (ANTS). The NTS presented an outlook of future transmission and generation development in the NEM and possible changes in the light of the Australian Government's Carbon Pollution Reduction Scheme as well as information on the potential market benefits of selected transmission developments.

The 2009 NTS undertook a scenario based analysis with a 20-year outlook period. Two scenarios were developed; a lower carbon price scenario (LCPS) and a higher carbon price scenario (HCPS). The two scenarios included assumptions on demand growth, generation developments and government policy.

In particular AEMO considered the following conceptual augmentations:

- Line series compensation on QNI to improve the power transfer capability between NSW and Queensland;
- A braking resistor at Loy Yang to improve the Victorian export capability; and
- A 500 kV line development between the NSW Hunter Valley and the coast to relieve transmission constraints on the existing 330 kV system. It was assumed in the analysis that the Bannaby – Sydney 500 kV development (see Section 6.4) had been completed.

AEMO's market simulations found positive market benefits under both scenarios for two cases:

- QNI line series compensation; and
- QNI line series compensation +

  The Loy Yang braking resistor +

  The Hunter Valley – coast 500 kV line.

Further details of the 2009 NTS can be found on AEMO's website.

TransGrid and Powerlink Queensland are reviewing the QNI line series compensation option in the light of the positive market benefits (see Section 6.3.4).

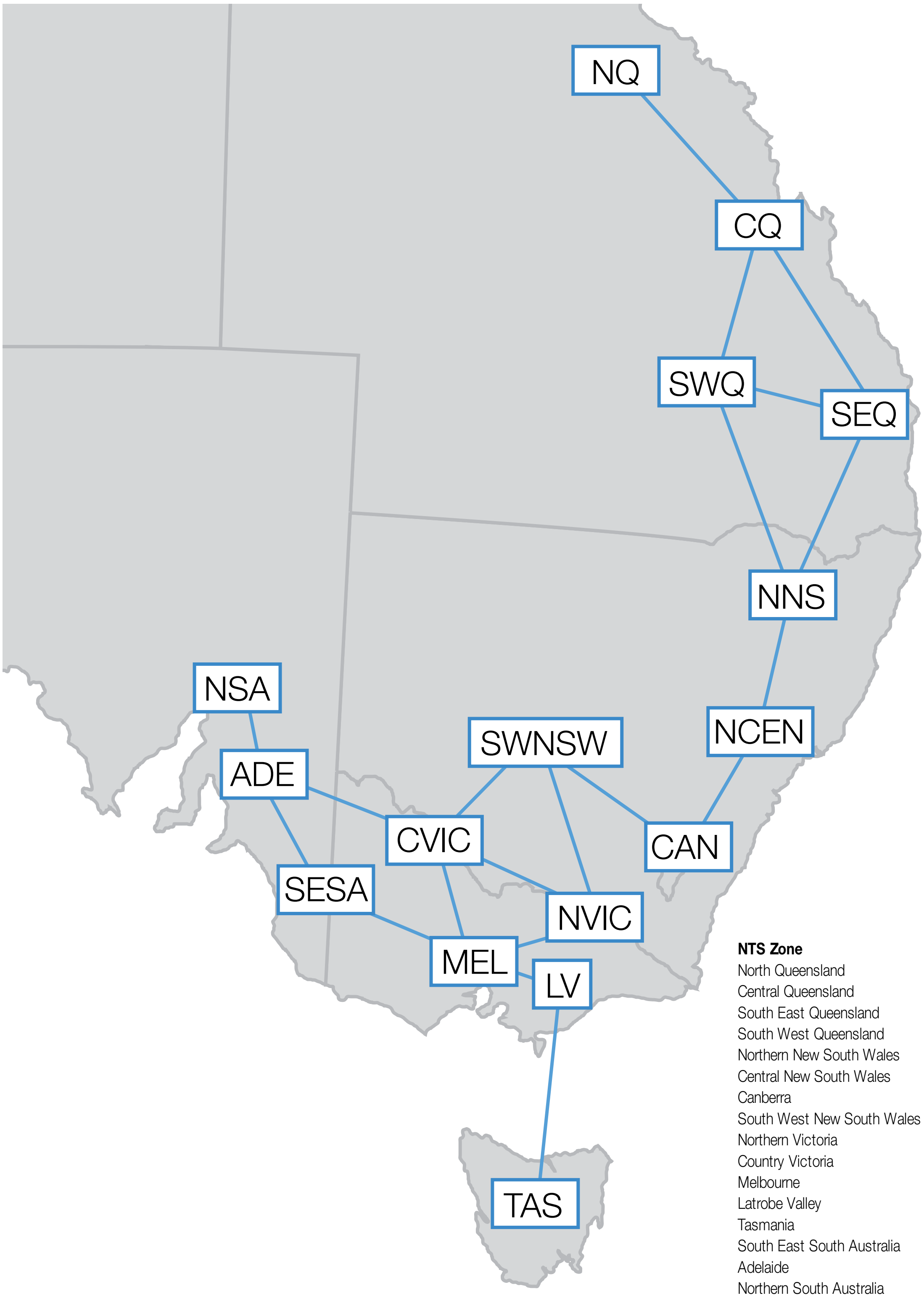
The development of a Hunter Valley – coast 500 kV line is part of TransGrid's strategic plan for the NSW network. Its timing would be governed by the detailed assessment of future generation developments and the load growth in the Newcastle – Sydney – Wollongong area.

National Transmission Network Development Plan

AEMO has the role of the national transmission planner and is required to produce a National Transmission Network Development Plan (NTNDP). The NTNDP will have regard to jurisdictional planning and regulatory documents (such as APRs) and, in turn, the jurisdictional planning bodies need to have regard to the NTNDP in formulating their plans.

The first NTNDP is to be published in 2010 and to this end AEMO has published a consultation document in early 2010 with consultation closing on 12th March 2010.

Figure 3.1 Current NTS Zones and National Transmission Flow Paths



NTS Zone	Abbreviation
North Queensland	NQ
Central Queensland	CQ
South East Queensland	SEQ
South West Queensland	SWQ
Northern New South Wales	NNS
Central New South Wales	NCEN
Canberra	CAN
South West New South Wales	SWNSW
Northern Victoria	NVIC
Country Victoria	CVIC
Melbourne	MEL
Latrobe Valley	LV
Tasmania	TAS
South East South Australia	SESA
Adelaide	ADE
Northern South Australia	NSA

Transmission Developments in NSW that may affect National Transmission Flow Paths

The national transmission flow paths (NTFPs) are the major transmission paths between large load and generating centres across the NEM. Figure 3.1 shows the NTFPs from past ANTSs and the 2009 NTS.

Within the national transmission planning framework the focus of the NSW Annual Planning Report is on supply reliability and NTFPs within the NSW jurisdiction as well as the development of interconnectors to regions adjoining NSW.

Network augmentation proposals by TNSPs that affect NTFPs have been taken into account in the past ANTSs and the 2009 NTS. They will also be reflected in the future NTNDP processes.

Accordingly, the following table indicates where TransGrid believes that the power transfer capacity of NTFPs may be affected (although not necessarily materially) by committed, proposed, or possible transmission developments in NSW. These developments are detailed in subsequent sections of this APR 2010.

Table 3.1 - Effects on Power Transfer Capability of NTFPs

Development	Status	Possible Commissioning Date	Possible Affected NTFP		APR 2010 Section(s)
			From	To1	
Albury Trip Scheme	Committed	2011	SWNSW	NVIC	5.2
Capital Wind Farm 330 kV switchyard	In-service		CAN	NCEN	5.1
Armidale to NSW north coast 132 kV lines – system protection scheme	In service		NNS	SEQ	5.1
Phase Angle Regulator on Armidale – Kempsey 132 kV line No. 965	In service		SWQ SEQ	NNS NNS	5.1
Armidale SVC power oscillation damping	Installed/testing		SWQ	NNS	5.1
Lismore 132 kV lines – System Protection Scheme	Country Energy works	2010	NNS	SEQ	
Western 500 kV Conversion	Completed	2010	NNS NCEN CAN	NCEN CAN NCEN	5.1
Coffs Harbour – Kempsey second 132 kV circuit	Completed	2010	NNS	NCEN	5.1
Uprating Tamworth – Armidale line No. 86 330 kV line	Committed	2010	NNS SWQ	SWQ NNS	5.2
Dumaresq – Lismore 330 kV line	Satisfied reg test	2014	NNS	SEQ	5.3
Development of supply to the ACT	Committed	2011	CAN	NCEN	5.2
Second Kempsey – Port Macquarie 132 kV line	Committed	2010/11	NNS	NCEN	5.2
Manildra – Parkes 132 kV line	Committed	2011/12	NCEN	CAN	5.2
Bannaby – Sydney 500 kV line	Anticipated proposal	Yet to be determined	CAN NNS	NCEN NCEN	6.4
Tomago – Stroud – Taree 132 kV development	Committed	2012/13 & 2015/16	NCEN	NNS	5.3
Yass and Canberra area shunt capacitors	Present proposal	Yet to be determined	SNY	CAN	6.2
NSW – Snowy line upgrades (No. 01 and No. 02 lines), System Protection Scheme and associated reactive plant	Anticipated proposal	Yet to be determined	SNY	CAN	6.2
Real-time line rating monitoring systems	Present proposal	Progressive developments	All	All	6.2
Reinforcement of voltage control in northern NSW (Second Armidale SVC or related reactive plant controls)	Anticipated proposal	Yet to be determined	NNS	SWQ	6.1
Upgrade of No. 8, 16 and 18 lines	Present proposal	Yet to be determined	CAN	NCEN	5.3
Yass – Bannaby and Yass – Marulan 330 kV line upgrade	Anticipated proposal	Yet to be determined	CAN	NCEN	6.2

The future possible system developments are listed in Table 3.2 below:

Table 3.2 - Future Possible System Developments

Development	Status	Possible Commissioning Date	Possible Affected NTFP		APR 2010 Section(s)
			From	To	
Hunter Valley – coast 500 kV line development	Possible development	Yet to be determined	NNS	NCEN	6.4
Hunter Valley – Tamworth – Armidale 500 kV line development	Possible development	Yet to be determined	NNS NNS	SWQ SEQ	6.4

Also included (in Table 3.3 below) is a list of projects involving interconnector development options that have been developed by TransGrid and interconnected organisations.

Table 3.3 - Projects Involving Interconnector Development Options

Development	Status	Possible Commissioning Date	Possible Affected NTFP		APR 2010 Section(s)
			From	To	
NSW – Queensland interconnection development options	Possible development	Yet to be determined	NNS	SWQ	6.4
NSW – Victoria interconnection development options	Possible development	Yet to be determined	SWNSW	NVIC	6.4
NSW – South Australia interconnection development options	Possible development	Yet to be determined	NSW zones	NSA or ADE	6.4

Scale Efficient Network Extensions

The AEMC has proposed Scale Efficient Network Extensions (SENEs) to facilitate extensions of the network across the NEM into areas of prospective disaggregated generation sources. It is proposed that SENEs will be covered in the NTNDP.

SENE developments will fall within TransGrid's responsibilities if and when required by the National Electricity Rules.

4

NSW Region Energy and Demand Projections

4 NSW Region Energy and Demand Projections

4.1 Introduction

This chapter and Appendix 3 provide details on projections of energy and demand for the NSW region of the NEM (which includes the state of New South Wales and the ACT) covering:

- NSW region aggregate energy in GWh;
- NSW region aggregate summer and winter peak demand in MW; and
- Summer and winter peak demand projections for individual connection points in the NSW region in both MW and MVAr.

These projections are used by TransGrid as one of the inputs to identify future transmission constraints and to quantify any associated transmission development proposals.

Explanation of Terms

Energy and demand projections in this Annual Planning Report are presented as "Native" quantities in accordance with requirements of guidelines provided by AEMO.

Native energy and Native demand projections include load supplied by "Scheduled" generators plus "Semi-Scheduled" and "Non-Scheduled" generators.

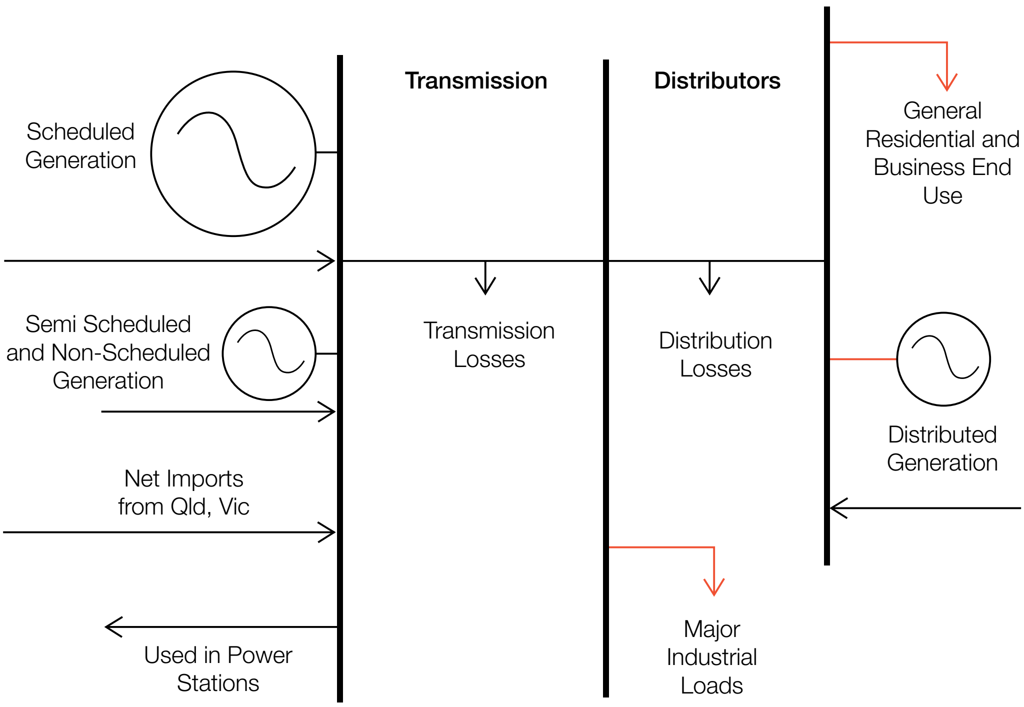
Scheduled generators are non-intermittent generators above 30 MW capacity. They are included in the NEM dispatch process.

Semi-Scheduled generators are intermittent generators above 30 MW capacity. They are either presently included in the NEM dispatch process or will eventually be so included. Wind generators above 30 MW capacity fall into this category.

Non-Scheduled generators are above 1 MW and below 30 MW capacity and are not included in the NEM dispatch process.

Figure 4.1 shows a simplified schematic representation of the flow of electricity from power station to end-use customers.

Figure 4.1 Electricity Supply



Information Sources

The NSW region aggregate energy and demand projections are prepared in conjunction with the ESOO. They are produced by TransGrid using in-house modelling in accordance with definitions, assumptions and procedures determined by the Load Forecasting Reference Group (LFRG) convened by AEMO.

As part of this process for 2010, KPMG Econtech was engaged by AEMO to supply Baseline, High and Low economic and demographic scenarios as well as historical data and projections of Semi-Scheduled and Non-Scheduled generation and capacity on a consistent basis for each region of the NEM. The data supplied by KPMG for Non-Scheduled generation only includes “Significant” Non-Scheduled generators i.e. those above 1 MW and below 30 MW capacity.

Summer and winter peak demand projections for individual connection points in the NSW region are provided by NSW region DNSPs, other major customers and the connection point demand projections are detailed in this Annual Planning Report in Appendix 3. TransGrid also produces aggregate DNSP connection point demand projections using this data and assumptions regarding diversity and losses.

Comparison with DNSP and Customer Projections

As the NSW region energy and demand projections are derived from high level top-down econometric modelling they usually produce differing results when compared with the aggregate DNSP connection point demand projections. In addition to the different methodologies used other reasons for the differences are attributable to the following:

- The NSW region energy projection does not take into account the detailed bottom-up modelling of consumption drivers which TransGrid understands DNSPs may use for their demand projections; and
- The NSW region demand projections and aggregate DNSP connection point demand projections cannot be directly compared due to a number of factors including diversity and losses. However a general comparison can be used to provide a reasonability check.

Overview

Information pertaining to energy and demand projections appears in this chapter as follows:

- Section 4.2: Energy projections for the NSW region;
- Section 4.3: Demand projections for the NSW region;
- Section 4.4: Aggregate DNSP connection point demand projections;
- Section 4.5: Semi-Scheduled and Non-Scheduled energy and demand projections; and
- Section 4.6: Supplementary information.

Additional information is presented in appendices as follows:

- Appendix 2: Background information on TransGrid’s load forecasting process; and
- Appendix 3: Tabular presentation of aggregate NSW region and individual connection point projections.

Summary of the NSW Region 2010 Energy and Demand Projections

Table 4.1 summarises historical and projected changes in the NSW region energy and demand over 10 year periods. Projected energy and summer peak demand growth are marginally higher whilst winter peak demand growth is marginally lower in the projection period compared with the historical period.

Table 4.1 NSW Region Energy and Demand Projections (Average annual percentage changes)

	Actual/estimated 2000-01 to 2009/10	Projected 2010-11 to 2019-20
Energy Sent Out	1.4%	1.8%
	Actual 2000-01 to 2009-10	**Projected 10% POE 2010-11 to 2019-20**
Summer Peak Demand	2.0%	2.3%
	Actual/estimated 2001 to 2010	**Projected 10% POE 2011 to 2020**
Winter Peak Demand	2.0%	2.2%

Changes since the 2009 APR

Changes in the 2010 projections compared with projections published in the 2009 APR are that:

- Energy projections are 3,034 GWh, or 3.8 per cent, on average (for the common forecast period 2010-11 to 2018-19) higher than last year’s projections;
- 10 per cent POE (Probability of Exceedence) summer demand projections are 163 MW or 1.0 per cent, on average (for the common forecast period 2010-11 to 2018-19), above last year’s projections; and
- 10 per cent POE winter demand projections are 232 MW or 1.4 per cent, on average (for the common forecast period 2010 to 2019) higher than last year’s projections.

These changes are examined below.

4.2 Energy Projections for the NSW Region

The total energy that the transmission and distribution systems must deliver to end-use customers is characterised by the quantity “Native energy”. This is the total electrical energy delivered to distribution network customers and larger customers that connect directly to the transmission network. As discussed in Section 4.1 Native energy includes the energy generated by Scheduled, Semi-Scheduled and Non-Scheduled generators.

Figure 4.2 shows Native energy projections for the NSW region for Baseline, High and Low economic growth scenarios. These scenarios were established by KPMG on behalf of AEMO.

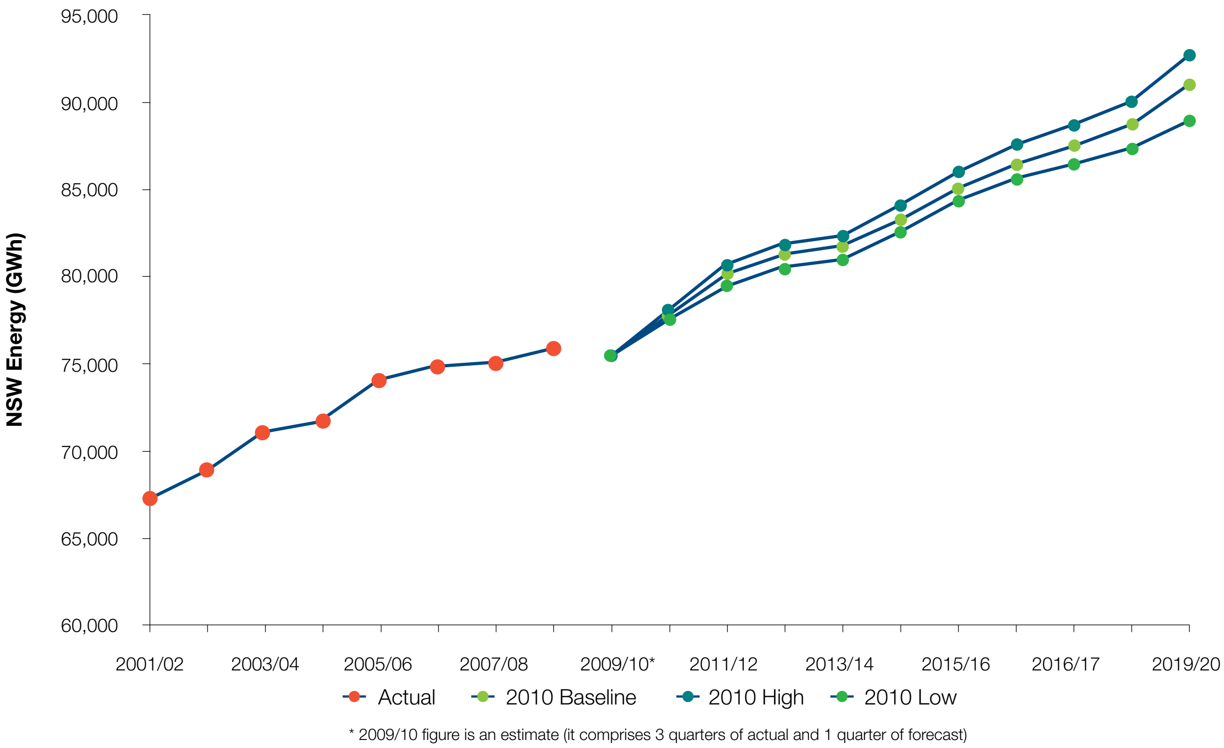
Compared with the 2009 projection the 2010 energy projection for the NSW region for the Baseline economic growth scenario is:

- 2.2 per cent higher for the 2010-11 financial year; and
- An average of 3.8 per cent higher over the 9-year forecast period.

These differences are due to changes in key assumptions/ conditions (compared with the previous forecast) in relation to:

- Economic growth: Global growth has recovered considerably after last year's financial crisis; the Australian economy has fared robustly in the past few months primarily due to the strong fiscal and monetary stimuli and improved business and consumer sentiments; the NSW economy held up better than expected in 2009-10 and growth is expected to pick up and reach pre-crisis levels in the coming years;
- Semi/Non Scheduled generation: A revision of NSW's Semi-Scheduled and Non-Scheduled generation projections which reflect currently available information;
- Delay of CPRS: In May 2009, the Rudd government announced the postponement of the CPRS by one year to 01 July 2011. Since then there has been considerable uncertainty regarding the shape and form of the final CPRS and its commencement date. The 2010 KPMG electricity price forecasts take into account the effect of a delayed CPRS[2];
- Post Modelling Adjustments: In light of new information in 2010, energy efficiency allowances have been incorporated in the forecasts to account for energy efficiencies due to phasing out of greenhouse intensive water heaters, introduction of NSW Energy Savings Scheme and phasing out of incandescent light bulbs. Additional allowances have been factored in for the operation of the NSW desalination plant; and
- Lower base of the starting year of the projections due to the downturn effect of the global financial crisis.

Figure 4.2 NSW Region Energy Projections



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[2] In late April 2010, the Federal government has announced a further delay in the implementation of the CPRS due the lack of bipartisan support for the scheme, combined with slower progress than expected in terms of global action on climate change. It now appears that the Government will not introduce the CPRS until after the end of the current commitment period of the Kyoto Protocol (which ends in 2012) and only when there is greater clarity on the actions of other major economies including the US, China and India. In accordance with AEMO guidelines, the 2010 NSW energy and demand projections do not incorporate this or any other policy changes related to CPRS announced after mid-April 2010.

4.3 Demand Projections for the NSW Region

Projections of the NSW region Native demand detailed in this section are identical to projections to be published in the 2010 ESOO.

Baseline, High and Low growth scenarios are prepared by TransGrid based on the respective underlying demographic and economic growth rates provided by KPMG. In addition the 90 per cent, 50 per cent and 10 per cent Probability of Exceedence (POE) demands represent the 10th, 50th and 90th percentiles respectively of the distribution of peak demand for each season.

Tables 4.2 and 4.3 respectively show actual historical summer and winter peak demands and projections of 90 per cent, 50 per cent and 10 per cent POE demands for each of the Baseline, High and Low scenarios for the next 10 years.

Table 4.2 NSW Region Summer Demand Projections (MW)

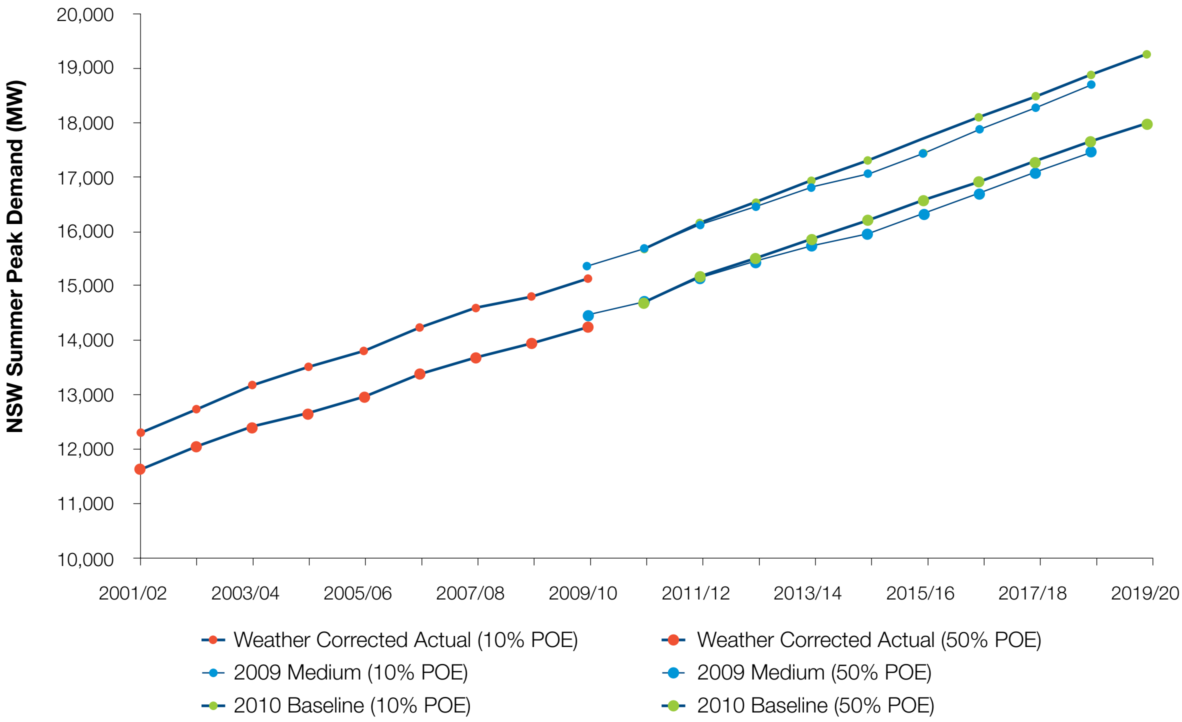
	Actual	90% POE			50% POE			10% POE		
Year		Baseline	High	Low	Baseline	High	Low	Baseline	High	Low
1999-00	10,826									
2000-01	11,739									
2001-02	11,155									
2002-03	12,621									
2003-04	12,311									
2004-05	12,946									
2005-06	13,462									
2006-07	12,981									
2007-08	13,071									
2008-09	14,288									
2009-10	14,051									
2010-11		13,767	13,798	13,706	14,687	14,718	14,626	15,657	15,688	15,596
2011-12		14,209	14,259	14,130	15,169	15,219	15,090	16,169	16,229	16,090
2012-13		14,504	14,586	14,404	15,504	15,586	15,394	16,544	16,636	16,434
2013-14		14,807	14,919	14,678	15,847	15,969	15,718	16,927	17,049	16,788
2014-15		15,122	15,273	14,955	16,202	16,363	16,035	17,322	17,493	17,145
2015-16		15,434	15,628	15,234	16,554	16,758	16,344	17,714	17,928	17,484
2016-17		15,751	15,997	15,499	16,911	17,167	16,649	18,101	18,377	17,829
2017-18		16,073	16,369	15,761	17,273	17,579	16,951	18,493	18,829	18,151
2018-19		16,394	16,751	16,022	17,624	18,001	17,242	18,884	19,291	18,472
2019-20		16,716	17,129	16,258	17,976	18,419	17,518	19,266	19,749	18,778

Table 4.3 NSW Region Winter Demand Projections (MW)

Year	Actual	90% POE			50% POE			10% POE		
		Baseline	High	Low	Baseline	High	Low	Baseline	High	Low
2000	12,064									
2001	11,927									
2002	12,321									
2003	12,641									
2004	13,107									
2005	13,186									
2006	13,166									
2007	13,985									
2008	14,368									
2009	13,091									
2010		13,877	13,897	13,846	14,236	14,257	14,205	14,655	14,676	14,625
2011		14,278	14,329	14,208	14,648	14,699	14,567	15,077	15,128	14,996
2012		14,629	14,700	14,501	14,999	15,079	14,870	15,448	15,528	15,309
2013		14,914	15,015	14,775	15,293	15,395	15,154	15,742	15,854	15,603
2014		15,187	15,318	15,077	15,586	15,707	15,467	16,045	16,177	15,926
2015		15,501	15,652	15,404	15,900	16,051	15,803	16,369	16,530	16,272
2016		16,002	16,176	15,893	16,411	16,595	16,302	16,900	17,094	16,791
2017		16,388	16,603	16,226	16,807	17,033	16,646	17,316	17,552	17,135
2018		16,749	17,005	16,488	17,178	17,444	16,907	17,697	17,973	17,416
2019		17,030	17,336	16,649	17,469	17,775	17,078	17,988	18,314	17,587
2020		17,421	17,793	16,944	17,870	18,252	17,374	18,409	18,811	17,893

Figures 4.3 and 4.4 compare the 2010 10 per cent and 50 per cent POE demand projections with weather corrected actual peak demands and the corresponding 2009 projections. Movements of actual peak demands above or below trend largely reflect weather extremes.

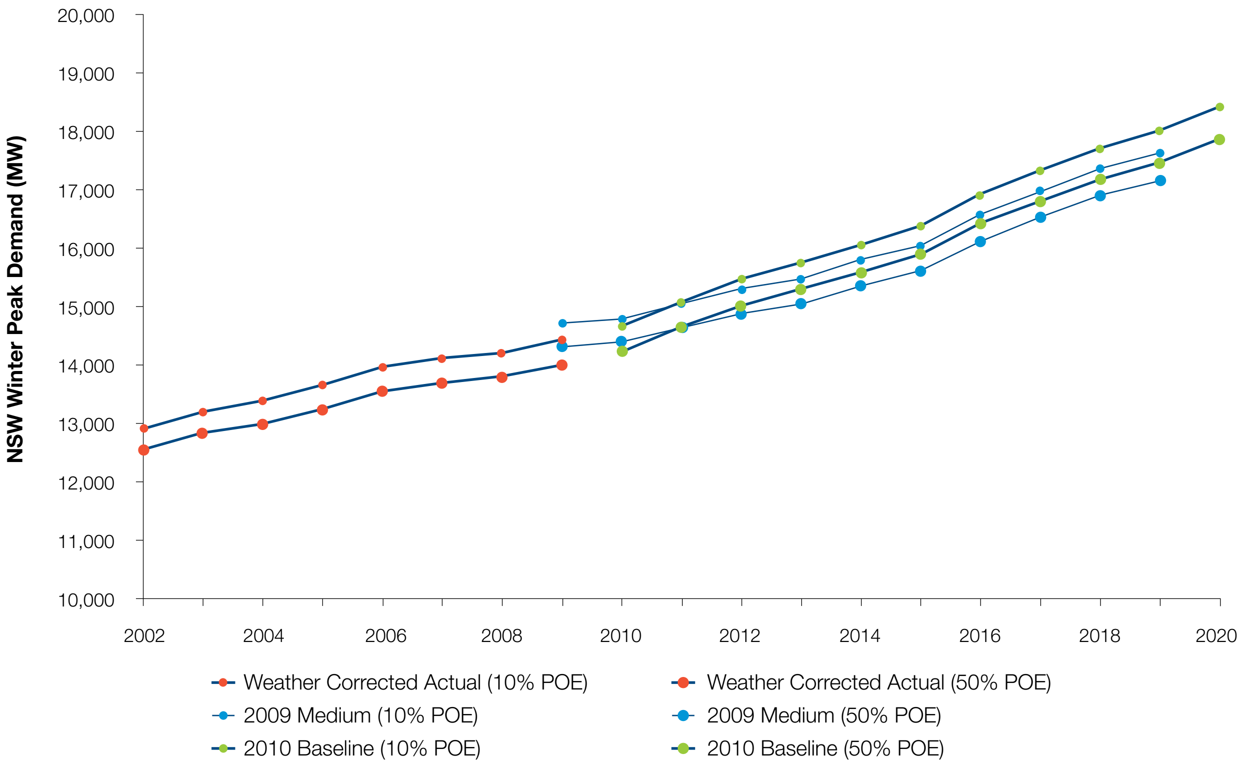
Figure 4.3 Comparison of NSW Region 2010 Summer Demand Projections with Corresponding 2009 Projections (Baseline Scenario) and Actual Weather Corrected Demands



Compared with the 2009 projection, the 2010 10 per cent POE summer demand projection is:

- 10 MW, or 0.06 per cent lower for the 2010/11 summer; and
- 190 MW, or 1.0 per cent higher for the 2018/19 summer.

Figure 4.4 Comparison of NSW Region 2010 Winter Demand Projections with Corresponding 2009 Projections (Baseline Scenario) and Actual Weather Corrected Demands



Compared with the 2009 projection, the 2010 10 per cent POE winter demand projection is:

- 140 MW, or 0.9 per cent lower for winter 2010; and
- 360 MW, or 2.0 per cent higher for winter 2019.

These differences between the 2010 and 2009 projections of peak demand reflect:

- Higher average demand for electricity, consistent with the NSW economy picking up pace and returning to the trend rate of growth in GSP;
- A revision of NSW's Semi-Scheduled and Non-Scheduled contributions to peak demand which reflect currently available information;
- Changes in assumptions with respect to post modelling adjustments (refer to Section 4.2); and
- Lower base of the starting year of the projections due to the global financial crisis.

4.4 Aggregate DNSP Connection Point Demand Projections

Details of summer and winter demand projections for individual customer connection points within TransGrid's network are shown in Appendix 3. This section provides a summary of that information by comparing the 2010 and 2009 demand projections aggregated across areas defined by the distribution networks of the following organisations:

- Energy Australia – eastern Sydney, the Central Coast, the Newcastle area and the Hunter valley;
- Integral Energy – western Sydney, the Blue Mountains and the south coast;
- Country Energy – the remainder of country New South Wales excluding the Australian Capital Territory; and
- ActewAGL – the Australian Capital Territory.

Whilst these areas cover the entire NSW region a simple aggregation of their demands is not directly comparable with corresponding NSW region demands as determined by TransGrid. This is because the DNSP forecasts:

- May not be provided on the basis of a similar reported economic scenario or exact POE conditions;
- Exclude some large transmission-connected loads that are included in the NSW region projections;
- Indicate the likely peak for that network or connection point, whenever it may occur, rather than the contribution to the overall NSW region peak;
- May exclude loads supplied by embedded generation operating within the DNSP's network at the time of peak; and
- May be based on differing methodologies used by each of the DNSPs.

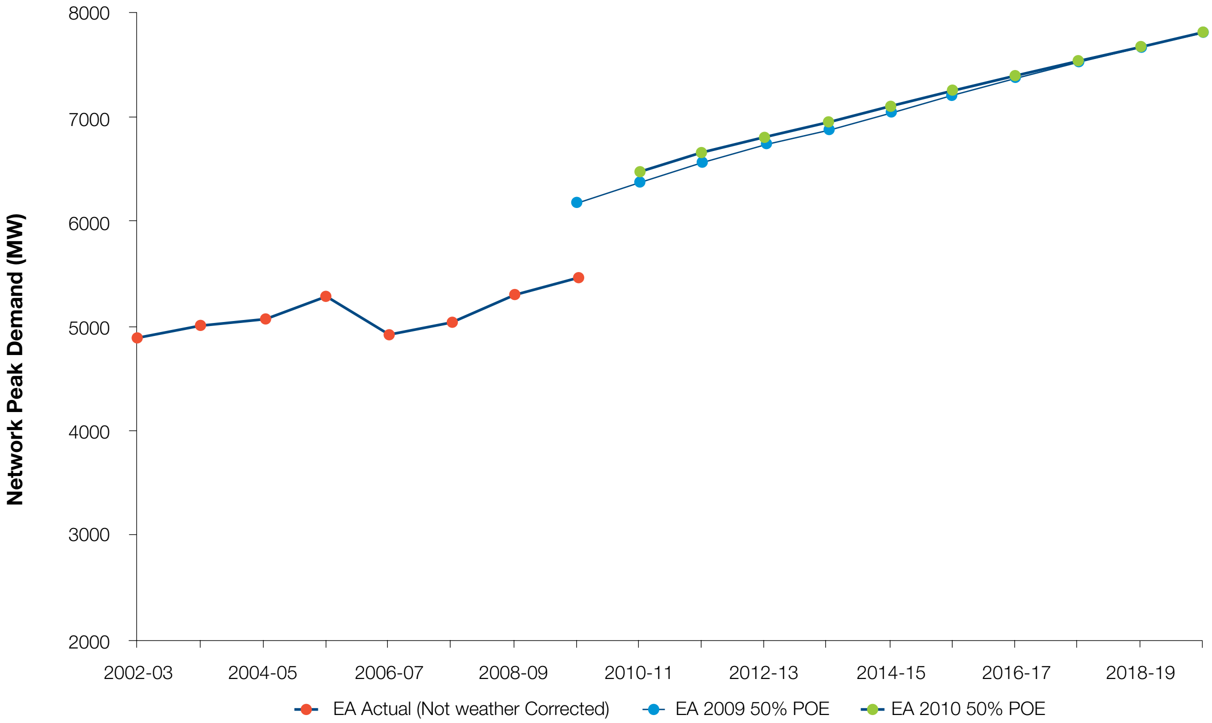
TransGrid has used diversified actual and forecast loads for the preparation of the charts in the next section. Where diversified loads were available, TransGrid has obtained the same directly from the DNSPs; in cases where diversified loads were not directly available, TransGrid has used diversity factors (based on historical data) wherever applicable.

4.4.1. Energy Australia

Figures 4.5 and 4.6 show actual and projected peak demands for Energy Australia's distribution network. The projections represent a 50 per cent POE demand and Baseline growth scenario.

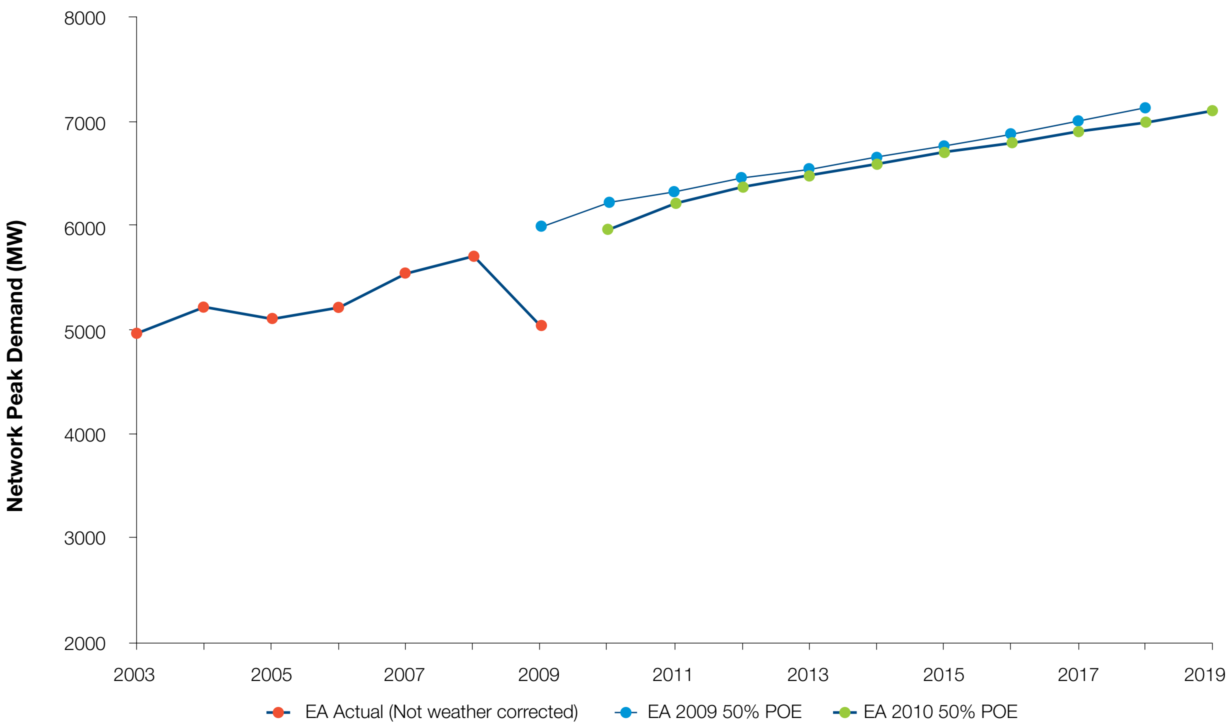
The 2010 Energy Australia summer demand forecasts are similar to the corresponding 2009 forecasts. The 2010 winter demand forecast path is slightly lower than that of last year possibly reflecting the relatively lower actual winter demands in the EA region due to a mild winter.

Figure 4.5 Comparison of Energy Australia 2010 Summer Demand Projection with the Corresponding 2009 Projection and Actual Demands



Network peak demands do not include transmission-connected loads or inter-distributor transfers

Figure 4.6 Comparison of Energy Australia 2010 Winter Demand Projection with the Corresponding 2009 Projection and Actual Demands



Network peak demands do not include transmission-connected loads or inter-distributor transfers

4.4.2. Integral Energy

Figures 4.7 and 4.8 below show actual and projected peak demands for Integral Energy's distribution network. The projections represent a 50 per cent POE demand and Baseline growth scenario.

Integral's 2010 summer and winter demand forecasts and their corresponding 2009 counterparts exhibit a similar growth rate but a lower trajectory this year compared to last year. This may be a reflection of the comparatively low actual demands in Integral's region of supply.

Figure 4.7 Comparison of Integral Energy 2010 Summer Demand Projection with the Corresponding 2009 Projection and Actual Demands

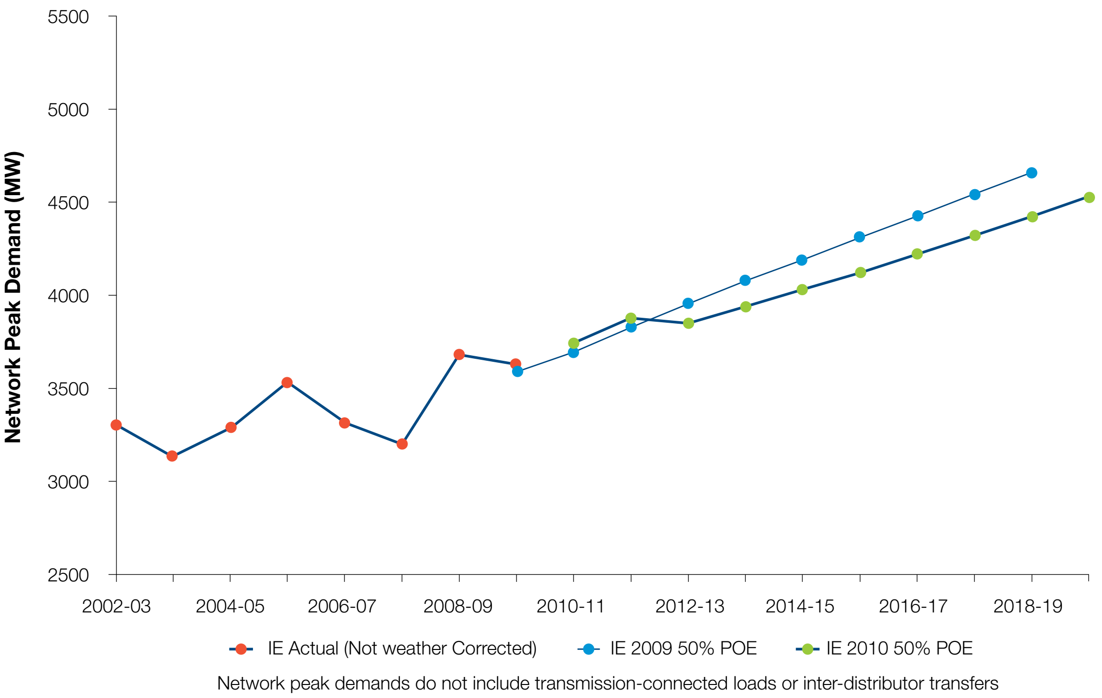
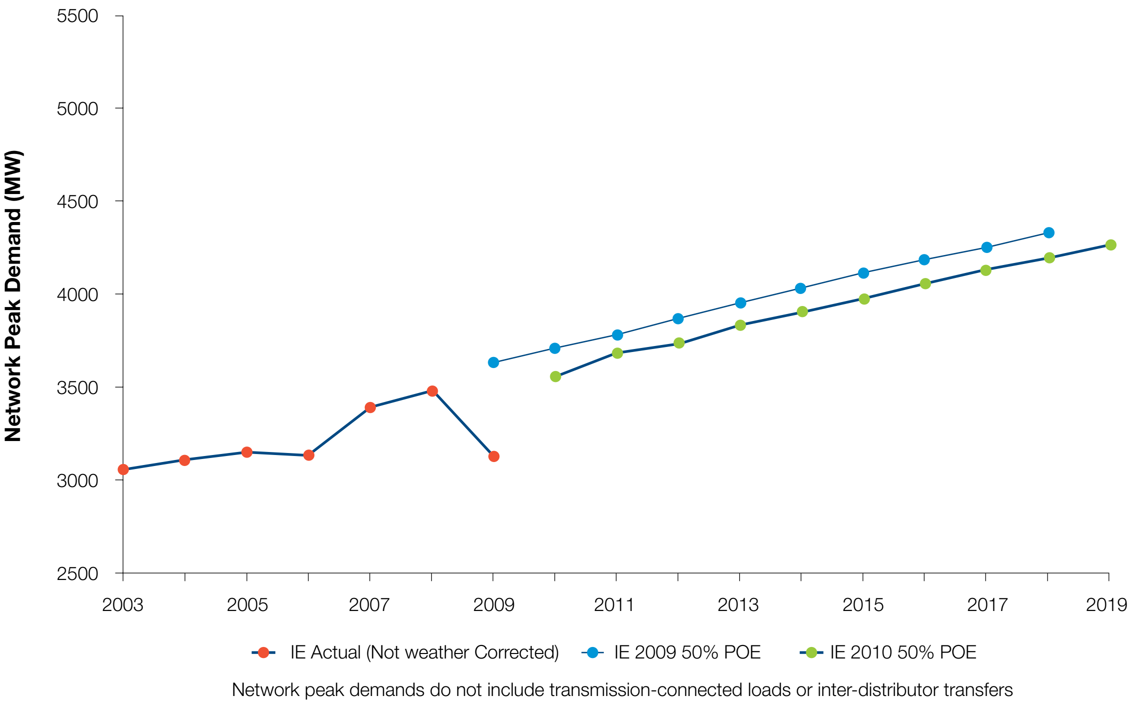


Figure 4.8 Comparison of Integral Energy 2010 Winter Demand Projection with the Corresponding 2009 Projection and Actual Demands

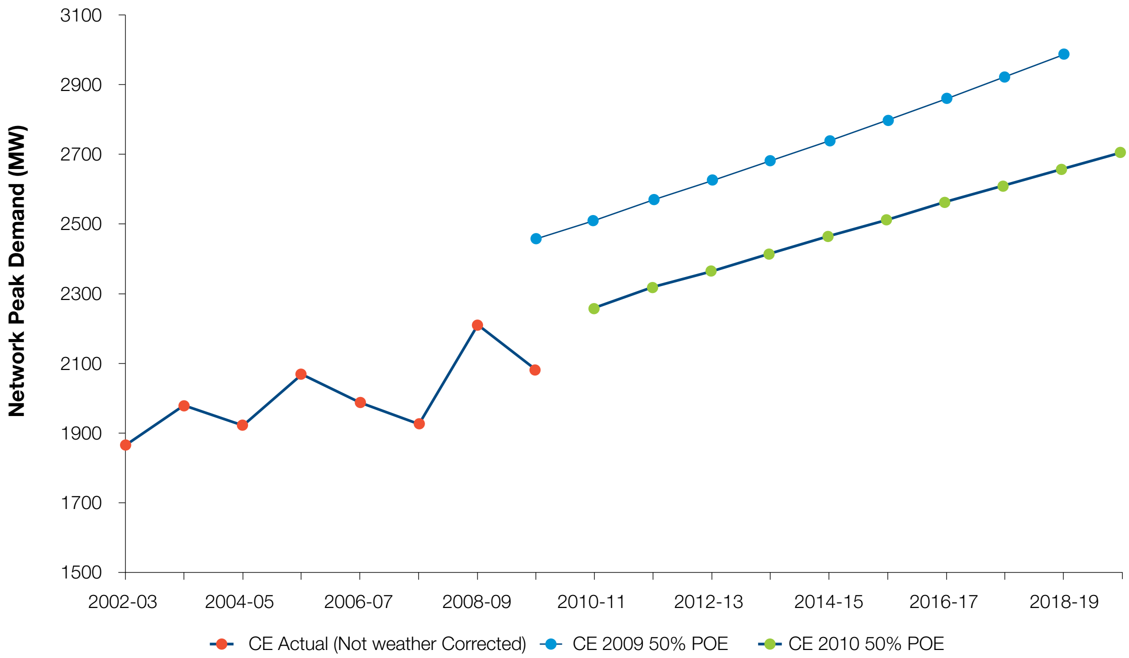


4.4.3. Country Energy

Figures 4.9 and 4.10 below show actual and projected peak demands within Country Energy's distribution network. The projections represent a 50 per cent POE demand and Baseline growth scenario.

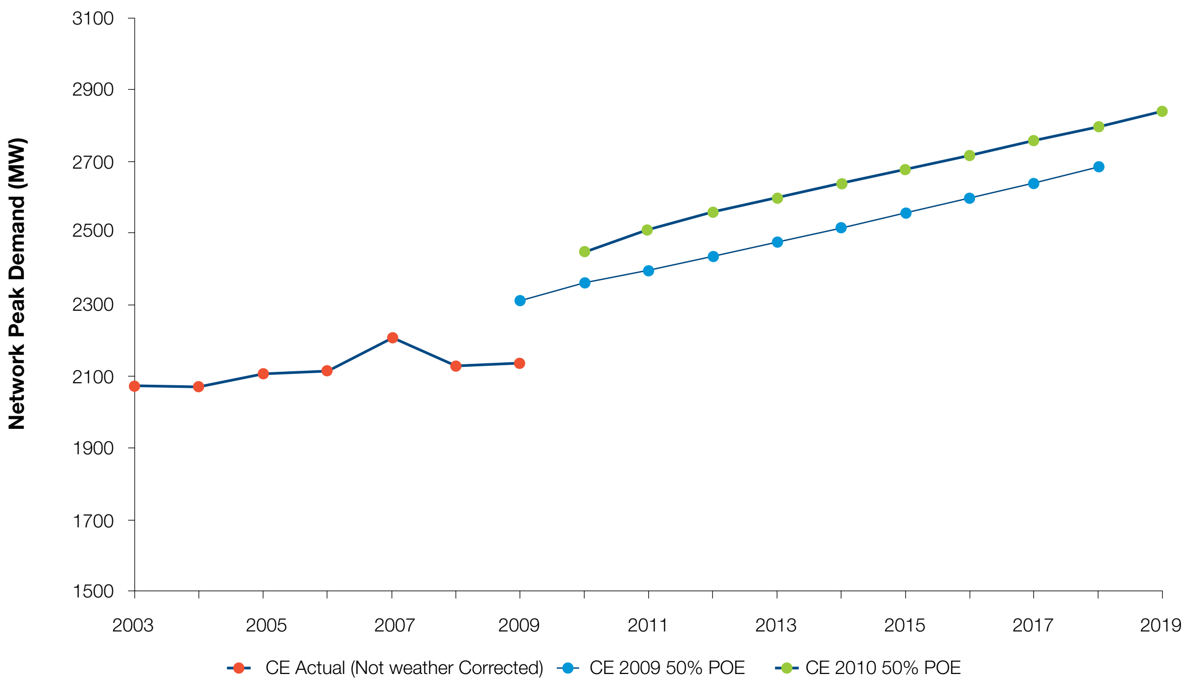
Country Energy's has forecast a lower trajectory of summer demand growth in 2010 compared to last year. However it expects that its 2010 demand forecasts for winter in the forecast period will be higher than last year's forecasts.

Figure 4.9 Comparison of Country Energy 2010 Summer Demand Projection with the Corresponding 2009 Projection and Actual Demands



Network peak demands do not include transmission-connected loads or inter-distributor transfers

Figure 4.10 Comparison of Country Energy 2010 Winter Demand Projection with the Corresponding 2009 Projection and Actual Demands



Network peak demands do not include transmission-connected loads or inter-distributor transfers

4.4.4. ActewAGL

Figures 4.11 and 4.12 below compare ActewAGL's 50 per cent POE demand forecast for 2010 to the corresponding 50 per cent POE forecasts last year.

ActewAGL's demand trajectories for summer are higher than last year's forecasts. The 2010 winter demand forecasts are comparable with last year's forecasts but show an overall reduction perhaps due to energy source substitution or energy efficiency measures.

Figure 4.11 Comparison of ActewAGL 2010 Summer Demand Projection with the 2009 Projection and Actual Demands

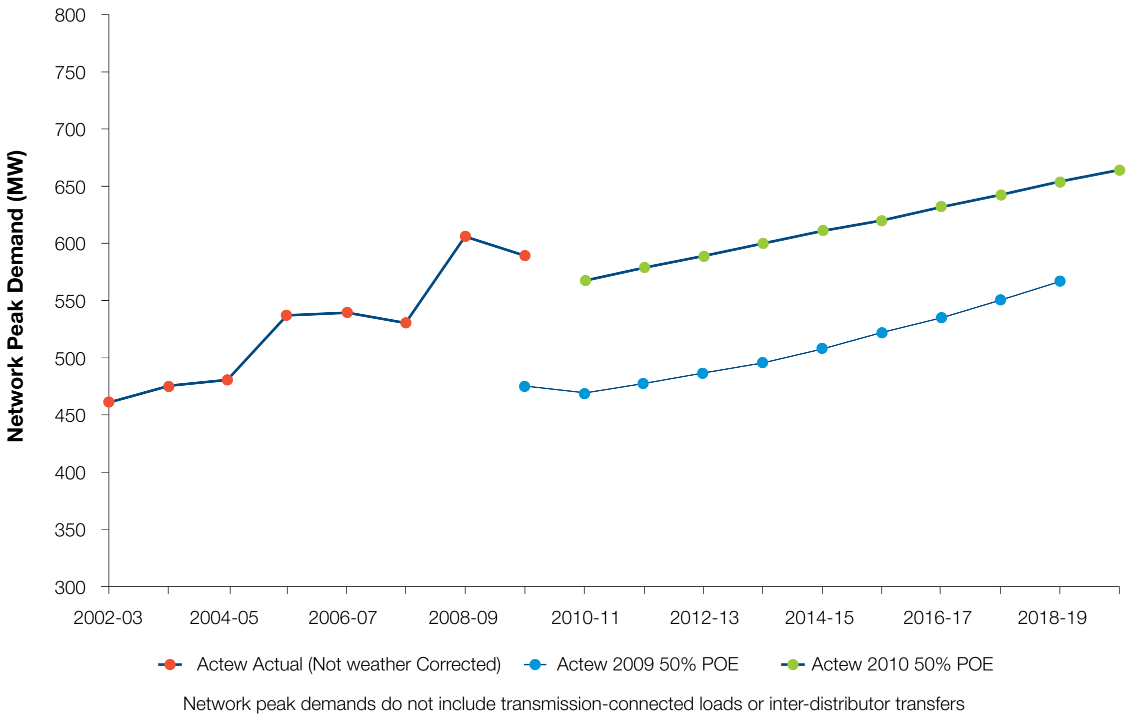
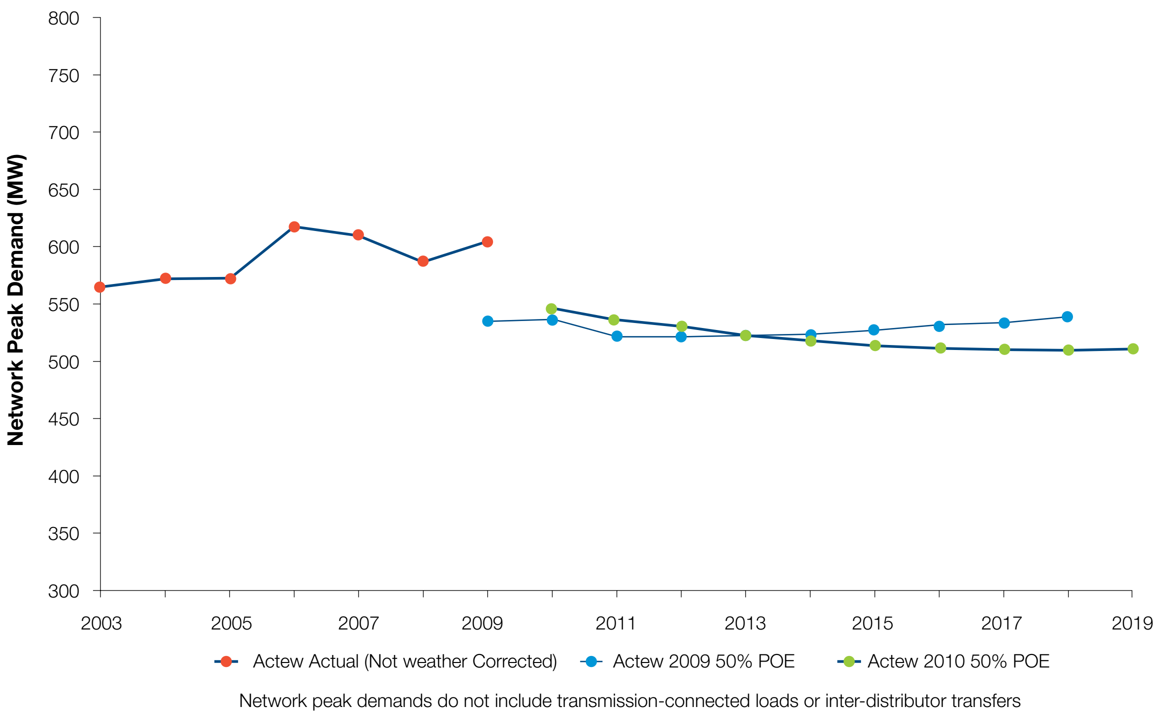


Figure 4.12 Comparison of ActewAGL 2010 Winter Demand Projection with the 2009 Projection and Actual Demands



4.5 Semi-Scheduled and Non-Scheduled Generation

The energy and peak demand projections in Sections 4.2 and 4.3 include assumptions about the level of Scheduled, Semi-Scheduled and Non-Scheduled generation (refer to Section 4.1 for an explanation of these terms).

Table 4.4 details the Semi-Scheduled and Non-Scheduled generation that has been included in these projections.

This includes generation that uses renewable fuel sources such as wind, solar, hydro, geothermal and biomass plus generation that uses non-renewable fuel sources, for example small scale thermal and gas fired generation. The projections of contribution to demand at the time of the NSW region peak have been estimated from capacity projections assuming wind and hydro availabilities at those times of 5 per cent and 20 per cent respectively.

Table 4.4 NSW Region Semi-Scheduled and Non-Scheduled Generation: Historical and Projected Capacity, Demand at time of NSW Region Summer Peak and Energy (Baseline Scenario)[3]

	Capacity (MW)		Demand at time of NSW Summer Peak (MW)		Energy (GWh)	
	Wind (Semi-scheduled)	Non-scheduled	Wind (Semi-scheduled)	Non-scheduled	Wind (Semi-scheduled)	Non-scheduled
2006-07	0	363	0	105	0	904
2007-08	0	577	0	131	0	913
2008-09	0	585	0	187	0	1,192
2009-10	0	805	0	285	0	1,627
2010-11	150	840	7	460	380	1,702
2011-12	742	882	37	502	1,884	1,808
2012-13	844	882	42	502	2,144	1,808
2013-14	913	882	46	502	2,319	1,808
2014-15	1,376	904	69	523	3,494	1,855
2015-16	1,621	904	81	523	4,117	1,855
2016-17	1,746	904	87	523	4,435	1,855
2017-18	1,746	906	87	525	4,435	1,860
2018-19	1,776	906	89	525	4,512	1,860
2019-20	2,127	910	106	529	5,404	1,868

[3] The High and Low scenarios of this Table are presented in Appendix 3.

4.6 Supplementary Information

Participation in the Load Forecasting Reference Group (LFRG)

The NSW region projections were developed by TransGrid in a manner consistent with projections for the other NEM regions developed at the same time. Consistency across regions is the objective of the LFRG and applies to the development of the projections to the extent of using common:

- Definitions of energy, demand and probabilities of exceedence;
- Historical data including Demand Side Participation survey data and Semi-Scheduled and Non-Scheduled generation data;
- Economic and demographic growth scenarios; and
- Semi-Scheduled and Non-Scheduled generation projections.

In addition to participating in the LFRG, TransGrid undertakes a process of continuous improvement in load forecasting processes and methodologies.

Energy and Demand Definitions

Measures of NSW region electrical energy and demand used in this APR represent quantities required to satisfy demand that originates within the NSW region of the NEM. Identical regional energy and demand measures are also used in the ESOO. The intra-regional break-down of demand in Appendix 3 is based on connection point metering data collected at transmission substations within the NSW region.

Aggregation of Connection Point Loads

Peak demands at individual connection points across the NSW region do not necessarily occur at the same time due to a lack of uniformity of weather conditions and local activity patterns that affect electricity consumption. Consequently the projections of aggregated connection point demands shown in Appendix 2 are adjusted using historically-based diversity factors. They are also adjusted for network losses.

Demand-Side Participation

Demand-side participation (DSP) occurs when consumers of electricity agree with their retailers or other parties to reduce their consumption in response to market events such as high spot prices. The regional demand projections in this APR include estimated amounts of DSP of up to 52 MW at time of summer peak and 11 MW at time of winter peak[4]. This implies that the projections could be reduced by up to that amount in the event that DSP arrangements are invoked. No other explicit allowance has been made for individual DSP programmes. However the projections implicitly allow for the continuation of any existing DSP that was operational in the past.

Temperature and Day Type Dependence of the NSW Energy and Demand Projections

For any given day in summer higher maximum demands are associated with higher temperatures. Conversely in winter higher maximum demands are associated with lower temperatures. Activity patterns also result in higher maximum demands on certain days (such as working weekdays) than others (such as weekends). Therefore the actual peak demand for a particular season depends on the extent and severity of extreme temperature spells that actually occur and on the timing of these spells. The peak demand projections in this APR represent standardised specific points in a statistical distribution which takes into account the probabilities of extreme temperatures occurring on various days of the week and at various times of the year. Specifically:

- 10 per cent POE projected peak demands for a given season are expected to be met or exceeded, on average, 1 year in 10;
- 50 per cent POE projected peak demands for a given season are expected to be met or exceeded, on average, 5 years in 10; and
- 90 per cent POE projected peak demands for a given season are expected to be met or exceeded, on average, 9 years in 10.

The transition from actual historical demands to projected demands may appear to reflect a high or low growth rate. This is because actual demands reflect actual weather and day type whereas the projected demands reflect standard conditions associated with each of the above specific points on the statistical distribution of demand.

[4] Source: Historical levels of load reduction in NSW, DSP Survey conducted by NEMMCO, 2009

5

Completed, Committed and Planned Augmentations

5 Completed, Committed and Planned Augmentations

5.1 Recently Completed Augmentations

This section describes augmentations that have been completed since publication of the APR 2009.

5.1.1. Armidale SVC: Power Oscillation Damping Control

To improve the damping of system oscillations a power oscillation damping control facility was installed on the Armidale SVC and largely completed in February 2009. Prior to actual commissioning, the facility will be tested when appropriate system conditions arise. The works are expected to be completed during 2010.

5.1.2. Western 500 kV Conversion Project

The main transmission network supplying the Newcastle/Sydney/Wollongong load area faced two major limitations:

- Line thermal limitations, particularly between the Hunter Valley and Newcastle; and
- Voltage control and reactive power support limitations.

To meet these limitations TransGrid implemented the following:

- Development of non-network projects to provide 350 MW of network support capability for the Newcastle – Sydney – Wollongong area for summer 2008/9. These works are complete (refer to Chapter 7); and
- Conversion of the existing Bayswater – Mount Piper and Mount Piper – Bannaby lines, which operated at 330 kV, to operate at their design voltage of 500 kV.

These works did not entail major line works but involved significant 500 kV and some 330 kV substation works at Bayswater and Mount Piper Power Stations and the establishment of new 500/330 kV substations at Bannaby and Wollar. It has also involved the reconnection of two generating units at Bayswater from the 330 kV switchyard to the new 500 kV switchyard.

The works at Bayswater and Wollar have been completed and are in service. Most of the works at Mt Piper and Bannaby have been completed and it is expected that all components will be in service by August 2010.

5.1.3. Wollar – Wellington 330 kV line and Wollar 500/330 kV Substation

To meet limitations in the reliability of supply to the Western area of NSW the following works were carried out:

- Construction of a new 330 kV transmission line from Wollar (north east of Mudgee) to Wellington 330 kV substation; and
- Termination of this line at a new 500/330 kV substation at Wollar.

These works were coordinated with the Western 500 kV Conversion Project. The works were completed in May 2010.

5.1.4. Second Coffs Harbour – Kempsey 132 kV Circuit

Low voltages and overloading of some network elements were expected to occur on outage of key elements of the 132 kV network supplying the NSW north coast at times of high demand.

To meet these limitations TransGrid and Country Energy carried out works to provide for the conversion of the Coffs Harbour – Kempsey 66 kV circuit (which connected to a number of intermediate substations) to its design voltage of 132 kV.

This required the connection of new and/or upgraded Country Energy substations at Raleigh, Boambee South and Macksville and the provision of a second transformer at TransGrid's Nambucca 132/66 kV substation.

These works were progressively completed in 2009/10.

5.1.5. Tamworth – Gunnedah 132 kV Line 969 Realignment

A new section of double circuit 132 kV line was constructed to re-align sections of the existing Tamworth – Gunnedah 132 kV line 969 near Tamworth and to provide an additional line outlet from Tamworth.

These works were completed in February 2010.

5.1.6. Development of Supply to the Macarthur Area and South West Sector

To meet limitations in the network supplying the Macarthur area and to meet requirements for supply to the South West Sector of Sydney the following works were constructed:

- Construction by TransGrid of a new 330/132/66 kV substation at Macarthur close to the route of the existing Kemps Creek – Avon 330 kV line;
- Construction by Integral Energy of two 132 kV circuits between Macarthur substation and its Nepean 132/66/33 kV substation; and
- Construction by Integral Energy of 66 kV connections from Macarthur substation to Campbelltown and an additional 66 kV feeder to Ambarvale.

TransGrid's works and Integral Energy's initial line connections were completed in October 2009.

5.1.7. Development of Supply to the Wagga Area

To meet a transformer capacity limitation at Wagga 132/66 kV substation and Country Energy's requirements for development of its 66 kV network, TransGrid and Country Energy proposed that TransGrid would:

- Construct a new Wagga North 132/66 kV substation; and

that Country Energy would:

- Proceed with planned rearrangements of its 66 kV network using Wagga North as a source of supply; and
- Construct a 66 kV feeder from Wagga 132/66 kV substation to supply its Holbrook, Henty, Culcairn and Uranquinty substations.

The Wagga North works were completed in late 2009.

5.1.8. Munmorah and Vales Point Short Circuit Rating Upgrades

Equipment replacement programs were carried out at Munmorah and Vales Point switchyards to overcome constraints imposed by the equipment ratings of the two switchyards.

These works were completed in December 2009.

5.1.9. Works to Connect a Gas Turbine Power Station at Munmorah

Delta Electricity has developed a new four unit gas turbine power station at Colongra (near Munmorah Power Station) with a capacity of 4 x 187 MW. To enable this power station to be connected to the transmission network TransGrid has extended the 330 kV busbar and installed new 330 kV switchbays at Munmorah switchyard.

These works were completed in December 2009.

5.1.10. Capital Wind Farm 330 kV Switchyard

Associated with the connection of the Capital wind farm near Canberra a new 330 kV switchyard was constructed and connected to the Kangaroo Valley – Canberra 330 kV transmission line. The new switchyard is owned and operated by TransGrid and was completed in 2009.

5.1.11. Completed Line Switchbays for Distributor Requirements

The following table summarises projects for the provision of line switchbays to meet NSW Distributors' requirements that were included as proposals in previous APRs and completed since the publication of the APR 2009.

Table 5.1.1 - Completed Line Switchbays for Distributor Requirements

Location	Installation	Completion
Haymarket 330/132 kV substation	Three new and one modified 132 kV switchbays to connect EnergyAustralia's new City North 132/11 kV zone substation and support 132 kV cable rearrangements.	Mar 2010
Sydney North 330/132 kV substation	Two 132 kV line switchbays to supply EnergyAustralia's Galston substation	Feb 2010
Tuggerah 330/132 kV substation	132 kV switchbay for connection of EnergyAustralia's Berkley Vale substation	2010
Vineyard 330/132 kV substation	132 kV line switchbay to supply Integral Energy's Rouse Hill substation	2010
Beryl 132/66 kV substation	66 kV switchbay for connection of Country Energy's frequency injection equipment	May 2010
Koolkhan 132/66 kV substation	One new 66 kV line switchbay to connect Country Energy's second Maclean 66 kV line	Apr 2010

5.1.12. Completed Substation Fault Rating Upgrades

The following table summarises substation fault rating upgrades that were included as proposals in previous APRs and completed since publication of the APR 2009.

Table 5.1.2 - Substation Fault Rating Upgrades

Location	Installation	Completion
Sydney West 330/132 kV substation	Equipment replacements to ensure that the 330 kV fault rating is ≥ 38 kA and the 132 kV fault rating is ≥ 38 kA.	Mid 2010

5.1.13. Transformer Replacements and Capacity Upgrades

The following table summarises transformer replacements and capacity upgrades that were included as proposals in previous APRs and completed since publication of the APR 2009.

Table 5.1.3 - Transformer Replacements and Capacity Upgrades

Location	Installation	Completion
Coffs Harbour 132/66 kV substation	Replacement of 60 MVA 132/66 MVA transformers by two new 120 MVA units	Mar 2010
Cowra 132/66 kV substation	Replacement of the two existing 30 MVA 132/66 kV transformers by two new 60 MVA 132/66 kV units	April 2010
Finley 132/66 kV substation	Install two new 60 MVA 132/66 kV transformers	May 2010
Gadara 132/11 kV substation	Install second 55 MVA 132/11 kV transformer	2009
Koolkhan 132/66 kV substation	Install third 60 MVA 132/66 kV transformer	April 2010
Orange 132/66 kV substation	Replacement of the three ageing 30 MVA transformers by two new 60 MVA 132/66 kV transformers	June 2010
Queanbeyan 132/66 kV Substation	Replacement of four 30 MVA transformers by two 120 MVA units as part of the substation replacement.	June 2010
Sydney South 330/132 kV substation	Replacement of No 1 and No 4 250 MVA single phase 330/132 kV transformers by new 375 MVA 3 phase units	May 2010
Wagga 330/132 kV substation	Replacement of two 375 MVA 330/132 transformers to meet EPA requirements for management of PCBs	Dec 2009

5.1.14. Capacitor Bank Installations

The following table summarises capacitor bank installations that were included as proposals in previous APRs and completed since publication of the APR 2009.

Table 5.1.4 - Capacitor Bank Installations

Location	Installation	Completion
Beryl 132/66 kV substation	One 8 MVAr 66 kV capacitor bank	May 2010

5.2 Committed Augmentations

This section describes network constraints within NSW that are being relieved by augmentations that TransGrid considers to be committed. For an augmentation to be considered committed it must satisfy criteria that are defined in AEMO's Electricity Statement of Opportunities and be approved by TransGrid's Board. These augmentations were previously the subject of proposals that were documented in previous APRs or regulatory consultations.

5.2.1. Uprating of Tamworth – Armidale 330 kV line No 86

In the APR 2006, it was proposed to uprate the Tamworth – Armidale 330 kV line No 86.

These works are planned to be completed by late 2010.

5.2.2. 500/330 kV transformer – Spare Radiator

There is a requirement for a spare 500/330 kV transformer radiator to be acquired as a result of the western 500 kV conversion project. This would enable the existing spare 500/330 kV transformer units to be used at Bayswater, Mt Piper or Bannaby.

Acquisition and storage of the radiator is planned to be completed by late 2010.

5.2.3. Development of Supply to the ACT

To meet reliability and security requirements of the ACT government TransGrid and ActewAGL have proposed that TransGrid would:

- Construct a single transformer 330/132 kV substation at Williamsdale;

- Convert the existing single circuit 330 kV line between Canberra and Williamsdale which presently operates at 132 kV to operate at 330 kV to supply Williamsdale;
- Provide 330 kV switchbays at Canberra 330 kV substation; and

that ActewAGL would:

- Construct two 132 kV circuits to connect Williamsdale to the ActewAGL 132 kV network in the Gilmore/Theodore area.

The TransGrid works are planned to be completed by mid 2011.

5.2.4. Glen Innes – Inverell 132 kV Line

To meet limitations in the network supplying the Inverell area TransGrid and Country Energy have proposed that TransGrid would construct a new 132 kV line between its Glen Innes and Inverell substations and provide a new 132 kV switchbay at each site to connect the line.

These works are planned to be completed by late 2010.

5.2.5. New Kempsey – Port Macquarie 132 kV Line

To meet limitations in the network supplying the north coast of NSW TransGrid and Country Energy have proposed that TransGrid would replace the existing 96G Kempsey – Port Macquarie single circuit 132 kV line by a new double circuit 132 kV line and provide 132 kV line switchbays at Kempsey and Port Macquarie 132 kV substations for the connection of the extra 132 kV circuit.

These works are planned to be completed by summer early 2011.

5.2.6. Manildra – Parkes 132 kV Line

To meet limitations in the network supplying the Cowra, Forbes and Parkes area, TransGrid and Country Energy have proposed that TransGrid would construct a new 132 kV line between Manildra 132/11 kV substation and Parkes 132/66 kV substation and provide a 132 kV line switchbay at each of those substations to connect the new line.

These works are planned to be completed during 2011.

5.2.7. Murray Switching Station and Upper Tumut Switching Station Rehabilitation

Minor rehabilitation works have been completed at Murray Switching Station (MSS) and Upper Tumut Switching Station (UTSS) which were transferred from Snowy Hydro to TransGrid in 2002.

Remaining works at MSS are programmed for completion during 2011. The works at UTSS will take place progressively through to 2014.

5.2.8. Sydney South – Beaconsfield 330 kV Cable Series Reactor Replacement

To reduce the loading on the Sydney South – Beaconsfield West 330 kV cable No. 41 it has been proposed to replace the 330 kV series reactor on this cable by a unit with a higher reactance.

These works are planned to be completed by mid 2010.

5.2.9. Beaconsfiled West 330/132 kV substation 132 kV Equipment Replacement

It is proposed to replace ageing 132 kV equipment at Beaconsfield West 330/132 kV substation and to provide additional 132 kV cable connections, a third 330/132 kV transformer and two 132 kV capacitors.

These works are planned to be completed by late 2012.

5.2.10. Development of Supply to Newcastle and the Lower Mid North Coast

To meet present and emerging limitations in the network supplying the Newcastle area and Lower mid north coast areas TransGrid and EnergyAustralia have proposed to carry out the following works:

- Establishment of a 330/132 kV substation at Tomago adjacent to Tomago 330 kV Switching Station with three 375 MVA 330/132 kV transformers;
- Construction of three short double circuit 132 kV lines between Tomago and suitable points in EnergyAustralia’s 132 kV network north of Tomago and rearrangement of that network;
- Installation of a 330 kV busbar and a second 375 MVA 330/132 kV transformer at Waratah West 330/132 kV substation;
- Conversion of the Newcastle – Waratah West 132 kV circuit 95N to 330 kV operation; and
- Installation of 330 kV and 132 kV switchgear to support the above.

The works are to be carried out in a staged manner with completion in the period 2010/11 – 2012/13.

5.2.11. Committed Line Switchbays for Distributor Requirements

The following table summarises committed projects for the provision of line switchbays to meet NSW Distributors' requirements.

Table 5.2.1 - Committed Line Switchbays for Distributor Requirements

Location	Installation	Completion	Comments
Griffith 132/33 kV substation	Five new or uprated 33 kV switchbays in support of Country Energy 33 kV works in the Griffith area	Late 2010	
Port Macquarie 132/33 kV substation	Two new 33 kV line switchbays to supply Country Energy's new Sovereign Hill 33/11 kV substation	Late 2010	

5.2.12. Committed Substation Fault Rating Upgrades

The following table summarises committed substation fault rating upgrades.

Table 5.2.2 - Committed Substation Fault Rating Upgrades

Location	Installation	Completion	Comments
Sydney North 330/132 kV substation	Equipment replacements to ensure that the 132 kV fault rating is ≥ 40 kA.	Late 2010	
Dapto 330/132 kV substation	Equipment replacements to ensure that the 330 kV fault rating is ≥ 30 kA and the 132 kV fault rating is ≥ 40 kA.	Late 2010	

5.2.13. Committed Transformer Replacements and Upgrades

The following table summarises committed transformer replacements and upgrades.

Table 5.2.3 - Committed Transformer Replacements and Upgrades

Location	Installation	Completion	Comments
Marulan	Install 200 MVA 330/132 kV transformer ex Armidale	Late 2010	Temporarily installed at Wallerawang
Beaconsfield West 330/132 kV substation	Installation of a third 330/132 kV transformer	Late 2012	In conjunction with 132 kV GIS replacement.
Sydney North 330/132 kV substation	Installation of a fifth 375 MVA 330/132 kV transformer	Late 2010	Includes modifications to existing transformer 330 kV connections
Wallerawang 330/132 kV substation	Replace two 215 MVA 330/132 kV transformers by new 375 MVA units	Mid 2011	To be co-ordinated with replacement of the 132/66 kV substation.

5.3 Planned Augmentations that have Completed the Regulatory Process

This section briefly describes network constraints within NSW that are being relieved by augmentations that have completed the regulatory process but have not progressed to the point where they can be considered committed in accordance with the criteria described in AEMO's Electricity Statement of Opportunities.

5.3.1. Supply to the NSW Far North Coast

The far north coast area of New South Wales includes the Ballina, Bellingen (part), Byron, Clarence Valley, Coffs Harbour, Kyogle, Lismore and Richmond Valley local government areas.

It is anticipated that with growing demand, existing thermal rating limitations on 132 kV lines supplying these areas will increase on outage of either the Armidale – Coffs Harbour 330 kV line or the Coffs Harbour – Lismore 330 kV line.

The severity of these limitations is dependent on the amount of network support available from Queensland via Directlink (the high voltage dc link between Mullumbimby and Terranora).

TransGrid and Country Energy have proposed to carry out the following works to meet these limitations:

- Uprate the 96C Armidale – Coffs Harbour 132 kV line to a conductor operating temperature of 100ºC;
- Construct a new 330 kV line between Dumaresq 330 kV switching station and Lismore 330/132 kV substation;
- Provide 330 kV switchgear at Dumaresq and Lismore to connect the new line;
- Provide reactive equipment at Lismore and Coffs Harbour; and
- Provide a second 330/132 kV transformer and related 330 kV and 132 kV switchgear at Coffs Harbour 330/132 kV substation.

Subsequent to completion of the regulatory consultation, during the route identification process, a requirement to provide a low cost 330/132 kV substation near Tenterfield was also identified.

These works are planned to be completed by mid 2014. TransGrid has issued a Request for Proposals for non-network alternatives with a view to deferring the project if possible.

5.3.2. Supply to the Lower Mid North Coast

To meet present and emerging limitations TransGrid and Country Energy are proposing the construction of the following to increase the capacity of the transmission system supplying the lower Mid North Coast:

- Construction of short sections of single circuit and double circuit 330 kV transmission line, to initially operate at 132 kV, between TransGrid's Tomago 330 kV substation and the Tarro area;
- Construction of a new double circuit 132 kV transmission line between Tarro and Country Energy's Stroud STS;
- Connections to enable a new Tomago – Stroud 132 kV circuit and a Tomago – Brandy Hill 132 kV circuit to be in service by summer 2012/13;
- Construction of a new single circuit 330 kV line between Stroud STS and Lansdowne (north of Taree) initially to be operated at 132 kV;
- Establishment of a new 132 kV switching station at Lansdowne;
- Construction of short sections of 132 kV transmission line between Lansdowne and TransGrid's Taree – Port Macquarie 132 kV line; and
- Connections to enable new 132 kV circuits from Stroud – Lansdowne, Taree – Lansdowne and Lansdowne – Port Macquarie to be in service by summer 2015/16.

The works are to be carried out in a staged manner with completion dates of 2012/13 and 2015/16.

5.3.3. Supply to the Sydney CBD and Inner Metropolitan Area

To meet present and emerging limitations TransGrid and EnergyAustralia are proposing construction of new large transmission network assets with major components, including the following, to increase the capacity of the transmission system supplying the area:

- Construction of sections of new double circuit 330 kV line and conversion of parts of an existing double circuit line to operate at 330 kV between Sydney West 330/132 kV substation and the new Holroyd substation;
- Construction of a new 330/132 kV substation in the Holroyd area;
- Installation of two 330 kV cables between the new Holroyd substation and the new Rookwood Rd substation; and
- Construction of a new 330/132 kV substation in the Potts Hill area (Rookwood Road, Potts Hill).

The works are expected to be completed for summer 2013/14.

5.3.4. Redevelopment of Orange 132/66 kV Substation

To meet the present and emerging limitations TransGrid and Country Energy are proposing the construction of a new large transmission network asset to increase the capacity of the transmission network to supply the Orange Area:

The proposal has the following components:

- Establishment of a new 132 kV switching station to the north of the existing Orange 132/66 kV substation;
- Line rearrangements to connect the 132 kV switching station to existing 132 kV lines and to Orange 132/66 kV substation; and
- Refurbishment works at Orange 132/66 kV substation.

The works are expected to be completed with progressive commissioning from late 2011.

5.3.5. Development of Southern Supply to the ACT

To meet the requirement of the ACT government, TransGrid and ActewAGL are proposing the construction of a new large transmission network asset and a new small distribution network asset.

The project consists of the following:

- Establishment of a new 330 kV switching substation at Wallaroo (northwest of Canberra);
- Formation of 330 kV circuits from Yass – Wallaroo and from Wallaroo – Canberra;
- Construction of a short section of 330 kV line from Wallaroo to the route of the Canberra – Williamsdale 330 kV line;
- Connection of the new line at Wallaroo and to the Canberra – Williamsdale 330 kV line;
- Provision of a second 375 MVA 330/132 kV transformer at Williamsdale; and
- Upgrading by ActewAGL of its existing Gilmore to Theodore 132 kV lines.

The works are expected to be completed by June 2012.

5.3.6. Supply to Lake Munmorah

To meet the anticipated load growth on the NSW Central Coast and to relieve the existing 33 kV network in the area EnergyAustralia and TransGrid are proposing the construction of a new large transmission network asset to provide increased capacity of supply to the Lake Munmorah area on the NSW Central Coast.

The proposal has the following components:

- Reconstruction of EnergyAustralia's existing Lake Munmorah 33/11 kV zone substation on the existing site as a 132/11 kV substation supplied at 132 kV from TransGrid's Vales Point and Munmorah 132 kV supply points; and
- Establishment of 132 kV busbars at TransGrid's Vales Point and Munmorah 132 kV supply points.

The works are expected to be completed in 2012.

5.3.7. Supply to the Hawks Nest/Tea Gardens Area

Hawks Nest is located approximately 75 kilometres south of Taree. It is presently supplied via a 33 kV network from EnergyAustralia's Tomago 132/33 kV substation. A backup 33 kV supply is available from Country Energy's Stroud 132/33 kV substation. The thermal capacity and voltage limits of both 33 kV networks have been reached.

To meet these limitations, Country Energy and TransGrid are proposing the construction of a new low cost, single transformer 132/33 kV substation in the Hawks Nest area supplied from the 963 Tomago – Taree 132 kV transmission line together with associated 33 kV line works to connect it to the local 33 kV network.

The proposal provides for TransGrid to construct short lengths of 132 kV line. The works are anticipated to be completed during 2010/11.

Country Energy completed the regulatory assessment process in 2009/10.

5.3.8. Proposed Minor Augmentation Projects Previously Reported

The following table summarises proposed minor augmentation projects that have previously been reported.

Table 5.3.1 - Minor Augmentations Previously Reported

Proposal	Need	Completion	Comments
Provide dual switching on 330 kV line 84 at Liddel	Improve reliability of supply	2012	83 and 84 lines carry supply to loads in the north of NSW. 83 line already has dual switching.
Provide 330 kV bus coupler circuit breaker at Newcastle 330 kV substation	Improve reliability of supply	2012	Newcastle is a critical major substation supplying large urban loads. The works are being combined with transformer work.
Provide a 330 kV bus coupler circuit breaker at Sydney South 330 kV substation	Improve reliability of supply	2012	Sydney South is a critical major substation supplying large urban loads
Provide a 330 kV bus coupler circuit breaker at Sydney West 330 kV substation	Improve reliability of supply	2012	Sydney West is a critical major substation supplying large urban loads. The bus coupler work is being combined with the connection of 330 kV lines to Holroyd
Replace the existing 7.5 MVAr 66 kV capacitor bank at Coffs Harbour 132/66 kV substation with a new 16 MVAr unit.	Replace ageing assets	Late 2011	
Albury Trip Scheme	Thermal loading of Jindera – Albury – ANM network	Late 2011	Country Energy plans to construct a Mulwala – Finley 132 kV circuit which will enable the Mulwala/Corowa load to be transferred to Finley.
Uprate Murray – Guthega 132 kV line	Capacity support for longer term requirements	Late 2011	Capacity support to be carried out with works to restore conductor clearances.

5.3.9. Proposed New Small Transmission Network Assets that have Completed the Regulatory Process

The following table summarises proposed new small transmission network assets that have completed the regulatory process.

Table 5.3.2 – Proposed New Small Network Assets that have Completed the Regulatory Process

Proposal	Completion	Comments
Wallerawang – Orange 132 kV Line 944 Replacement and Upgrade	Mid 2013	
Vineyard third 330/132 kV Transformer	Early 2011	

5.3.10. Proposed Transformer Replacements and Upgrades that have Completed the Regulatory Process

The following table summarises proposed transformer replacements and upgrades that have completed the regulatory process.

Table 5.3.3 - Proposed Transformer Replacements and Upgrades that have Completed the Regulatorty Process

Location	Installation	Completion	Comments
Sydney East 330/132 kV substation	Installation of a fourth 375 MVA 330/132 kV transformer	Late 2013	
Narrabri 132/66 kV substation	Replacement of three 30 MVA transformers by two 60 MVA units released from Coffs Harbour	Mid 2011	

5.3.11. Proposed Line Switchbays for Distributor Requirements Previously Reported

The following table summarises proposed projects for the provision of line switchbays to meet NSW Distributors' requirements that have previously been reported.

Table 5.3.4 - Proposed Line Switchbays for Distributor Requirements Previously Reported

Location	Installation	Completion	Comments
Newcastle 330/132 kV substation	One new 132 kV line switchbay	2014	DNSP requirement
Lismore 330/132 kV substation	Provide a new 132 kV switchbay	Late 2012	DNSP requirement
Tamworth 132/66 kV substation	Provide a new 66 kV switchbay	Late 2012	DNSP requirement
Cooma 132/66 kV substation	Provide a new 132 kV switchbay	2011	DNSP requirement
Williamsdale 330/132 kV substation	Provide two new 132 kV switchbays	2012	DNSP requirement

5.3.12. Proposed Replacement Transmission Network Assets Previously Reported

The following table summarises proposed replacement transmission network assets that have previously been reported.

Table 5.3.5 - Proposed Replacement Transmission Network Assets Previously Reported

Location	Installation	Completion	Comments
Broken Hill 220/22 kV substation	Replace the control systems and some plant on both SVCs	2012/13	
Kemps Creek 500/330 kV substation	Replace the control systems and some plant on both SVCs	2012/13	
Dapto – Sydney South 330 kV line	Dapto – Sydney South 330 kV line rehabilitation	Late 2011	
Wallerawang 132/66 kV substation	Establishment of a new Wallerawang 132/66 kV substation	Late 2013	Construction on a new site.

5.4 NER Rule 5.6.2A Reporting

The information described in Section 2.5 requiring TransGrid to provide forecast constraint information and indicate whether it intends to issue a Request for Proposal with respect to the projects covered in Chapter 5 are provided in the following two sections.

5.4.1. Forecast Constraint Information

The required forecast constraint information with respect to projects in Chapter 5 is provided in Table 5.4.1 below.

Table 5.4.1 - Forecast Network Limitations

Anticipated Proposal or Limitation	Reason for Limitation	Connection Point at which MW reduction would apply	MW at Time Limitation is Reached
Supply to the NSW Far North Coast	Thermal Overload	Lismore	Summer 2010/11; 70MW
Supply to the Lower Mid North Coast (Stage 1: Tomago-Stroud)	Thermal Overload	Taree	Summer 2010/11; 49MW
Supply to the Lower Mid North Coast (Stage 2: Stroud-Taree)	Thermal Overload	Taree	Summer 2012/13; 11MW
Supply to the Sydney CBD and Inner Metropolitan Area	Thermal Overload	Haymarket or Beaconsfield West	Summer 2013/14; 80MW
Proposed Transformer Replacements and Upgrades that have Completed the Regulatory Process: • Sydney East 330/132 kV substation	Thermal Overload	Sydney East	Summer 2013/14; 9MW

5.4.2. Intent to Issue Request for Proposal

The required indication of TransGrid's intent to issue a request for Proposal for non-network services is provided in the following table.

Table 5.4.2 - Anticipated issue of Request for Proposal for Non-Network Services

Anticipated Proposal or Limitation	Intend to Issue RfP	Date
Supply to the NSW Far North Coast	Yes	2010
Supply to the Lower Mid North Coast	To be assessed	
Supply to the Sydney CBD and Inner Metropolitan Area	RfP completed	
Development of Southern Supply to the ACT	No	
Upgrade of Nos 8, 16 and 18 lines	No	
Proposed New Small Transmission Network Assets that have Completed the Regulatory Process: • Vineyard third 330/132 kV Transformer	No	
Proposed Transformer Replacements and Upgrades that have Completed the Regulatory Process: • Sydney East 330/132 kV substation	To be assessed	

6

Constraints and Proposed Network Developments within Five Years

6 Constraints and Proposed Network Developments within Five Years

The following sections describe specifically identified present and emerging constraints within TransGrid's network over a five year planning horizon. Where new small transmission network assets or new large transmission network assets are proposed to relieve these constraints they are detailed as required by the NER. Where there is no proposed new transmission network asset, one or more options for relief of the constraint may be described.

Section 6.1 summarises proposals for new small transmission network assets that address constraints that are forecast to emerge within five years. Further details of each proposal, including need, options considered and regulatory test calculations are contained in Appendix 5.

Section 6.2 describes constraints that are expected to emerge within a five year planning horizon for which there are augmentation proposals other than proposals for new small transmission network assets or where augmentation proposals are anticipated prior to publication of the APR 2011.

Also included in this section are proposals for replacement transmission network assets.

Section 6.3 describes other constraints expected to emerge within a five year planning horizon where there is at present no firm proposal. One or more options for the removal of each constraint are described. They may appear as proposals in future Annual Planning Reports.

The constraints detailed in this APR 2010 are subject to change with respect to the number and nature of the constraints and their timing. In some cases changes will occur at short notice. Changes may be brought about by changes in load growth, new load developments as well as DM and local generation developments. In all cases, options for the relief of constraints will be developed and commitments will be made in time to ensure that standards of supply are maintained.

The NER requires the Annual Planning Report to set out planning proposals for future connection points. These can be initiated by generators or customers or arise as the result of joint planning with a Distributor. Proposals for augmentations to the capacity of existing connection points and proposals for new connection points are detailed in Appendix 4.

6.1 Proposed New Small Transmission Network Asset Summary

This section summarises, in Table 6.1.1 below, proposals for new small transmission network assets that address constraints that are forecast to emerge within five years. Further details of each proposal including need, options considered and regulatory test calculations are contained in Appendix 5.

Table 6.1.1 - Proposed New Small Transmission Network Assets

Proposal	Service Date	Cost ($M)	Details in
Beaconsfield West – 2 x 160MVAr 132 kV capacitors	2012	7	Appendix 5.1
Reinforcement of voltage control in northern NSW	2012	10	Appendix 5.2
Quality of supply metering	Progressive installations	<1 per installation	Appendix 5.3
Real time line rating monitoring systems	Progressive installations	Up to around 1 per line	Appendix 5.4

The information contained in this section and Appendix 7 initiates regulatory consultation for these proposals as required by the National Electricity Rules. Interested parties have 20 business days from the publication of this APR 2010 to make written submissions in respect to these proposals. The last day for submissions is 28th July 2010. Contact details appear in Appendix 7.

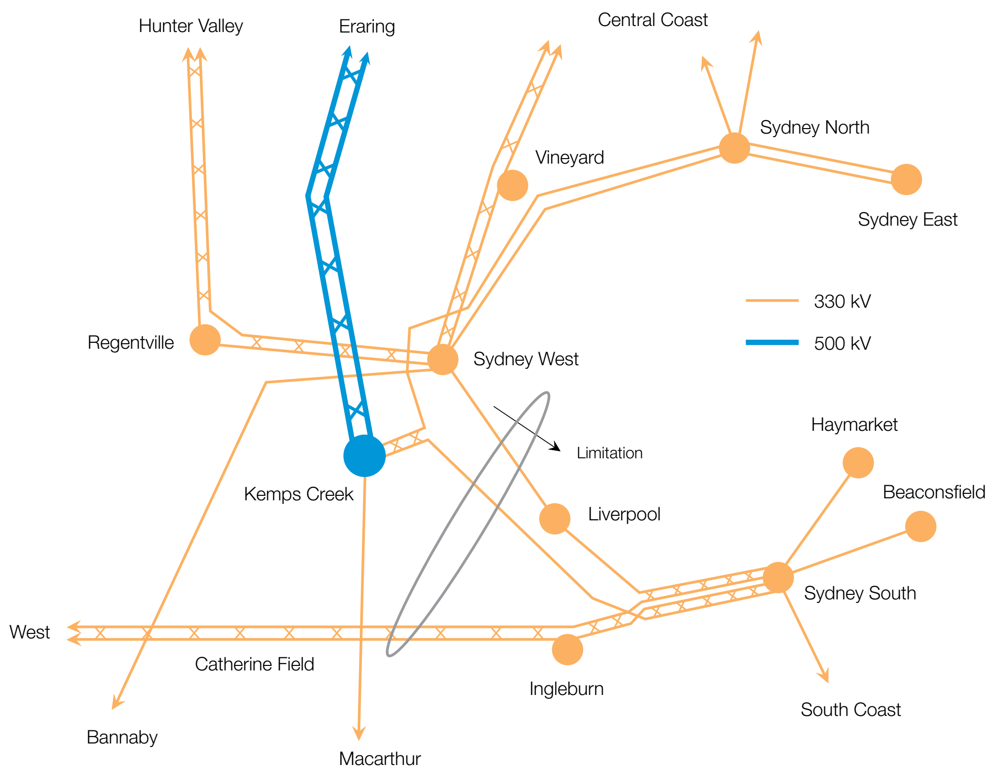
6.2 Other Proposals

This section describes constraints that are expected to emerge within a five year planning horizon for which there are augmentation proposals other than proposals for new small transmission network assets or where augmentation proposals are anticipated prior to publication of the APR 2011.

Also included in this section are proposals for replacement transmission network assets.

6.2.1. Supply to Southern Sydney

Southern and Western Sydney Main System



Supply to the greater Sydney area is provided via major 500 kV and 330 kV substations at Kemps Creek, Sydney North, Sydney East, Sydney West, Sydney South, Vineyard, Regentville, Liverpool, Ingleburn, Beaconsfield and Haymarket as shown in the figure above. A new Macarthur 330/132 kV substation connected to the Kemps Creek – Avon line has also recently been commissioned.

These substations are interconnected with the State's power stations to the north and west of Sydney and the main grid to the south.

The load areas of Sydney South, Liverpool and Ingleburn and the CBD substations at Beaconsfield and Haymarket are, in effect, supplied by four 330 kV overhead circuits from Wallerawang in Western NSW and Kemps Creek and Sydney West substations in Western Sydney. The Sydney South – Dapto 330 kV line carries power from Sydney South to and from the south coast.

Following the forced outage of one of the four 330 kV circuits under high system load conditions the remaining circuits will be heavily loaded. There is a need to secure this system in anticipation of the next circuit outage by the rescheduling of generation in the system. This however may only relieve the line loadings to a marginal degree and hence in accordance with the NSW planning criteria there is a need to reinforce this system to avoid the shedding of load. Reinforcement is expected to be required by about 2015.

Three conceptual network options to address the immediate system needs are:

- Development of an additional single circuit connection between Kemps Creek and Liverpool;
- Development of an additional single circuit connection between Kemps Creek and Sydney South; and
- Uprating of the Sydney West – Liverpool and Kemps Creek – Sydney South transmission lines through the use of high temperature conductors.

These options provide relief for the immediate system deficiencies but there is a long-term need to further support the system in this area. It is envisaged that the existing system will need to be reinforced with two additional circuits between Kemps Creek / Sydney West and Sydney South. To avoid an unnecessary proliferation of lines the more immediate network solution would need to fit within an overall strategy for the area.

Development of options for new capacity will be based on the following principles:

- Because of the high cost of developments in this urban area development options will have to provide sufficient capacity for long-term needs;
- Maximum use will be made of existing easements where possible. It is preferred that any new lines would be of double circuit construction;

- Options will need to take account of significant community and environmental constraints. This may include the rationalisation of some existing connections to the same capacity where it is in the community's interest. There is potential to close-corridor new lines and remove sections of existing single circuit lines that are in the vicinity of heavily developed residential areas. Attention will also be given to assessing the potential for underground cable development, recognising the significantly higher cost and limited capability of cable developments; and
- If existing lines need to be rebuilt or conductors upgraded, the timing of construction will need to take into account their unavailability for extended periods.

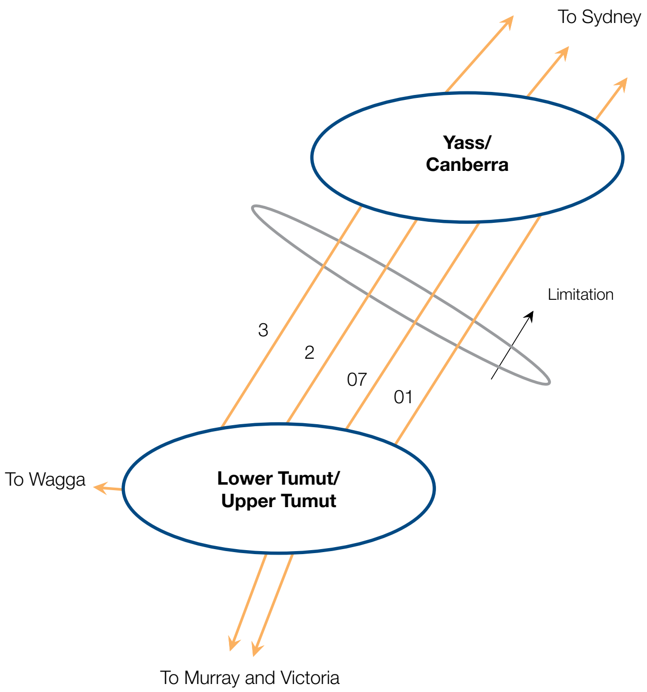
A proposal that satisfies the above principles is the initial construction of a new double circuit overhead line from Kemps Creek to near Liverpool operated as a single circuit line when commissioned. In order to minimize the number of 330 kV lines in the vicinity of Liverpool it may be feasible to use part of the easement of the existing Sydney West – Liverpool single circuit 330 kV line by reconstructing the line to double circuit on the approach to Liverpool.

It is considered that, subject to community consultation, it would be prudent to secure routes for new lines in the near future. There will need to be extensive community consultation before the precise format of this proposal will be determined.

It is anticipated that an application notice addressing these limitations will be issued in 2010/11.

6.2.2. Capacity of the Snowy to Yass / Canberra 330 kV System

Snowy – Yass/Canberra 330 kV Connections



At times of high demand in NSW the capability for the import of power from the south at Snowy and Uranquinty or from Victoria is an important component in the supply to the State.

The potential future development of gas-fired power stations and wind farms in the south of NSW and the potential upgrading of the interconnection with Victoria all lead to higher power flows north of Snowy.

Four 330 kV lines immediately north of Snowy carry significant levels of power to the NSW loads. Depending on the dispatch of generation the system north of Snowy can be loaded to its maximum capability at times of high NSW loads.

The 01 Upper Tumut – Canberra and 02 Upper Tumut – Yass 330 kV lines presently operate with a design temperature of 85°C. The Lower Tumut – Yass and Lower Tumut – Canberra 330 kV lines have a design temperature of 100°C. The lower design temperature of the two lines from Upper Tumut effectively limits the overall capability of the four 330 kV lines.

The capability of this system to transfer power is also limited by the voltage control capability at Yass and Canberra. This capability is eroded by load growth in the Yass / Canberra area.

There is a growing need to increase the capability of the system to meet the NSW peak demand and also to achieve market benefits. Various options are being investigated including:

- Reactive support plant;
- New line development;
- Upgrading of the Upper Tumut – Yass and Upper Tumut – Canberra 330 kV lines north of Snowy. This requires work in the sensitive national park areas of the Snowy;
- Installation of power flow control plant;
- Real time line monitoring; and
- Implementation of a system protection scheme.

It is feasible to raise the conductor clearances on the Upper Tumut – Yass and Upper Tumut – Canberra 330 kV lines to provide a 100°C design temperature which would enable an increased line loading.

In past summers Snowy Hydro has implemented a scheme (system protection scheme or SPS) which extends the capability of the 330 kV lines north of Snowy by tripping a load in NSW in co-ordination with the running back of a Snowy generator within a short time after the outage of one of the four 330 kV lines. Snowy Hydro has made this scheme available to the market and it has been operated by AEMO (NEMMCO). TransGrid is considering providing this scheme in the future and the AER has provided an allowance as part of TransGrid's 2009/10 – 2013/14 Revenue Reset. It would be necessary to contract network support from a NSW load north of Snowy and a generator south of the Yass / Canberra area to facilitate the scheme and the market benefits would need to be shown to exceed the cost of the scheme.

At this stage the preferred option is the implementation of a system protection scheme in combination with the upgrading of the No. 01 and No. 02 330 kV lines. Reactive support plant would be required to ensure that the full line ratings could be utilised without being limited by voltage control constraints.

It is anticipated that an application notice addressing these limitations will be issued in 2010.

6.2.3. Capacity of the Marulan – Avon, Marulan – Dapto and Kangaroo Valley – Dapto 330 kV lines

The Marulan – Avon No. 16, Marulan – Dapto No. 8 and Kangaroo Valley – Dapto No. 18 330 kV lines on the south coast of NSW shown in the figure below supply power to the Wollongong area and also carry part of the power transferred from the south of the state towards the Sydney area.

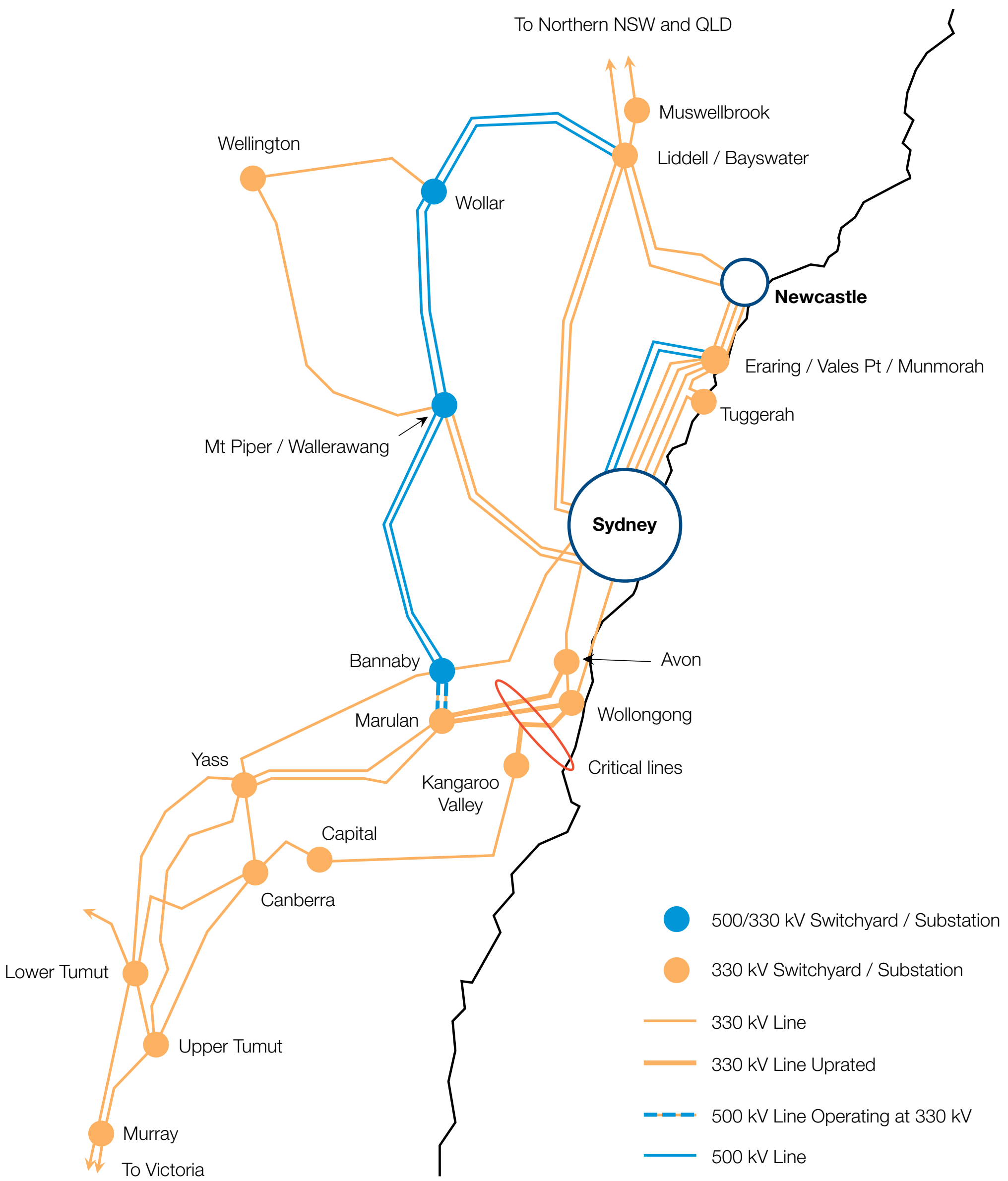
High power transfers from the western coalfields power stations coupled with high power transfers from southern NSW generation result in high loadings on the three 330 kV lines.

Real-time line monitoring facilities are being installed on these lines to maximise the available power transfer capability across this section of the network.

These lines are designed for an operating temperature of 85°C. TransGrid intends to raise the critical spans to increase the conductor clearance to ground to achieve an operating design temperature of 100°C.

Previous reporting on the work involved for the western 500 kV upgrade covered the need to upgrade the 330 kV lines. Consequently, this project has completed the regulatory consultation process and is described here for completeness.

Critical South Coast 330 kV Lines



6.2.4. Supply to the Forster/Tuncurry Area

The Forster/Tuncurry area is expected to continue to develop. The capacity of Country Energy's 66 kV network that supplies this area from Taree has been reached. In addition the 132/66 kV transformers at Taree are becoming heavily loaded.

To meet these limitations Country Energy is proposing the construction of a 132/66 kV substation in the Nabiac area supplied from the existing 963 Tomago – Taree 132 kV line together with sections of 132 kV and 66 kV lines to form connections to the new substation.

The proposal provides for TransGrid to assume ownership, operation and maintenance of 132 kV assets at Nabiac substation on completion of the works, which is anticipated by about 2011.

It is anticipated that Country Energy and TransGrid will initiate the regulatory consultation process addressing these limitations in 2010.

6.2.5. Supply to the Kew, Laurieton and Lake Cathie Areas

The Kew/Laurieton area is supplied from Taree via Country Energy's 66 kV network and Lake Cathie via Country Energy's 33 kV network from Port Macquarie. The loading is approaching the capability of these networks.

To relieve this limitation Country Energy intends to establish a 132/66 kV substation near Herons Creek and to progressively establish a 66 kV network to supply the area. TransGrid would own the 132 kV busbar and connections within that substation on completion of the works, the first stage of which is anticipated by about 2012.

It is anticipated that Country Energy and TransGrid will initiate the regulatory consultation process addressing these limitations in 2010/11.

6.2.6. Supply to the Tomerong/Nowra Area

To meet present and emerging limitations in the Tomerong/Nowra area TransGrid and Integral Energy are proposing the construction of a new large transmission network asset to increase the capacity of the transmission network supplying the area.

The proposal has major components as follows:

- Construction of a new 330/132 kV substation;
- Construction of a short section of double circuit 330 kV transmission line from the new substation to TransGrid's Kangaroo Valley to Capital Wind Farm line west of the substation;
- Construction of short sections of 132 kV transmission line from the new substation to Integral Energy's 132kV lines to the east;
- Connections to enable the new 330 kV and 132 kV circuits to be formed; and
- The necessary control, protection and communications services.

It is expected that the regulatory consultation process addressing these limitations will be completed in 2010.

6.2.7. Vales Point – Munmorah Line Flows

A single 330 kV line (No. 23) connects the Munmorah and Vales Point 330 kV switchyards. For many years a 330 kV series reactor in this line was used to control fault levels at the two switchyards. This reactor had a very limited power flow rating. Following the decommissioning of generators at Munmorah and Vales Point and the upgrading of the 330 kV switchyards the series reactor became redundant.

The 2009 Electricity Statement of Opportunities indicated that the Munmorah Power Station will be available until winter 2014 and the future role of the power station is being assessed. If it is decided to decommission the power station it may be necessary to install a new series reactor to control power flows in this area of the NSW central coast system. This would be necessary to avoid uneconomic restrictions on the base-load power stations in the area. The new reactor would need an appropriate rating to match the 330 kV line.

The load at risk will depend on the timing of any closure of Munmorah power station and the location of any generation development that replaces it. The line series reactor would provide a relatively low cost means of avoiding restrictions on baseload generation that is important in meeting the State's load.

6.2.8. Voltage Levels in the Yass/Canberra Area

The voltage levels in the Snowy area govern the voltages in the main system in the Yass / Canberra area and the voltages in the northern Victorian 330 kV system. At times of high Victorian import from NSW or high import to NSW from the south it is necessary to maintain relatively high Snowy area voltages. In contrast to this it is sometimes necessary to maintain low voltages in the Snowy area to avoid excessive voltages in the 330 kV system from Canberra to Kangaroo Valley.

In order to manage the conflicting voltage requirements on the system it is proposed to relocate a 330 kV shunt reactor from Kemps Creek to Yass. The cost of this project is then only the cost of a new 330 kV switchbay at Yass and the relocation cost.

The load at risk is not readily quantifiable. The shunt reactor would be installed to provide flexibility in managing the system voltage levels.

6.2.9. Eraring Generation Capacity

Eraring Power Station units 1 and 2 are connected to the Eraring 330 kV switchyard and units 3 and 4 are connected to the 500 kV switchyard. Each of these units may output about 700 MW. At present one 500/330 kV transformer connects the Eraring 500 kV and 330 kV switchyards. The Eraring – Kemps Creek 500 kV double circuit line connects the 500 kV switchyard to the remainder of the main system.

The contingent outage of the 500/330 kV transformer under certain system conditions may lead to the outage of both units 3 and 4 which could be a significant loss of generation to the state. In order to maintain the reliability of supply to NSW loads it is proposed to install a second 500/330 kV transformer.

6.2.10. Reactive Support from Coalfields Generators

The voltage control issues on the NSW main transmission network result from the high power transfers from the power stations to the load centres. In the core main system, limitations arise in supplying the Newcastle - Sydney – Wollongong area over the relatively long distances from the major coal-fired generating centres of NSW (Hunter Valley, western coalfields and Central Coast).

Reactive power support to the main transmission network has been provided for many years through the installation of switched shunt capacitor banks and Static VAr Compensators (SVCs). An important component of the reactive power support is also the MVAr or voltage control capability of generators. A fundamental assumption in the planning of the NSW main transmission network to meet reliability obligations has been that the full MVAr capability of generators would be available to support the main transmission network.

The planning of the main system is based on the known reactive power generating capability of each power station unit. This capability is documented in TransGrid's operating manuals and is based on historical documentation and advice from the power station owners. This reactive generation capability can exceed the MVAr capability set out in the Registered Performance Standard of each unit. In general most of the MVAr capability of each power station is required under contingency conditions for different power system situations.

AEMO has an obligation to ensure system security and is required to manage the difference between the performance standard levels and the generating capability that is required for system security. In the past AEMO has entered into contracts for network control ancillary services (NSCAS). The NSCAS arrangements in the NEM are presently being reviewed by AEMO.

AEMO, in meeting their security obligations, may contract for only part of the available capability. The remainder of the capability is required for reliability of supply but is not accounted for in the NEM financial arrangements. Theoretically the generators may not be obliged to provide this additional capability. It is technically feasible for generators to avoid providing the MVAr capability for which they are not covered under the Market by limiting the MVAr output of the units via the excitation systems.

The gap between the Performance Standard and the unit capability could feasibly be replaced by 330 kV capacitor banks at each of the power stations.

TransGrid's past approach to this issue departs from that in other jurisdictions where reactive power capability would be acquired as necessary under network support contracts.

Hence it is now intended that the additional reactive power capability above the performance standard level that is necessary for future planning of the NSW power system would be acquired under network support contract arrangements. This applies to the Hunter Valley, western coalfields and Central Coast generators. This has been foreshadowed in past APRs and has been reviewed and endorsed by the AER in the TransGrid Revenue Reset process.

The following table provides a guide to the MVAr capability that will need to be contracted.

Note that the below MVAr values represent the requirements above the performance standard and some part of these values may be contracted separately under ancillary service agreements by AEMO.

TransGrid expects to initiate arrangements for network support contracts in 2010. Should it prove not possible to arrange the contracts for MVAr support then TransGrid would need to install 330 kV capacitor banks under a Contingent Project arrangement.

Table 6.2.1 - Reactive Power Capability Required to be Contracted

Area	Stations	Total MVAr contract requirement (indicative) above the performance standard		
		2011/12	2012/13	2013/14
Hunter Valley	Bayswater units 1 & 2 and Liddell units 1 to 4	198	275	317
Hunter Valley –	Bayswater units 3 & 4	Nil	Nil	Nil
Central Coast	Eraring units 1 to 4	92 (at maximum)	92	92
	Vales Pt, Munmorah and Colongra	236	377 (at maximum)	377
Western coalfields	Mt Piper and Wallerawang	489 (at maximum)	489	489
Total		**1015**	**1233**	**1275**

6.2.11. Reinforcement of Supply within the Sydney Central Business District (CBD)

EnergyAustralia takes supply from TransGrid's Beaconsfield West and Haymarket 330/132 kV substations each being supplied by a single 330 kV cable. Power systems analysis undertaken by both TransGrid and EnergyAustralia has identified an emerging constraint and a need to reinforce the cable network within the CBD by 2012. Further, by around 2016 additional emerging constraints have been identified in the 330 kV cable network supplying both Beaconsfield West and Haymarket.

The preferred solution to address the 2012 constraint is to establish an additional cable link between Beaconsfield West and Haymarket 330/132 kV substations. Initially this cable link will have to be operated at 132 kV due to the lack of a 330 kV busbar at Beaconsfield West. The preferred solution to address the 2016 constraint is to install a Rookwood Road to Beaconsfield West 330 kV cable and a Beaconsfield West to Haymarket 330 kV cable. This later 330 kV cable will fully replace the functionality of the earlier cable installed between Beaconsfield West to Haymarket in 2012.

The feasibility study conducted for this work has confirmed that the installation of a 132 kV cable in the MetroGrid cable tunnel and subsequently installing a further 330 kV cable in the tunnel at a later date is not feasible. Consequently the preferred solution is to advance the installation of the 330 kV cable in the MetroGrid tunnel.

The details of the preferred solution then, which addresses both the need to reinforce supply within the CBD in 2012 and reinforce supply to the CBD in 2016 are:

- EnergyAustralia to install a 700m section of 132 kV cable between Beaconsfield West substation and the Sydney Park MetroGrid cable tunnel portal;
- TransGrid to advance the installation of a cable in the MetroGrid tunnel by four years to 2012. This cable would be connected to EnergyAustralia's 132 kV cable and operated initially at 132 kV; and
- TransGrid to connect the cable to the Beaconsfield West 132 kV busbar and Haymarket 132 kV busbar.

It is expected that the regulatory consultation for the establishment of a 132 kV cable circuit between Beaconsfield West and Haymarket will be completed during 2010.

6.2.12. Minor Augmentation Proposals

The NER requires annual planning reports to include information pertinent to all proposed augmentations to the network irrespective of their cost. Table 6.2.2 below details proposals for minor augmentations, i.e. those where the capitalised expenditure is estimated to be less than $5 million. None of these proposals will have a material inter-network impact.

Table 6.2.2 - Minor Augmentation Proposals

Proposal	Need	Completion	Cost ($M)	Other Options Considered	Comments
Provide a new 80 MVAr 132 kV capacitor bank at Yass	To maintain adequate power transfer capability from the southern generators towards Sydney and the NSW south coast as the load grows	2012/13	2.3		It is aimed to ensure that voltage control constraints are no more limiting than line thermal rating capability
Provide a new 120 MVAr 132 kV capacitor bank at Canberra	As above	2012/13	2.8		As above
Provide a new 200 MVAr 330 kV capacitor bank at Sydney South	To maintain adequate power transfer capability to the loads of southern Sydney	2012/13	4.7		
Transposition works on the Wallerawang – Sydney South/ Ingleburn No. 76/77 double circuit 330 kV line	To meet the NER requirements for balanced voltages	Yet to be determined	About 1		The level of unbalance in the system three phase voltages has been calculated to exceed the NER requirements under certain power transfer conditions
Multiple contingency protection scheme	To minimise the possibility of a widespread disturbance to the NSW main system following multiple circuit outages for example during bushfires	2013	0.3		This will be arranged through control system facilities

6.2.13. Proposed Replacement Transmission Network Assets

The NER requires annual planning reports to include information pertinent to all asset replacement proposals where the capitalised expenditure is estimated to be more than $5 million. These proposals are detailed in Table 6.2.3 below.

Table 6.2.3 - Proposed Replacement Transmission Network Assets

Proposal	Need	Completion	Cost ($M)	Other Options Considered	Comments
Griffith 132/33 kV transformers replacement	Condition-based replacement	2013/14	7	Use of non-standard transformers	
Munyang 132/33 kV transformers replacement	Condition-based replacement	2014	18	Use of oil-insulated transformers	Gas insulated transformers to meet environmental requirements
Kempsey 33/66 kV transformers replacement	Condition-based replacement	2012	7		
Replacement of Newcastle No. 2 330/132 kV single-phase transformer bank with a three-phase unit	Condition-based replacement	2012	10		

6.3 Other Constraints Emerging Within Five Years

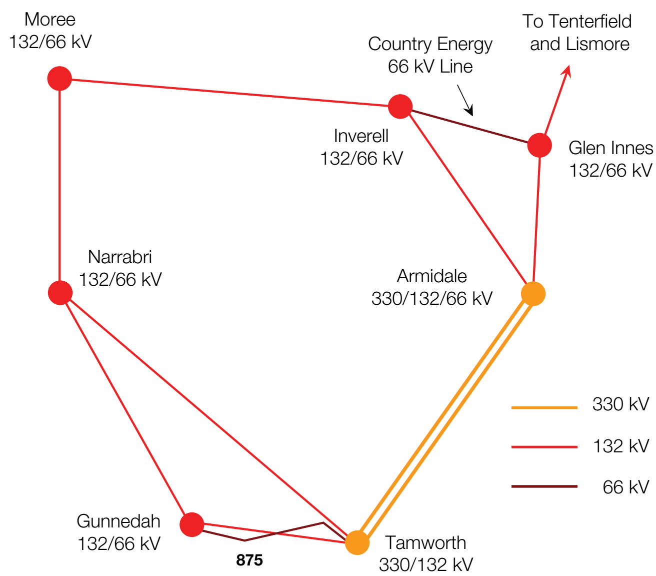
A number of constraints are envisaged to emerge within a five year planning horizon where in each case there is at present no firm proposal. These constraints together with possible developments to meet them are detailed in the following sections. They may appear as proposals in future Annual Planning Reports.

6.3.1. Supply to the Gunnedah, Narrabri and Moree Areas

The transmission system supplying the Gunnedah, Narrabri and Moree areas is around 300 km long and is shown in the figure below. Its capacity is limited by thermal constraints on outage of critical 132 kV lines. These limitations are expected to emerge in summer 2016/17.

Expansion of a mine in the Boggabri area has been proposed. Should that proceed, the limitations are expected to emerge following commissioning of the mine.

Transmission System Supplying Gunnedah, Narrabri and Moree



Options available to address these limitations include:

- Construction of a 132 kV line from Tamworth to Gunnedah possibly on the route of the existing Tamworth – Gunnedah 66 kV line 875;
- Construction of a 330 kV line (initially operating at 132 kV) from Tamworth to Narrabri;
- Construction of a 330 kV line from Dumaresq to a new 330/132 kV substation near Moree;
- Uprating of 132 kV lines in the area; and
- Demand management and/or local generation.

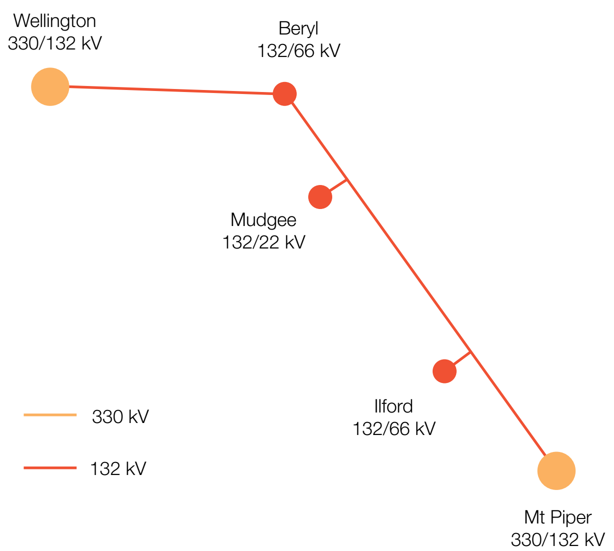
The preferred network option is the construction of a new 132 kV line primarily on the route of the existing Tamworth – Gunnedah 66 kV line. This line was constructed in 1947. As extensive refurbishment would have been required to maintain it in a satisfactory condition, sections of it have been dismantled with the route being retained for future development.

A new section of double circuit 132 kV line has recently been constructed near Tamworth to re-align sections of the existing Tamworth – Gunnedah 132 kV line near Tamworth and to provide an additional line outlet from Tamworth.

6.3.2. Supply to Beryl

Beryl 132/66 kV substation is supplied via 132 kV lines from Wellington and Mt Piper 330/132 kV substations. The Mt Piper – Beryl 132 kV line also supplies 132 kV substations at Ilford and Mudgee as shown in the diagram below.

Transmission System Supplying Beryl



On outage of the Wellington – Beryl 132 kV line at times of high load, unacceptably low voltages can occur at Beryl. A second 66 kV capacitor has recently been installed at Beryl. However, due to expansion of mines in the area, this limitation is expected to emerge again in the next few years.

Options to relieve the limitation include:

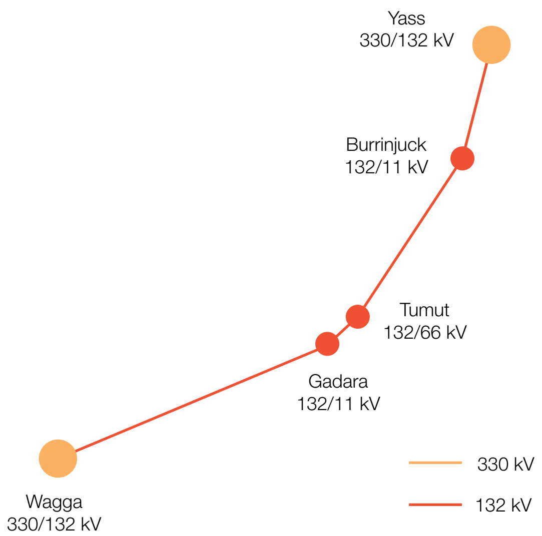
- Installation of additional capacitors at Beryl or within Country Energy's network supplied from Beryl;
- Establishment of a second Wellington – Beryl 132 kV line, possibly utilising part of the route of and existing Country Energy 66 kV line;
- Establishment of a 330/132 kV substation near Beryl, supplied from the Wollar – Wellington 330 kV line; or
- Demand management or local generation.

At this stage the preferred option is establishment of a second Wellington – Beryl 132 kV line.

6.3.3. Supply to Tumut/Gadara

The Tumut/Gadara area is supplied via a 132 kV connection between Yass and Wagga 330/132 kV substations as shown in the diagram below.

Transmission System Supplying Tumut/Gadara



An expansion of the Visy mill at Gadara has recently been completed. The need to augment supply to the area will be determined in consultation with Visy and in consideration of the level of service it requires.

6.3.4. NSW to Queensland Transmission Capacity

QNI connects the New South Wales and Queensland power systems. Its power transfer capability is governed by overall system-wide stability limitations and also by voltage control and line rating limitations in the supporting 330 kV systems. Directlink operates in parallel with QNI.

QNI can be heavily loaded depending on the dispatch of generation across the NEM. There is potential for upgrading of the interconnector capability and also for the development of new interconnecting lines.

Powerlink and TransGrid published a Final Report in October 2008 relating to the potential upgrade of QNI. The Final Report detailed the outcomes of comprehensive technical and economic studies relating to several technically feasible upgrade options (each delivering different increments in interconnection transfer capability) carried out in accordance with the Regulatory Test.

The Final Report also responded to submissions from market participants to the Interim Report for Public Consultation published earlier that year.

Powerlink and TransGrid considered five augmentation options:

- A System Protection Scheme that controls load and generation following a system disturbance;
- A new SVC at Armidale;
- Series compensation of the interconnecting 330 kV lines;
- A HVDC Back-to-back scheme in QNI; and
- A second HVAC interconnection.

The Final Report indicated that the installation of series compensation with an estimated cost of around $120 million provided the highest net market benefits in the majority of scenarios considered. The optimum timing under the most plausible scenario is 2015/16. Based on that timing, TransGrid and Powerlink considered it premature to recommend an upgrade option.

Since the 2008 Powerlink/TransGrid report, there have been a number of market developments, including mooted generation investments, legislation of the expanded renewables energy target and the revision of the Regulatory Test. AEMO's NTS 2009 also identified potential positive market benefits from upgrading QNI.

In the light of these developments, Powerlink and TransGrid have agreed to undertake the investigations necessary to evaluate the economic viability (and optimal timing) of an upgrade to QNI, applying the methodology of the RIT-T. Depending on the results which emerge, the organisations may decide to progress an upgrade through the formal RIT-T process. The investigation will be progressed during 2010 and 2011.

6.3.5. Line Switchbays for Distributor Requirements

Planning by DNSPs for augmentations of distribution networks may result in proposals that require significant expenditure within the DNSP's network and relatively minor expenditure within TransGrid's network. In these cases the consideration of network development options and application of the regulatory test is carried out by the DNSP. Joint planning with TransGrid ensures that transmission network requirements are adequately addressed. These cases typically result in requirements for new or uprated switchbays to be provided at TransGrid substations.

The following table details switchbay requirements that are envisaged within a five year planning horizon where there is at present no firm proposal.

Table 6.3.1 - Line Switchbays for Distributor Requirements Within Five Years

TransGrid Location	Details	Indicative Date	Distribution Development
Sydney West	Two 132 kV switchbays	2011/12	Supply to developments in the vicinity of Sydney West
Taree	One 33 kV switchbay	2013/14	Supply to Harrington/ Coopernook
Tumut	One 66 kV switchbay	2013/14	Supply to Batlow
Wellington	One 132 kV switchbay	2012/13	Supply to the Dubbo area

6.3.6. Transformer Capacity Upgrades and Replacements

The following table details transformer capacity upgrades and replacements at existing substations that are envisaged to be required within a five year planning horizon but where there is at present no firm proposal.

Table 6.3.2 - Transformer Capacity Upgrades and Replacements Within Five Years

Location	Details	Indicative Date
Canberra	Replace No 2 bank of 330/132 kV single phase transformers by a new 375 MVA three phase unit	2013/14
Wagga	Rebuild 132/66 kV Substation	2015
Murray	Augment 330/132 kV transformer capacity	2013/14
Newcastle	Replace the two remaining banks of single phase 330/132 kV transformers by new 375 MVA three phase units	2016
Tamworth	Rebuild 132/66 kV Substation; Replace two of the three 60 MVA 132/66 kV transformers by new 120 MVA units	2013/14
Yanco	Replace two 45 MVA 132/33 kV transformers by two new 60 MVA units	2012/13

6.3.7. System Reactive Plant Requirements

The growing load on the network requires ongoing installations of reactive support plant.

Capacitors are used to raise system voltages and to correct the power factor of loads. They are mainly applied at times of high loads on the system. Reactors are used to depress high system voltages that might occur at times of light system load. Reactors are also applied to absorb excess reactive power generated by cable systems and lightly loaded transmission lines. Static VAr Compensators (SVCs) may also be applied where a dynamic source of reactive support is required.

TransGrid's planning approach to maintaining the reactive power supply/demand balance throughout NSW is set out in Appendix 1.

The following table details reactive plant installations that are envisaged to be required within a five year planning horizon but where there is at present no firm proposal.

Table 6.3.3 - System Reactive Plant Requirements

Location	Details	Indicative Date
Sydney West	Extension of one 80 MVAr 132 kV capacitor bank to 160 MVAr	About 2013/14
Regentville	One new 80 MVAr capacitor bank	About 2013/14
Canberra	One 120 MVAr 132 kV capacitor bank replacing an existing 80 MVAr bank	About 2013/14
Canberra	One new 200 MVAr 330 kV capacitor bank	About 2013/14

6.4 Longer Term Constraints and Indicative Developments

The following table briefly summarises constraints that are expected to arise over a longer time frame than five years. One or more indicative developments to meet the constraints are given.

Table 6.4.1 - Longer Term Constraints and Indicative Developments

Constraint	Indicative Development(s)	Time Frame (Years)
Yass – Bannaby and Yass – Marulan 330 kV Lines	See Section 6.4.1 below	>5
Hunter Valley – Tamworth – Armidale system	See Section 6.4.2 below	About 5
Tamworth and Armidale 330 kV switchyards	See Section 6.4.3 below	About 5
Kemps Creek 500/330 kV transformer augmentation	See Section 6.4.4 below	About 5
500/330 kV transformer capacity limitation at Kemps Creek	Installation of a third 500/330 kV transformer at Kemps Creek or a new 500 kV substation in Sydney.	>5
Spare Armidale SVC transformer	A spare transformer to provide improved SVC reliability	About 5
Limitations in supply to south western NSW	Wagga – Darlington Point/Finley 330 kV line.	10
Supply to Sydney East	Development of a third 330 kV circuit from Sydney North to Sydney East by upgrading an existing line	About 5
Further development of the 500 kV system supporting the Newcastle – Sydney – Wollongong load area	See Section 6.4.5	About 5
• Deteriorating supply demand balance in Victoria/South Australia; • The need for additional NSW import; or • Significant renewable energy developments in South Australia and Victoria	NSW – South Australia interconnection development – see Section 6.4.6 NSW – Victoria interconnection development – see Section 6.4.7	>5
Bannaby – Yass and Yass – Wagga 500 kV system	See Section 6.4.1 on the Yass – Bannaby and Yass – Marulan 330 kV lines	>5
Further development of supply to the Sydney Inner Metropolitan area	Augmentation of Rookwood Road substation to provide a 330 kV phase shifting transformer, provision of a new 330 kV cable between Rookwood Road and Beaconsfield West Substations, provision of a 330 kV busbar at Beaconsfield West, provision of a section of 330 kV cable between Beaconsfield West and Haymarket and provision of an additional 330 kV switchbay at Haymarket	>5
Tamworth 330/132 kV Transformers	Replacement of the three existing 150 and 200 MVA transformers by two 375 MVA units	About 5
Bannaby third 500 kV Transformer Bank		>5
Vineyard 330 kV Line Reinforcement		>5
Third Mt Piper – Wallerawang 330 kV Line		>5

6.4.1. Yass-Bannaby and Yass-Marulan 330 kV Lines

Following the development of the Bannaby 500/330 kV Substation in 2010 the transmission connections between Bannaby / Marulan and the Yass area are now as shown in the figure below. The connections consist of the Bannaby – Yass single circuit No. 61 330 kV line and the two Marulan – Yass single circuit 330 kV lines, No. 4 and No. 5.

These three 330 kV lines are supported by the Kangaroo Valley – Capital Wind Farm – Canberra 330 kV line. The four 330 kV lines connect the southern system at Yass and Canberra to the remainder of the NSW main system.

The power supply sources in the south west of NSW comprise the extensive Snowy scheme, the Uranquinty gas turbine power station and distributed minor hydro power stations. There is also significant power transfer between NSW and Victoria. It is expected that wind farm and other renewable generation will be developed in south west and western NSW in the future.

Major loads are supplied from Canberra and Yass 330 kV substations and also from Wagga, Jindera and Darlington Pt 330 kV substations. In addition 220 kV substations supply the far western loads at Balranald and Broken Hill.

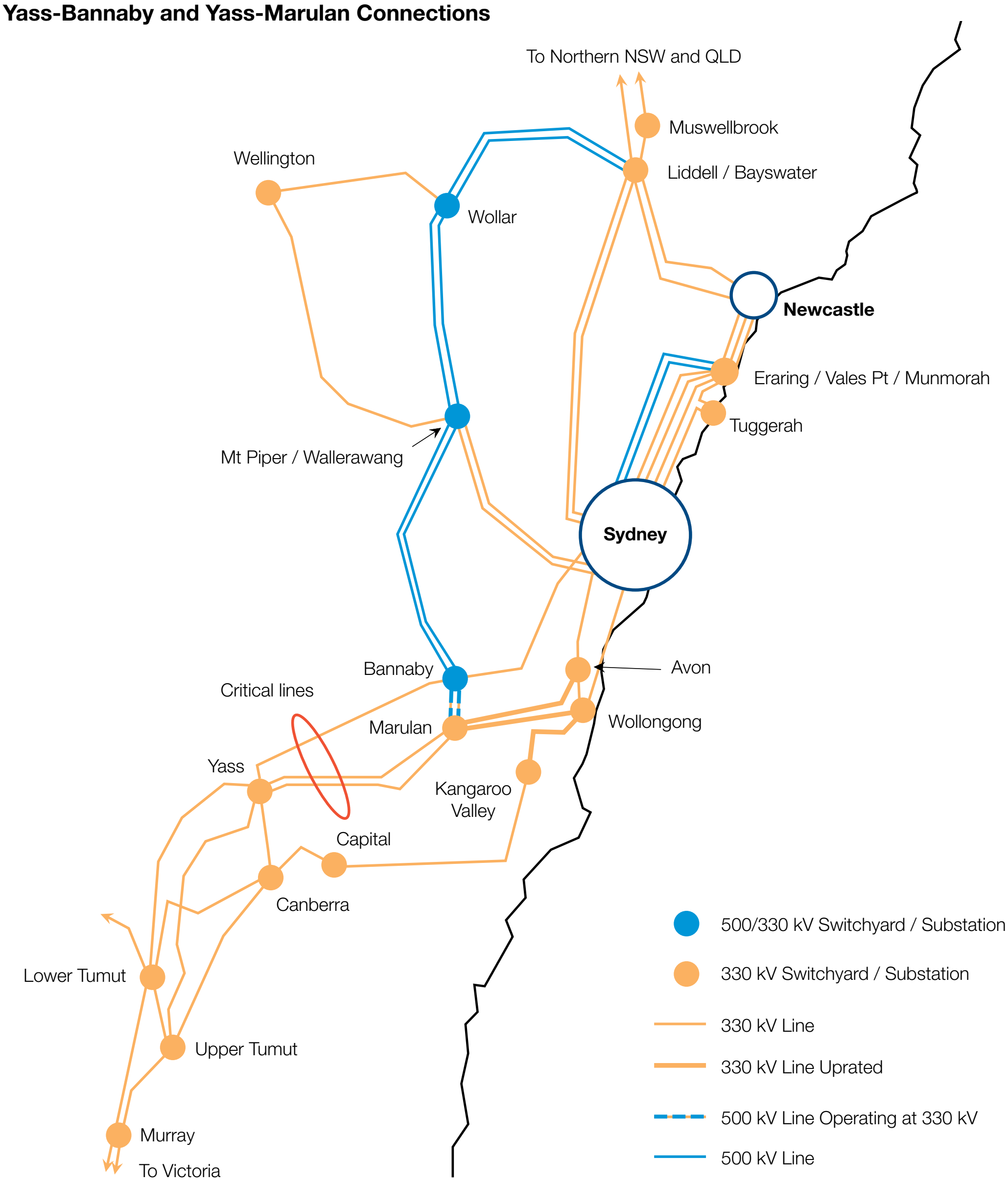
NSW import from the South

NSW relies on import from the south to supply high loads in the State. At times of high NSW load the import capability is governed by the thermal rating of the four 330 kV lines immediately north of Snowy. The import capability is of the order of 3,200 – 3,300 MW in summer and the NSW import reaches this limit at times of NSW peak load.

Section 6.2.2 identifies a project for upgrading the four 330 kV lines north of Snowy. This upgrade will improve the ability of the system to absorb the power transfer as a result of the combined Snowy export to NSW, Victorian export and Uranquinty generation.

The power flow north from Yass and Canberra equals the NSW import from the south minus the total south west area load including Yass and Canberra. Alternatively the power transfer

Yass-Bannaby and Yass-Marulan Connections



north from Yass and Canberra equals the loading on the lines immediately north of Snowy minus the load at Yass and Canberra.

Significant southern generation development, coupled with higher levels of import from Victoria may cause the power transfer capability to be reached.

NSW export to the south

The NSW south west loads are supplied by:

- The power flow south to Yass and Canberra; plus
- The output of the Snowy generators, Uranquinty and minor power stations; plus
- Any export from Victoria to NSW.

The total NSW south west load including Yass and Canberra is now about equal to the total power transfer capability from the north to Yass and Canberra. Hence the supply to the NSW south west system is now reliant on southern generation or import from Victoria.

As the NSW south west load grows there will be an increasing dependence on southern generation or import from Victoria. It is expected that within the next decade there will be a need to upgrade the 330 kV system.

Future Network Development Options

The preferred short-term network development option for upgrading the power transfer capability is the upgrading of the existing No. 4, No. 5 and No. 61 lines to higher thermal rating by modifying towers and re-tensioning of the conductors. No new line development would be required.

The future potential for a national transmission system between NSW and the southern states will be dependent on the transmission developments that TransGrid undertakes in this area. TransGrid's long-term plan for the 500 kV system that supports the major load centres in NSW is documented in the Strategic Network Development Plan.

The 500 kV system extends south to Bannaby and there is a potential for extension of this system into the southern states.

TransGrid's long-term plan for the system south of Bannaby has the following components:

- A 500 kV link from the Bannaby area to Yass which could be formed by reconstructing one of a number of 330 kV single circuit lines;
- A 500 kV link from Yass to the Wagga area; and
- Further interconnection development from the Wagga area to Victoria.

These future developments will be influenced by AEMO's National Transmission Network Development Plan.

6.4.2. Hunter Valley – Tamworth – Armidale 330 kV System

The northern NSW supply system is shown in the figure below. The 330 kV system extends north from Liddell to Armidale via Muswellbrook and Tamworth. The system comprises essentially four 330 kV lines:

- Liddell – Tamworth No. 84 line;
- Liddell – Tamworth via Muswellbrook (No. 83 and No. 88 line);
- Tamworth – Armidale No. 85 line; and
- Tamworth – Armidale No. 86 line,

together with an underlying 132 kV system.

The 330 kV lines are conventional steel tower design except for the No. 86 line which is a wood pole line with relatively small conductors.

A double circuit 330 kV line extends north from Armidale to Dumaresq and forms part of the QNI linking the Queensland and New South Wales networks.

Armidale is connected via a 330 kV line to Lismore via Coffs Harbour. Lismore is in turn connected to the Queensland system via Directlink.

The 330 kV system supplies the northern NSW loads from the Muswellbrook, Tamworth, Armidale, Coffs Harbour and Lismore 330 kV substations. In addition power transfer between NSW and Queensland (via QNI and Directlink) is carried over the 330 kV system. Sections of the 330 kV system impose limitations on the capability for NSW export to Queensland at times of high northern load.

The rating of the Tamworth – Armidale No. 86 330 kV line has in the past imposed limitations on NSW export capability to Queensland. Under future scenarios of load and generation development the low rating of the line also imposes limitations on the power transfer to and from Queensland and on the ability to connect potential northern NSW generation. The small conductor on the No. 86 line incurs relatively high power losses at times of high loading on the line.

The No. 86 line has been upgraded to its maximum feasible capability which brings its rating closer to that of the parallel No. 85 line.

The rating of the 330 kV lines between Liddell and Tamworth also impose limitations on the supply to the northern system loads and NSW export over QNI and Directlink.

It is aimed to reinforce supply to the Lismore area and the preferred network development is a 330 kV line from Dumaresq to Lismore.

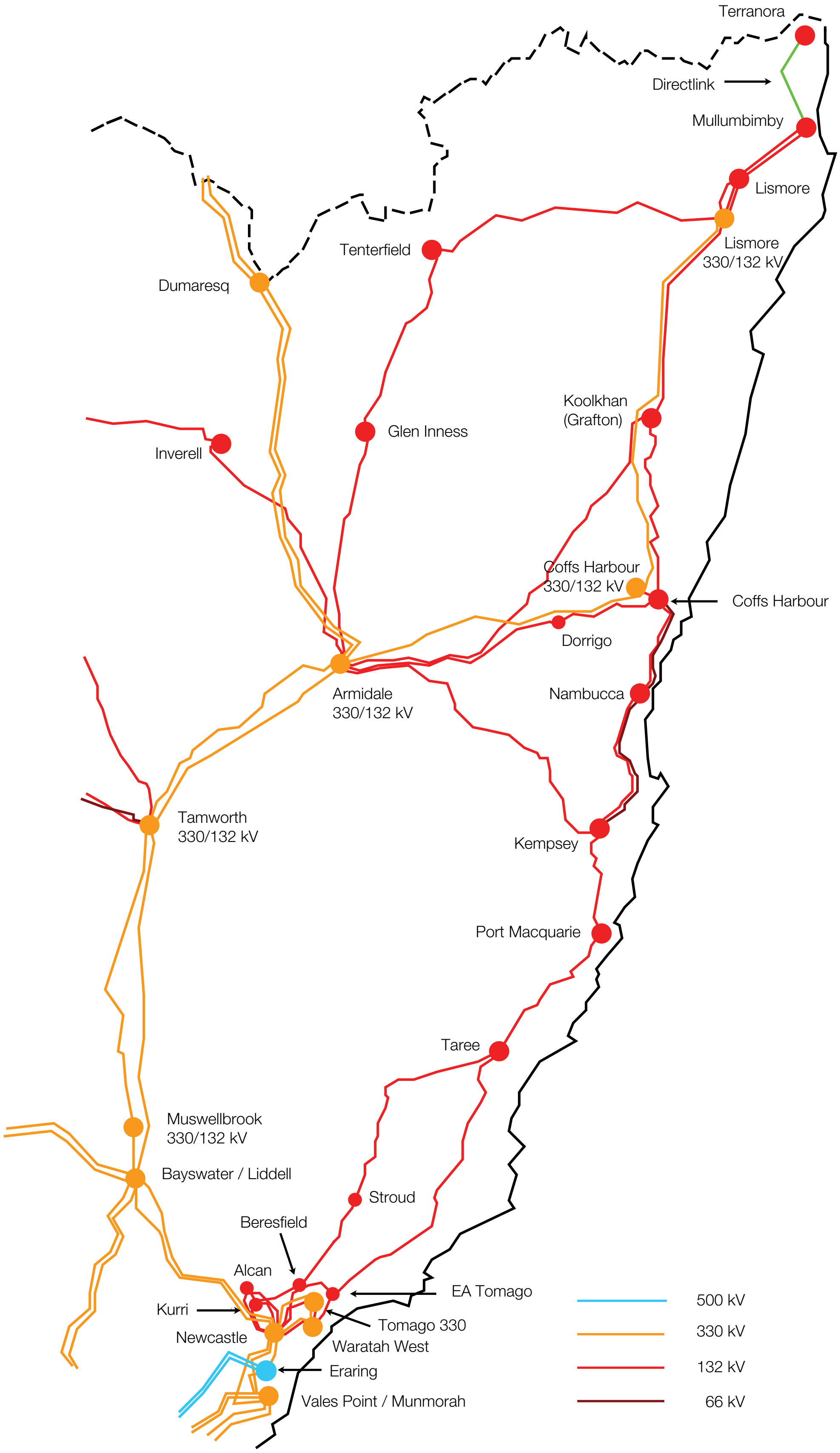
Ongoing load development in the northern area and upgrading of the power transfer levels with Queensland will require upgrading of one or both sections of the Hunter Valley – Tamworth – Armidale link.

TransGrid is considering upgrading the Liddell – Tamworth 330 kV lines to a higher design temperature.

In the longer term it is planned to replace some of the single circuit 330kV lines with double circuit 330 kV or 500 kV lines. Whilst a 330 kV system development may provide adequate capability there is potential for extension of the 500 kV system north of the Hunter Valley and extension of this system into Queensland to provide a high level interconnection development.

These future developments will be influenced by AEMO's National Transmission Network Development Plan.

Northern NSW Connections



6.4.3. Tamworth and Armidale 330 kV Switchyards

The 330 kV switchyards at Tamworth and Armidale were originally constructed to service the relatively small loads in northern NSW when there was a limited 330 kV network development extending north of Liddell. The switchyards are configured with single busbars and bus section circuit breakers.

Since the initial development of the Tamworth and Armidale substations the 330 kV network has been extended to Coffs Harbour and Lismore and QNI has been connected to Armidale. There has also been a need to connect new plant, in the form of shunt reactors, shunt capacitors and an SVC, to the 330 kV switchyards. There is now a significant northern area load and high power transfers between NSW and Queensland.

In the future it is expected that there will be new wind farms and gas-fired generation development in the area.

The existing busbar arrangements are considered to have a lower level of reliability than is required for this critical part of the NSW system.

It is proposed to develop new 330 kV switchyards with a breaker-and-a-half arrangement to make these switchyards compatible with other major main system switchyards. These developments would be staged over the middle part of the next decade.

6.4.4. Kemps Creek 500/330 kV transformer augmentation

The two 500/330 kV transformers (installed in the early 1980s) at Kemps Creek have a fixed ratio. The voltage levels on the 330 kV system in the Sydney area are then directly tied to the voltage levels on the 500 kV system.

There are opportunities to maximise the reactive power capability of the Sydney supply system by replacing the fixed ratio transformers with transformers with on-load tap changing facilities. Maximising the reactive capability will effectively defer the need for additional line development to the Sydney area. The transformer augmentation is proposed for the mid to late part of this decade.

6.4.5. Further Development of Supply to the Newcastle – Sydney – Wollongong Area

The load in the Newcastle – Sydney – Wollongong area is growing. It is expected that this load growth will be partially met by generation developments within the load area. However under a range of future generation development scenarios in NSW, involving generation development occurring outside of the load area, there will be a need for network reinforcement. This is expected to be achieved through a sequence of reactive plant installations followed by the development of the 500 kV network.

Reactive support would be used to the maximum extent in order to defer the relatively high cost 500 kV network development for as long as possible.

The majority of the State's electricity usage occurs in the Newcastle – Sydney – Wollongong area. At the time of peak NSW demand the load in this area accounts for over 75% of the State's power demand. The area also accounts for about a third of the total load in the NEM.

As loads continue to grow augmentation of the 500 kV and 330 kV "core" network will be required to ensure the maintenance of reliable supply to the Newcastle – Sydney – Wollongong area and to ensure that efficient and competitive National Electricity Market (NEM) operations are maintained.

In the future the transmission capability within the core NSW network will be mainly determined by the following two factors:

- The thermal rating of transmission lines, particularly under high ambient temperature conditions. Significant network limitations will apply in relation to the thermal capacity of:
  - The two 330 kV transmission lines between the Hunter Valley power stations (Liddell and Bayswater) and the Newcastle area; and
  - The 330 kV transmission lines from the south at Bannaby and Marulan to Sydney and the south coast.
- The ability to control voltage at all points on the network to within acceptable limits for customers and to maintain the integrity of the overall supply system, particularly with respect to the Sydney area.

TransGrid develops the NSW electricity transmission network to ensure that there is sufficient network capability to transmit the output of generators to the major load centres in NSW at an acceptable standard of reliability. In doing so it is essential that the transmission network is developed so that it has adequate capability to transfer power under a range of future generation development scenarios.

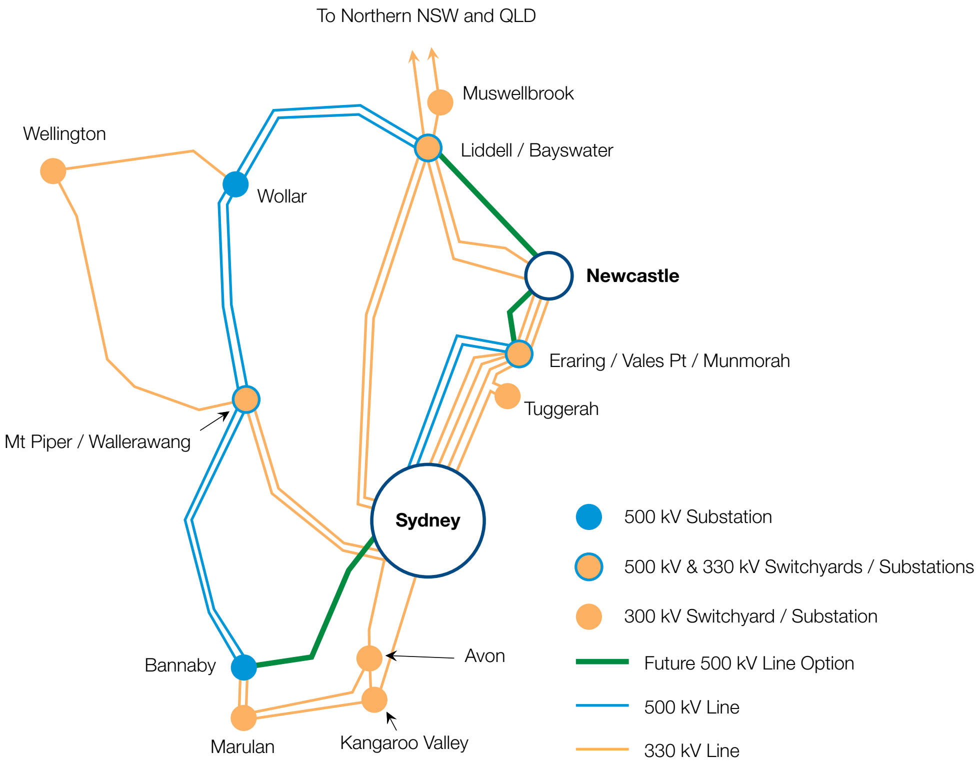
The number of locations where new generation could be connected to the NSW transmission network without the need to augment the network is now limited. The transfer of power from generators that are connected outside the Newcastle – Sydney – Wollongong area is constrained by limitations in transmission line capacity to the major load centres in the area. Connection of additional generators within the area is technically restricted by limitations in the fault interrupting capability of major substation equipment. Environmental and social constraints also restrict the feasibility of siting significant quantities of new generation near the urbanised areas.

The concept of developing a strong 500 kV transmission ring around the Newcastle – Sydney – Wollongong area to minimise the need for new transmission line routes into the Sydney basin was developed in the 1970s and partially implemented through the 1980s and early 1990s with three sections being completed over this time. The Eraring – Kemps Creek section was completed in the early 1980s. The Bayswater – Mt Piper and Mt Piper – Bannaby sections were initially placed in service at 330 kV in the mid 1980s to early 1990s but have now been converted to 500 kV operation. TransGrid has published a Strategic Network Development Plan setting out the 500 kV development concept.

Further development of a strong 500 kV ring around the Newcastle – Sydney – Wollongong area will address the emerging transmission network limitations. It will alter power flows to reduce the loading on the 330 kV lines between the

Hunter Valley power stations and the Newcastle area, between the Hunter Valley and western power stations and the Sydney area and between the south of the state and the Sydney area. It will also support voltage control in the Newcastle – Sydney – Wollongong area. Additionally it will facilitate new generation connection over a wide range of feasible locations.

Options for Future 500 kV Ring Developments



Two links of the 500 kV ring remain to be developed as indicated in the figure above:

- A 500 kV line between Bannaby and Sydney which is the most effective solution to both line rating and voltage control issues under a large set of future scenarios of load and generation development; and
- A 500 kV line between the Hunter Valley and the coast via the Newcastle area which is the preferred development for particular generation expansion scenarios which lead to significantly increased power flow from the north of the State towards Sydney.

In the absence of definitive information on future generation planting it is necessary to base plans for the immediate future development of the NSW power system on options to meet a range of possible future generation development scenarios. These generation development scenarios cover coal-fired and gas-fired generation developments and wind farm developments across a range of load growth scenarios.

TransGrid's scenarios indicate the need to first develop the southern link in the ring, particularly to accommodate southern gas-fired generation development. The northern link would be developed in response to major northern generation or load development. The NTS 2009 showed that there are market benefits associated with the Hunter Valley – coast 500 kV line under a set of scenario assumptions which resulted in generation planting in northern NSW. AEMO had assumed that the Bannaby – Sydney 500 kV line was in service in this analysis.

The 2010 NTNDP will include a set of scenarios for future market development and TransGrid will further refine its own set of scenarios to ensure alignment.

It is anticipated that an application notice for the Bannaby – Sydney 500 kV line development will be issued in 2010/11. Non-network development alternatives to support the Newcastle – Sydney – Wollongong area would be expected to be brought out and, if feasible and economic, would be further developed with the proponents.

The need and timing for the Hunter Valley – coast 500 kV link is being kept under review.

Some strategic property purchases have been made and more may be required to facilitate the development of the Bannaby – Sydney and Hunter Valley – coast 500 kV lines.

6.4.6. NSW – South Australia Interconnnection

There is significant potential for the development of wind generation in South Australia. There has also been significant attention to the potential for geothermal generation in the Innaminka area of South Australia. The existing South Australia – Victoria interconnection and size of the South Australian load places limitations on the ability to absorb this generation in South Australia.

There is potential for the development of a 500 kV HVAC interconnection between South Australia and NSW. This has a number of advantages, including:

- It would enable the connection of significant levels of renewable energy sources in South Australia;
- It would provide a transmission path to transfer excess renewable energy from South Australia to NSW;
- It would enable the transfer of base-load energy to South Australia;
- It would reinforce the existing South Australia – Victoria and Victoria – NSW interconnections and improve the capability for power transfer between the states;
- There is potential for wind farm development at Broken Hill and this could be connected into the interconnecting line; and
- It would provide access to vast tracts of area that are suitable for solar power developments.

TransGrid is investigating this interconnection and its connection into the NSW 500 kV system. ElectraNet and AEMO are jointly working on conceptual options for improving the interconnection from South Australia. TransGrid is contributing to this investigation. HVDC options are also being considered.

6.4.7. NSW – Victoria Interconnection

TransGrid has previously worked with AEMO (VENCorp) on options for improving the NSW – Victoria interconnection. It is aimed to improve both the import and export capability. A number of options have been considered:

- Upgrading of Victorian lines and transformers, SVC installation and a braking resistor to improve the Victorian export capability;
- Reactive support in the Jindera area, line series compensation of the Lower Tumut – Wagga – Jindera system or other power flow control devices to improve the Victorian import capability; and
- Major 330 kV line development to provide a significant increase in the Victorian import capability.

These developments were documented in AEMO's NTS 2009.

TransGrid's long-term plan for the system south of Bannaby has the following components:

- A 500 kV link from the Bannaby area to Yass;
- A 500 kV link from Yass to the Wagga area; and
- Further interconnection development from the Wagga area to Victoria.

These future developments will be influenced by AEMO's National Transmission Network Development Plan.

6.5 NER Rule 5.6.2A Reporting

The information described in Section 2.5 requiring TransGrid to provide forecast constraint information and indicate our intent to issue a Request for Proposal with respect to the projects covered in Chapter 6 are provided in the following two sections.

6.5.1. Forecast Constraint Information

The required forecast constraint information with respect to projects in Chapter 6 is provided in Table 6.5.1 below.

Table 6.5.1 - Forecast Network Limitations

Anticipated Proposal or Limitation	Reason for Limitation	Connection Point at which MW reduction would apply	MW at Time Limitation is Reached
New Small Network Assets: • Beaconsfield West – 2 x 160 MVAr 132 kV Caps • Reinforcement of Voltage Control in Northern NSW	 Thermal Overload and Voltage Control Voltage Control	 Haymarket Northern NSW loads	 Summer 2012/13; 45MW Summer 2013/14; 60 MW
Supply to Southern Sydney	Thermal Overload	Southern Sydney	Around 5 years
Capacity of the Snowy to Yass / Canberra 330 kV System	Line thermal ratings reached	NSW Supply overall	See Section 6.2.2
Supply to the Tomerong/Nowra Area	Thermal Overload	Integral Energy: Mt Terry & Shoalhaven	Summer 2010/11; 94 MW
Reactive Support from Coalfields Generators	Voltage Control	NSW supply overall with the main impact on the Newcastle, Sydney Wollongong load area	Summer and Winter 2011/12; 200 MW
Vales Point – Munmorah Line Flows	Line thermal ratings reached	Generation in the Central Coast	See Section 6.2.7
Voltage Levels in the Yass/Canberra Area	Voltage control	Yass/Canberra area	See Section 6.2.8
Eraring Generation Capacity	Transient Stability	Eraring Power Station	See Section 6.2.9
Minor Augmentation Proposals: • Yass 132 kV – 80 MVAr capacitor bank • Canberra 132 kV – new 120 MVAr cap bank • Sydney South 330 kV – 200 MVAr cap bank	 Voltage control Voltage control Voltage control	 Yass/Canberra area and NSW loads north of this area Sydney area	Yass/Canberra. Limitation in transfer capability to NSW is about the order of 400 MW in summer 2012/13 with summer and winter high load periods both critical Sydney South. Supply capability deficiency of about 170 MW in summer 2012/13 with summer and winter high load periods both critical
Supply to Beryl	Voltage Control	Beryl	Summer 11/12; 3 MW
Supply to Tumut/Gadara	See Section 6.3.3	See Section 6.3.3	See Section 6.3.3
NSW to Queensland Transmission Capacity	See Section 6.3.4	See Section 6.3.4	See Section 6.3.4
Transformer Capacity Upgrades and Replacements: • Yanco – Replace 2 x 45 MVA Txs with 60 MVA	 Thermal Overload	 Yanco	 Summer 2012/13; 1 MW

6.5.2. Intent to Issue Request for Proposal

The required indication of TransGrid's intent to issue a Request for Proposal for non-network services is indicated in the Table 6.5.2 below.

Table 6.5.2 - Anticipated issue of Request for Proposal for Non-Network Services

Anticipated Proposal or Limitation	Intend to Issue RfP	Date
New Small Network Assets:		
• Beaconsfield West – 2 x 160 MVAr 132 kV Caps	No	
• Reinforcement of Voltage Control in Northern NSW	No	
Supply to Southern Sydney	Yes	To be assessed
Capacity of the Snowy to Yass / Canberra 330 kV System	Yes	To be assessed
Supply to the Tomerong/Nowra Area	No	
Reactive Support from Coalfields Generators	Yes	2010/11
Vales Point – Munmorah Line Flows	No	
Voltage Levels in the Yass/Canberra Area	No	
Eraring Generation Capacity	No	
Minor Augmentation Proposals:		
• Canberra 132 kV – 120 MVAr Cap Bank	No	
• Canberra 132 kV – Upgrade No.1 80 MVAr Cap Bank to 120 MVAr		
• Canberra 330 kV – 200 MVAr Cap Bank	No	
• Yass 132 kV – 80 MVAr Cap Bank	No	
• Sydney South 330 kV – 200 MVAr Cap Bank	No	
• Sydney Area 330 kV – 200 MVAr Cap Bank	No	
• Sydney South 132 kV – Expansion of 80 MVAr Cap Bank	No	
	No	
Supply to Beryl	No	
Supply to Tumut/Gadara	No	
NSW to Queensland Transmission Capacity	To be assessed	To be assessed
Constraints Within 5 Years:		
Transformer Capacity Upgrades and Replacements:		
• Griffith – Replace 3 x 45 MVA 132/33 kV Transformers	No	
• Yanco – Rebuild Substation; Replace 2 x 45 MVA Transformers with 60 MVA	No	
System Reactive Plant Requirements	To be assessed	To be assessed
Further Development of Supply to the Newcastle – Sydney – Wollongong Area	Yes	To be assessed

7

Other Planning Issues in NSW

7 Other Planning Issues in NSW

7.1 Sustainability

7.1.1. Consideration of Non-Network Options by TransGrid

The Annual Planning Report provides advance information to the market on the nature and location of emerging network constraints. This is intended to encourage interested parties to formulate and propose feasible non-network options, including Demand Management (DM), Demand Side Response (DSR) and local or embedded generation options, to relieve the emerging network constraints. The advantages that non-network options offer in relieving transmission network constraints are that they may:

- Reduce, defer or eliminate the need for new transmission or distribution investment; and/or
- Reduce, defer or eliminate the costs and environmental impacts of construction and operation of fossil fuel based power stations.

TransGrid considers DM, local/embedded generation and bundled options on an equal footing with network options when planning its network augmentations and applying the AER's regulatory test.

For any option to be considered during the evaluation and analysis process, it must be feasible and capable of being implemented in time to relieve the emerging constraint.

For an option to be recommended for implementation after evaluation and analysis, it must satisfy the regulatory test. It must also have a proponent who is committed to implement the option and to accept the associated risks, responsibilities and accountabilities.

It is expected that DM and local generation options would emerge from joint planning with Distributors, from the market or from interested parties.

TransGrid's joint planning with NSW Distributors provides a mechanism to identify opportunities for DM and local/embedded generation options. The NSW Distributors follow a similar process to TransGrid in preparing planning reports for their networks, thereby providing another useful source of information for proponents of DM and local generation options.

Contact details for initial enquiries by interested parties are given in Appendix 7.

Demand Management or Demand Side Response

DM or DSR options may include, but are not limited to, combinations of the following:

- Reduction in electricity demand at points of end-use through:
  - Improved energy efficiency devices and systems;
  - Thermal insulation;
  - Renewable energy sources such as solar; and
  - Alternative reticulated energy sources such as natural gas.
- Reduction in peak electricity consumption at points of end-use through:
  - Tariff incentives;
  - Load interruption and reduction incentives;
  - Arrangements to transfer load from peak to off-peak times;
  - Energy storage systems;
  - Standby generators; and
  - Power factor correction equipment.

Embedded or Local Generation

Embedded or Local generation options may include generation or cogeneration facilities located on the load side of a transmission constraint. Alternative energy sources may include, but are not limited to:

- Bagasse;
- Biomass;
- Gas (e.g. natural gas or LPG);
- Hydro;
- Solar; and
- Wind.

Promotion of DM and Local Generation Alternatives by TransGrid

TransGrid actively promotes DM and local generation alternatives through:

- Identifying opportunities for DM and local generation options through joint planning with the Distributors and engaging expert external consultants where warranted;
- Informing the market of constraints via the Annual Planning Report and consultations for alleviating individual constraints;
- Participation in initiatives and reviews that include consideration of DM and its relationship to the development of electricity networks; and
- Joint sponsorship of research projects involving DM and embedded generation.

7.1.2. Recent Non-Network Projects

Western 500 kV Conversion Non-Network Project

TransGrid undertook to acquire 350 MW (effective capacity) of network support services for the Newcastle – Sydney – Wollongong area from non-network sources. Following a competitive tendering process three proponents were selected to form a portfolio consisting of a large industrial load, a demand management aggregator and an embedded generator.

TransGrid contracted 350 MW of network support from this portfolio to ensure that it met its planning and reliability obligations during summer 2008/9 while allowing for deferral of the Western 500 kV conversion project by one year to 2009/10.

The AER approved the pass-through of network support payments made to the service providers. At the conclusion of the support period (March 2009) TransGrid adjusted its 2009/10 TUOS payments returning in excess of $14 million in unused funding for network support to its customers.

It was the largest ever acquisition of network support from non-network sources in the NEM to defer a major capital works programme while maintaining the reliability of supply to customers.

7.1.3. Future DM and other Non-Network Projects

DM projects and initiatives that TransGrid is likely to implement in the next five years include:

- Network support to cover operational risk management measures for the Sydney Inner Metropolitan load area at times of peak demand, [summer of 2012/13]; and
- TransGrid has signed agreements with the NSW distributors to cooperate on demand management innovation projects. Joint projects include initiatives to reduce peak demand and some research and development projects.

Other non-network projects that are likely to be progressed are:

- Provision of reactive power for main system network support which may come from non-network sources;
- Provision of network support, possibly from non-network sources, to improve the power transfer capability between Snowy and Yass/Canberra. This may include implementation of a special system protection scheme; and
- Provision of Network Support and Control Ancillary Service (NSCAS). The AEMC is currently consulting on the future framework in this regard which may require TNSPs to procure and deliver reactive power capability for main system security and reliability. Part of the NSCAS may come from non-network sources.

7.1.4. Price Signals and Financial Incentives to Encourage DM and Local Generation

TransGrid is a provider of bulk transmission network services and is best placed to implement ‘bulk’ DM options. For example, it is the customers connected at the transmission voltage levels and electricity distribution businesses that are exposed to and respond to transmission pricing structures. These pricing structures reflect the requirements of the National Electricity Rules and the associated Transmission Pricing Methodology approved by the AER.

Among these structures, the monthly maximum demand charge is designed to encourage demand side response at the time of maximum demand on the transmission network.

In addition, TransGrid can and does provide financial incentives via direct payments under network support contracts with wholesale suppliers of demand reductions such as larger end users or embedded generators or DM aggregators. Contractual payments to smaller suppliers of DM are now proving practical for TransGrid with the advent of DM aggregators. Significantly, the regulatory incentive framework is evolving to provide improved commercial incentives for TransGrid to engage in these activities.

The full impact of transmission pricing structures, as well as distribution sector DM activities, is not always obvious at TransGrid’s ‘bulk’ connection points with electricity distributors. This is because this level of demand response is ‘embedded’ in the aggregated actual demand at these connection points. The forecast demand at these connection points, provided by the electricity distributors for transmission planning purposes, also includes anticipated demand response within each Distributor’s franchise area.

7.1.5. Gas, Wind and Solar Generation

TransGrid is an electricity transmission network provider connecting generation to distribution networks and to large electricity consumers in NSW. An important part of TransGrid’s planning and development function is to provide connections for proposed new generators. In recent years the vast majority of applications to connect to TransGrid’s network have been from proponents of gas or wind powered generation.

Since 2008, TransGrid has successfully directly connected to its network the following generation:

- Uranquinty Gas Fired Power Station, capability 664 MW;
- Capital Wind Farm, capability 141 MW; and
- Colongra Gas Fired Power Station, capability 667 MW.

In addition to these new direct connections, TransGrid has also worked with the NSW Distributors to coordinate and assist with the connection of new generating systems of various technologies and scale. This includes the 400MW Tallawarra gas fired power station embedded into Integral Energy’s 132kV network and the Cullerin Range Wind Farm embedded into Country Energy’s 132kV network.

The status of the supply demand balance in the NSW region, the scope for peaking generators to assist in managing trading risk and the Mandatory Renewable Energy Target scheme are among the factors contributing to the above mentioned new generation connections.

During the 2009/10 financial year, TransGrid has witnessed a significant deferment of a majority of the wind energy developments. Reasons provided to TransGrid for this include:

- The collapse of the value of Renewable Energy Certificates (RECs) traded under the government’s Mandatory Renewable Energy Target (MRET) scheme;
- Increased regulatory risk arising from the delay in enacting Carbon Pollution Reduction Scheme (CPRS) legislation; and
- Increased difficulty in securing project financing due to the global financial crisis.

During the 2010/11 financial year, an increased level of connection activity is possible, particularly if some or all of the above issues are resolved.

An area of particular interest will be the funding allocation as a result of the Federal Governments Solarflagship program, the initial stage expected to be announced in the second half of 2010. If projects within NSW are successful in their funding bids then additional connection activity would result from solar generators.

TransGrid is neither a proponent nor a builder of generating plant but is committed to assisting the connection of new generation to its network. The expected increasing level of interest in grid connections, particularly for gas, wind and, possibly, solar generation, creates challenges in meeting the expectations of intending generators. For example, there are often commercial pressures on generation proponents to meet relatively short development lead times. Accordingly, timely resolution of transmission connection arrangements is important to securing finance for these projects particularly in the current climate of restricted credit.

A key challenge for TransGrid in meeting these expectations is to reconcile the impact of intending generators technical performance with TransGrid's performance obligations to existing generators and consumers, including obligations set out in pre-existing connection agreements.

Further there are confidentiality requirements in the NER that limit TransGrid's ability to publicly disseminate basic information about planned generator connections. Recent changes to the National Electricity Rules have attempted to remove some of these impediments to collaboration between new generators and network service providers. This should enhance the potential for efficient network developments associated with generator connections.

Under the NER, transmission services associated with connecting generators to TransGrid's existing network are usually classified as 'Negotiated' (as defined under the NER) and are subject to a negotiating framework approved by the AER. However, where the electricity services required to connect a generator can be provided on a contestable basis (e.g. they are dedicated to the generator and can be readily sourced from providers other than TransGrid) then they are not subject to regulation under the NER. These arrangements allow TransGrid and generation proponents scope to negotiate connection arrangements bilaterally and thus provide a degree of flexibility in those arrangements.

The Impact of Climate Change Policies on NSW Transmission

The Mandatory Renewable Energy Target (MRET) scheme and the Federal Government's proposed Carbon Pollution Reduction Scheme (CPRS) are factors which could promote increased wind and other renewable generation development activity in NSW. The NSW Government is also actively supporting these initiatives with the establishment of development precincts to encourage renewable energy initiatives for planning approval purposes.

There is a material amount of good quality wind generation resource in NSW that is also proximate to existing transmission lines. Generation developments that do not require the construction of new transmission links can be developed relatively quickly. To date this has been the focus of wind generation development in NSW.

In early 2010, the Ministerial Council of Energy (MCE) submitted to the AEMC a Rule Change Proposal aimed at encouraging NEM Network Service Providers, such as TransGrid, to develop extensions to networks for the connection of multiple sources of renewable energy. These extensions have been termed Scale Efficient Network Extensions (SENEs). This proposal is currently going through the Rule change consultation process.

Wind farm connection activity occurs within both the transmission and distribution networks with Country Energy particularly affected. Accordingly, TransGrid is developing its existing joint planning arrangements with affected DNSPs to assist in the co-ordination of generation connection activities.

As wind and other renewable energy generation sources develop across the State network, congestion levels are likely to increase in some locations. As a result, in the longer term, the need for network reinforcement and/or extension work may emerge which will be addressed through the existing planning process.

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Appendices

Appendix 1
TransGrid's Network Planning Approach

A1.1 General

The NSW transmission network has been planned and developed by TransGrid and its predecessor organisations, commencing with the Electricity Commission of NSW, for over 50 years.

Under NSW legislation TransGrid has responsibilities that include planning for future NSW transmission needs, including interconnection with other networks.

In addition, as a Transmission Network Service Provider (TNSP) TransGrid is obliged to meet the requirements of the NER. In particular, TransGrid is obliged to meet the requirements of clause S 5.1.2.1:

> "*Network Service Providers* must plan, design, maintain and operate their *transmission networks* to allow the transfer of power from *generating units* to Customers with all facilities or equipment associated with the *power system* in service and may be required by a *Registered Participant* under a *connection agreement* to continue to allow the transfer of power with certain facilities or *plant* associated with the *power system* out of service, whether or not accompanied by the occurrence of certain faults (called "*credible contingency events*").

The NER sets out the required processes for developing networks as well as minimum performance requirements of the network and connections to the network. It also requires TransGrid to consult with Registered Participants and interested parties and to apply the AER's regulatory test to development proposals.

TransGrid's planning obligations are also interlinked with the licence obligations placed on Distribution Network Service Providers (DNSP) in NSW. TransGrid must ensure that the system is adequately planned to enable the licence requirements to be met.

TransGrid also has obligations to meet community expectations in the supply of electricity, including ensuring that developments are undertaken in a socially and environmentally responsible manner.

In meeting these obligations TransGrid's approach to network planning is socially and economically based and is consistent with both the NER and the regulatory test. It includes consideration of non-network options such as demand side response and DM and/or embedded generation, as an integral part of the planning process. Joint planning with DNSPs, directly supplied industrial customers, generators and interstate TNSPs is carried out to ensure that the most economic options, whether network options or non-network options, consistent with customer and community requirements are identified and implemented.

TransGrid has traditionally planned the network to achieve supply at least community cost, without being constrained by State borders or ownership considerations. Prior to commencement of the NEM transmission augmentations were subjected to a cost-benefit assessment according to NSW State Treasury guidelines. A similar approach is applied the NEM where the AER's regulatory test (RIT-T from 1st August 2010) is applied to meet the requirements of Chapter 5 of the NER.

Jurisdictional Planning Requirements

In addition to meeting requirements imposed by the NER, environmental legislation and other statutory instruments, TransGrid is expected by the NSW jurisdiction to plan and develop its transmission network on an "n-1" basis. That is, unless specifically agreed otherwise by TransGrid and the affected distribution network owner or major directly connected end-use customer, there will be no inadvertent loss of load (other than load which is interruptible or dispatchable) following an outage of a single circuit (a line or a cable) or transformer, during periods of forecast high load.

In fulfilling this obligation, TransGrid must recognise specific customer requirements as well as AEMO's role as system operator for the NEM. To accommodate this, the standard "n-1" approach can be modified in the following circumstances:

- Where agreed between TransGrid and a distribution network owner or major directly connected end-use customer, agreed levels of supply interruption can be accepted for particular single outages, before augmentation of the network is undertaken (for example the situation with radial supplies);
- Where requested by a distribution network owner or major directly connected end-use customer and agreed with TransGrid there will be no inadvertent loss of load (other than load which is interruptible or dispatchable) following an outage of a section of busbar or coincident outages of agreed combinations of two circuits, two transformers or a circuit and a transformer (for example supply to the inner metropolitan/CBD area of Sydney); or
- The main transmission network, which is operated by AEMO, should have sufficient capacity to accommodate AEMO's operating practices without inadvertent loss of load (other than load which is interruptible or dispatchable) or uneconomic constraints on the energy market.
  At present AEMO's operational practices include the re-dispatch of generation and ancillary services following a first contingency, such that within 30 minutes the system will again be "secure" in anticipation of the next critical credible contingency.

In 2005 the NSW Government introduced mandatory licence conditions on DNSPs which set out certain reliability standards for sub-transmission and distribution networks. The licence conditions specify "n-1, 1 minute" reliability standards for sub-transmission lines and zone substations supplying loads greater than or equal to specified minimums, e.g. 15 MVA in urban and non-urban areas.

These requirements imply a consequential obligation on TransGrid to provide a commensurate level of reliability in its network supplying NSW DNSPs.

Country Energy has requested TransGrid to provide a commensurate reliability standard at connection points to its network, i.e. "n-1, 1 minute" reliability where Country Energy's maximum demand is greater than or equal to 15 MVA.

These jurisdictional requirements and other obligations require the following to be observed in planning:

- At all times when the system is either in its normal state with all elements in service or following a credible contingency:
  - Electrical and thermal ratings of equipment will not be exceeded; and
  - Stable control of the interconnected system will be maintained, with system voltages maintained within acceptable levels.
- A quality of electricity supply at least to NER requirements is to be provided;
- A standard of connection to individual customers as specified by Connection Agreements is to be provided;
- As far as possible connection of a customer is to have no adverse effect on other connected customers;
- Environmental constraints are to be satisfied;
- Social constraints are to be satisfied;
- Acceptable safety standards are to be maintained; and
- The power system in NSW is to be developed at the lowest cost possible whilst meeting the constraints imposed by the above factors.

Consistent with a responsible approach to the environment it is also aimed to reduce system energy losses where economic.

A further consideration is the provision of sufficient capability in the system to allow components to be maintained in accordance with TransGrid's asset management strategies.

National Planning Requirements

AEMO has the role of the national transmission planner and is required to produce a National Transmission Network Development Plan. The NTNDP will have regard to jurisdictional planning and regulatory documents (such as APRs) and, in turn, the jurisdictional planning bodies need to have regard to the NTNDP in formulating their plans. The first NTNDP is to be published in 2010. Through a close working relationship TransGrid's future plans will be consistent with AEMO's.

The Network Planning Process

The network planning process is undertaken at five levels:

1. Connection Planning

Connection planning is concerned with the local network directly related to the connection of loads and generators. Connection planning typically includes connection enquiries and the formulation of draft connection agreements leading to a preliminary review of the capability of connections. Further discussions are held with specific customers where there is a need for augmentation or for provision of new connection points.

2. Network Planning within the New South Wales Region

The main 500 kV, 330 kV and 220 kV transmission system is developed in response to the overall load growth and generation requirements and may be influenced by interstate interconnection power transfers. Any developments include negotiation with affected NSW and interstate parties.

The assessment of the adequacy of 132 kV systems requires joint planning with DNSPs. This ensures that development proposals are optimal with respect to both TransGrid and DNSP requirements leading to the lowest possible cost of transmission to the end customer. This is particularly important where the DNSP's network operates in parallel with the transmission network, forming a meshed system.

3. Inter-regional Planning

The development of interconnectors between regions and of augmentations within regions that have a material effect on inter-regional power transfer capability are coordinated with network owners in other states in accordance with the NER. The inter-regional developments will be consistent with the NTNDP.

4. Consideration of Non-Network Alternatives

TransGrid's planning process includes consideration of non-network alternatives which can address the emerging constraint(s) under consideration and may defer or cancel the need for network augmentations.

5. Compliance with NER Requirements

TransGrid's approach to the development of the network since the advent of the NEM is in accordance with National Electricity Rules and other rules and guidelines promulgated by the AER.

Planning Horizons

Transmission planning is carried out over a short-term time frame of one to five years and also over long-term time frames of five to 20 years or more. The short-term planning supports commitments to network developments with relatively short lead-times. The long-term planning considers options for future major developments and provides a framework for the orderly and economic development of the transmission network and the strategic acquisition of critical line and substation sites.

In this Annual Planning Report the constraints that appear over long-term time frames are considered to be indicative. The timing and capital cost of possible network options to

relieve them may change significantly as system conditions evolve. TransGrid has published outline plans for long-term developments.

Identifying Network Constraints and Assessing Possible Solutions

An emerging constraint may be identified during various planning activities covering the planning horizon. It may be identified through:

- TransGrid's planning activities;
- Joint planning with a DNSP;
- The impact of prospective generation developments;
- The occurrence of constraints affecting generation dispatch in the NEM;
- The impact of network developments undertaken by other TNSPs; or
- As a result of a major load development.

During the initial planning phase a number of options for addressing the constraint are developed. In accordance with NER requirements, consultation with interested parties is carried out to determine a range of options including network, DM and local generation options and/or to refine existing options.

A cost effectiveness or cost-benefit analysis is carried out in which the costs and benefits of each option are compared in accordance with the AER's regulatory test. In applying the regulatory test the cost and benefit factors may include:

- Avoiding unserved energy caused by either a generation shortfall or inadequate transmission capability or reliability;
- Loss reductions;
- Alleviating constraints affecting generation dispatch;
- Avoiding the need for generation developments;
- Fuel cost savings;
- Improvement in marginal loss factors;
- Deferral of related transmission works; and
- Reduction in operation and maintenance costs.

Options with similar Net Present Value would be assessed with respect to factors that may not be able to be quantified and/or included in the regulatory test, but nonetheless may be important from environmental or operational viewpoints. These factors include:

- Reduction in greenhouse gas emissions or increased capability to apply greenhouse-friendly plant;
- Improvement in quality of supply above minimum requirements; and
- Improvement in operational flexibility.

Application of Power System Controls and Technology

TransGrid seeks to take advantage of the latest proven technologies in network control systems and electrical plant where these are found to be economic. For example, the application of static VAr compensators has had a considerable impact on the power transfer capabilities of parts of the main grid and has deferred or removed the need for higher cost transmission line developments.

System Protection Schemes have been applied in several areas of the NSW system to reduce the impact of network limitations on the operation of the NEM and to facilitate the removal of circuits for maintenance.

The broad approach to planning and consideration of these technologies together with related issues of protection facilities, transmission line design, substation switching arrangements and power system control and communication is set out in the following sections. This approach is in line with international practice and provides a cost effective means of maintaining a safe, reliable, secure and economic supply system consistent with maintaining a responsible approach to environmental and social impacts.

A1.2 Planning Criteria

The NER specifies the minimum and general technical requirements in a range of areas including:

- A definition of the minimum level of credible contingency events to be considered;
- The power transfer capability during the most critical single element outage. This can range from zero in the case of a single element supply to a portion of the normal power transfer capability;
- Frequency variations;
- Magnitude of power frequency voltages;
- Voltage fluctuations;
- Voltage harmonics;
- Voltage unbalance;
- Voltage stability;
- Synchronous stability;
- Damping of power system oscillations;
- Fault clearance times;
- The need for two independent high speed protection systems; and
- Rating of transmission lines and equipment.

In addition to adherence to NER and regulatory requirements, TransGrid's transmission planning approach has been developed taking into account the historical performance of the components of the NSW system, the sensitivity of loads to supply interruption and state-of-the-art asset maintenance procedures. It has also been recognised that there is a need for an orderly development of the system taking into account the long-term requirements of the system to meet future load and generation developments.

A set of deterministic criteria, detailed below, are applied as a point of first review, from which point a detailed assessment of each individual case is made.

Main Transmission Network

The NSW main transmission system is the transmission system connecting the major power stations and load centres and providing the interconnections from NSW to Queensland and Victoria. It includes the majority of the transmission system operating at 500 kV, 330 kV and 220 kV.

This system comprises over 7,000 km of transmission circuits supplying a peak load of over 14,000 MW throughout NSW.

Power flows on the main transmission network are subject to overall State load patterns and the dispatch of generation within the NEM, including interstate export and import of power. AEMO operates the interconnected power system and applies operational constraints on generator dispatch to maintain power flows within the capability of the NSW and other regional networks. These constraints are based on the ability of the networks to sustain credible contingency events that are defined in the NER. These events mainly cover forced outages of single generation or transmission elements, but also provide for multiple outages to be redefined as credible from time to time. Constraints are often based on short-duration loadings on network elements, on the basis that generation can be re-dispatched to relieve the line loading within 15 minutes.

The rationale for this approach is that, if operated beyond a defined power transfer level, credible contingency disturbances could potentially lead to system-wide loss of load with severe social and economic impact.

Following any transmission outage, for example during maintenance or following a forced line outage for which line reclosure has not been possible, AEMO applies more severe constraints within a short adjustment period, in anticipation of the impact of a further contingency event. This may require:

- The re-dispatch of generation and dispatchable loads;
- The re-distribution of ancillary services; and
- Where there is no other alternative, the shedding of load.

AEMO may direct the shedding of customer load, rather than operate for a sustained period in a manner where overall security would be at risk for a further contingency. The risk is, however, accepted over a period of up to 30 minutes. In performing its planning analysis, TransGrid must consider AEMO's imperative to operate the network in a secure manner.

Therefore in the first instance, TransGrid's planning for its main network concentrates on the security of supply to load connection points under sustained outage conditions, consistent with the overall principle that supply to load connection points must be satisfactory after any single contingency.

The main 500 kV, 330 kV and 220 kV transmission system is augmented in response to the overall load growth and generation requirements and may be influenced by interstate interconnection power transfers. Any developments include negotiation with affected NSW and interstate parties.

The reliability of the main system components and the ability to withstand a disturbance to the system are critically important in maintaining the security of supply to NSW customers. A high level of reliability implies the need for a robust transmission system. The capital cost of this system is balanced by:

- Avoiding the large cost to the community of widespread shortages of supply;
- Providing flexibility in the choice of economical generating patterns leading to the most economic energy supply to consumers;
- Allowing reduced maintenance costs through easier access to equipment; and
- Minimising electrical losses which also provides benefit to the environment.

The planning of the main system must take into account the risk of forced outages of a transmission element coinciding with adverse conditions of load and generation dispatch. Two levels of load forecast (summer and winter) are considered, as follows.

Loads at or exceeding a one in two year probability of occurrence (50% probability of exceedence)

> The system will be able to withstand a single contingency under all reasonably probable patterns of generation dispatch or interconnection power flow. In this context a single contingency is defined as the forced outage of a single transmission circuit, a single generating unit, a single transformer, a single item of reactive plant or a single busbar section.
>
> Provision will be made for a prior outage (following failure) of a single item of reactive plant.
>
> Further the system will be able to be secured by re-dispatching generation (AEMO action), without the need for pre-emptive load shedding, so as to withstand the impact of a second contingency.

Loads at or exceeding a one in ten year probability of occurrence (10% probability of exceedence)

> The system will be able to withstand a single contingency under a limited set of patterns of generation dispatch or interconnection power flow.
>
> Further the system will be able to be secured by re-dispatching generation (AEMO action), without the need for pre-emptive load shedding, so as to withstand the impact of a second contingency.

These criteria do not apply to radial sections of the main system.

Under all conditions there is a need to achieve adequate voltage control capability. TransGrid has traditionally assumed that all on-line generators can provide reactive power support within their rated capability but in the future intends to align with other utilities in relying only on the reactive capability given by performance standards. Reactive support beyond the performance standards may need to be procured under network support arrangements.

A further consideration is the provision of sufficient capability in the system to allow components to be maintained in accordance with TransGrid's asset management strategies.

Overall supply in NSW is heavily dependent on base-load coal-fired generation in the Hunter Valley, western area and Central Coast. These areas are interconnected with the load centres via numerous single and double circuit lines. In planning the NSW system, taking into account AEMO's operational approach to the system, there is a need to consider the risk and impact of overlapping outages of circuits under high probability patterns of load and generation.

The analysis of network adequacy must take into account the probable load patterns, typical dispatch of generators and loads, the availability characteristics of generators (as influenced by

maintenance and forced outages), energy limitations and other factors relevant to each case.

Options to address an emerging inability to meet all connection point loads would be considered with allowance for the lead time for a network augmentation solution.

Before this time consideration may be given to the costs involved in re-dispatch in the energy and ancillary services markets to manage single contingencies. In situations where these costs appear to exceed the costs of a network augmentation this will be brought to the attention of network load customers for consideration. TransGrid may then initiate the development of a network or non-network solution through a consultation process.

Relationship with Inter-Regional Planning

In addition to concerns about security of supply to load point connections, TransGrid also monitors the occurrence of constraints in the main transmission system that affect generator dispatch. TransGrid's planning therefore also considers the scope for network augmentations to reduce constraints that may satisfy the regulatory test.

Under the provisions of the NER a Region may be created where constraints to generator dispatch are predicted to occur with reasonable frequency when the network is operated in the "system normal" (all significant elements in service) condition. The creation of a Region does not however consider the consequences to load connection points if there should be a network contingency.

In effect the capacity of interconnectors that is applied in the market dispatch is the short-time capacity determined by the ability to maintain secure operation in the system normal state in anticipation of a single contingency. The operation of the interconnector at this capacity must be supported by appropriate ancillary services. However AEMO does not operate on the basis that the contingency may be sustained but TransGrid must consider the impact of a prolonged plant outage.

As a consequence it is probable that for parts of the network that are critical to the supply to loads, TransGrid would initiate augmentation to meet an 'n-1' criterion before the creation of a new Region.

The development of interconnectors between regions will be undertaken where the augmentation satisfies the regulatory test. The planning of interconnections will be undertaken in consultation with the jurisdictional planning bodies of the other states.

It is not planned to maintain the capability of an interconnector where relevant network developments would not satisfy the regulatory test.

Networks Supplied from the Main Transmission Network

Some parts of TransGrid's network are primarily concerned with supply to local loads and are not significantly impacted by the dispatch of generation (although they may contain embedded generators). The loss of a transmission element within these networks does not have to be considered by AEMO in determining network constraints, although ancillary services may need to be provided to cover load rejection in the event of a single contingency.

Supply to Major Load Areas and Sensitive Loads

The NSW system contains six major load areas with indicative loads as follows:

Load Area	Indicative Peak Load
The NSW north, supplied from the Hunter Valley, Newcastle and over QNI	1,000 MW
Newcastle area	2,400 MW (this includes aluminium smelters with a load greater than 1,000 MW)
Greater Sydney	6,000 MW
Western Area	600 MW
South Coast	700 MW
South and South West	1,600 MW

Some of these load areas, including individual smelters, are supplied by a limited number of circuits, some of which may share double circuit line sections. It is strategically necessary to ensure that significant individual loads and load areas are not exposed to loss of supply in the event of multiple circuit failures. As a consequence it is necessary to assess the impact of contingency levels that exceed 'n-1'.

Outages of network elements for planned maintenance must also be considered. Generally this will require 75% of the peak load to be supplied during the outage. While every effort would be made to secure supplies in the event of a further outage, this may not be always possible. In this case attention would be directed to minimising the duration of the plant outage.

Urban and Suburban Areas

Generally the urban and suburban networks are characterised by a high load density served by high capacity underground cables and relatively short transmission lines. The connection points to TransGrid's network are usually the low voltage (132 kV) busbars of 330 kV substations. There may be multiple connection points and significant capability on the part of the Distributor to transfer load between connection points, either permanently or to relieve short-time loadings on network elements after a contingency.

The focus of joint planning with the DNSP is the capability of the meshed 330/132 kV system and the capability of the existing connection points to meet expected peak loadings. Joint planning addresses the need for augmentation to the meshed 330/132 kV system and TransGrid's connection point capacity or to provide a new connection point where this is the most economic overall solution.

Consistent with good international practice, supply to high-density urban and central business districts is given special consideration. For example, the inner Sydney metropolitan network serves a large and important part of the State load. Supply to this area is largely via a 330 kV and 132 kV underground cable network. The two 330 kV cables are part of TransGrid's network and the 132 kV cable system is part of EnergyAustralia's network. The jointly developed target reliability standard for the area is that the system will be capable of meeting the peak load under the following contingencies:

(a) The simultaneous outage of a single 330 kV cable and any 132 kV feeder or 330/132 kV transformer; or

(b) An outage of any section of 132 kV busbar.

Thus an 'n-1' criterion is applied separately to the two networks. The decision to adopt a reliability criterion for the overall network that is more onerous than 'n-1' was made jointly by TransGrid and EnergyAustralia after consideration of:

- The importance and sensitivity of the Sydney area load to supply interruptions;
- The high cost of applying a strict 'n-2' criterion to the 330 kV cable network;
- The large number of elements in the 132 kV network;
- The past performance of the cable system; and
- The long times to repair cables should they fail.

The criterion applied to the inner Sydney area is consistent with that applied in the electricity supply to major cities throughout the world. Most countries use an 'n-2' criterion. Some countries apply an 'n-1' criterion with some selected 'n-2' contingencies that commonly include two cables sharing the one trench or a double circuit line.

The above criterion is applied in the following manner in planning analysis:

- Under system normal conditions all elements must be loaded within their "recurrent cyclic" rating;
- System loadings under first contingency outages will remain within equipment recurrent cyclic ratings without corrective switching other than for automatic switching or "auto-change-over";
- Cyclic load shedding (in areas other than the Sydney CBD) may be required in the short term following a simultaneous outage of a single 330 kV cable and any 132 kV transmission feeder or 330/132 kV transformer in the inner metropolitan area until corrective switching is carried out on the 330 kV or 132 kV systems;
- The system should be designed to remove the impact of a bus section outage at existing transmission substations. New transmission substations should be designed to cater for bus section outages;
- The load forecast to be considered is based on "50 percent probability of exceedence";
- Loading is regarded as unsatisfactory when 330/132 kV transformers and 330 kV or 132 kV cables are loaded beyond their recurrent cyclic rating; and
- Fault interruption duty must be contained to within equipment ratings at all times.

Outages of network elements for planned maintenance must also be considered. Generally this will require 75% of the peak load to be supplied during an outage. While every effort would be made to secure supplies in the event of a further outage, this may not be always possible. In this case attention would be directed to minimising the duration of the outage.

Non Urban Areas

Generally these areas are characterised by lower load densities and, generally, lower reliability requirements than urban systems. The areas are often supplied by relatively long, often radial, transmission systems. Connection points are either on 132 kV lines or on the low voltage busbars of 132 kV substations. Although there may be multiple connection points to a Distributor they are often far apart and there will be little capacity for power transfer between them. Frequently supply limitations will apply to the combined capacity of several supply points together.

The focus of joint planning with the DNSP will usually relate to:

- Augmentation of connection point capacity;
- Duplication of radial supplies;
- Extension of the 132 kV system to reinforce or replace existing lower voltage systems and to reduce losses; and
- Development of a higher voltage system to provide a major augmentation and to reduce network losses.

TransGrid's aim is to provide a level and reliability of supply at connection points that is complementary to that provided by the DNSP within its own network. For example Country Energy provides fully duplicated supply ('n-1' reliability) to a load area of 15 MW or more in the former Advance Energy area, and will provide a switched alternative supply if the load exceeds about 5 MW, and requires TransGrid to provide a commensurate level of reliability at connection points to its network.

Supply to one or more connection points would be considered for augmentation when the forecast peak load at the end of the planning horizon exceeds the load firm 'n-1' capacity of TransGrid's network. However, consistent with the lower level of reliability that may be appropriate in a non-urban area, an agreed level of risk of loss of supply may be accepted. Thus augmentations may actually be undertaken:

- When the forecast load exceeds the firm capacity by an agreed amount;
- Where the period that some load is at risk exceeds an agreed proportion of the time; or
- An agreed amount of energy (or proportion of annual energy supplied) is at risk.

As a result of the application of these criteria some radial parts of the 330 kV and 220 kV network are not able to withstand the forced outage of a single circuit line at time of peak load, and in these cases provision has been made for under-voltage load shedding.

Provision is also required for the maintenance of the network. Additional redundancy in the network is required where maintenance cannot be scheduled without causing load restrictions or an unacceptable level of risk to the security of supply.

Transformer Augmentation

In considering the augmentation of transformers, appropriate allowance is made for the transformer cyclic rating and the practicality of load transfers between connection points. The outage of a single transformer (or single-phase unit) or a transmission line that supports the load carried by the transformer is allowed for.

Provision is also required for the maintenance of transformers. This has become a critical issue at a number of sites in NSW where there are multiple transformers in service. To enable maintenance to be carried out, additional transformer capacity or a means of transferring load to other supply points via the underlying lower voltage network may be required.

Consideration of Low Probability Events

Although there is a high probability that loads will not be shed as a result of system disturbances no power system can be guaranteed to deliver a firm capability 100% of the time, particularly when subjected to disturbances that are severe or widespread. In addition extreme loads, above the level allowed for in planning, can occur, usually under extreme weather conditions.

The NSW network contains numerous lines of double circuit construction and whilst the probability of overlapping outages of both circuits of a line is very low, the consequences could be widespread supply disturbances.

Thus there is a potential for low probability events to cause localised or widespread disruption to the power system. These events can include:

- Loss of several transmission lines within a single corridor, as may occur during bushfires;
- Loss of a number of cables sharing a common trench;
- Loss of more than one section of busbar within a substation, possibly following a major plant failure;
- Loss of a number of generating units; and
- Occurrence of three-phase faults, or faults with delayed clearing.

In TransGrid's network, appropriate facilities and mechanisms are put in place to minimise the probability of such events and to ameliorate their impact. The decision process considers the underlying economics of facilities or corrective actions, taking account of the low probability of the occurrence of extreme events. TransGrid will take measures, where practicable, to minimise the impact of disturbances to the power system by implementing power system control systems at minimal cost in accordance with the NER.

A1.3 Protection Requirements

Basic protection requirements are included in the NER. The NER requires that protection systems be installed so that any fault can be detected by at least two fully independent protection systems. Backup protection is provided against breaker failure. Provision is also made for detecting high resistance earth faults.

Required protection clearance times are specified by the NER and determined by stability considerations as well as the characteristics of modern power system equipment. Where special protection facilities or equipment are required for high-speed fault clearance they are justified on either a NER compliance or a benefit/cost basis.

All modern distance protection systems on the main network include the facility for power swing blocking (PSB). PSB is utilised to control the impact of a disturbance that can cause synchronous instability. At the moment PSB is not enabled, except at locations where demonstrated advantages apply. This feature will become increasingly more important as the interconnected system is developed and extended.

A1.4 Transient Stability

In accordance with the NER transient stability is assessed on the basis of the angular swings following a solid fault on one circuit at the most critical location that is cleared by the faster of the two protections (with intertrips assumed in service where installed). At the main system level a two phase-to-ground fault is applied and on 132 kV systems which are to be augmented a three-phase fault is applied.

Recognition of the potential impact of a three-phase fault at the main system level is made by instituting maintenance and operating precautions to minimise the risk of such a fault.

The determination of the transient stability capability of the main grid is undertaken using software that has been calibrated against commercially available system dynamic analysis software.

Where transient stability is a factor in the development of the main network, preference is given to the application of advanced control of the power system or high-speed protection systems before consideration is given to the installation of high capital cost plant.

A1.5 Steady State Stability

The requirements for the control of steady state stability are included in the NER. For planning purposes steady state stability (or system damping) is considered adequate under any given operating condition if, after the most critical credible contingency, simulations indicate that the halving time of the least damped electromechanical mode of oscillation is not more than five seconds.

The determination of the steady state stability performance of the system is undertaken using software that has been calibrated against commercially available software and from data derived from the monitoring of system behaviour.

In planning the network, maximum use is made of existing plant, through the optimum adjustment of plant control system settings, before consideration is given to the installation of high capital cost plant.

A1.6 Line and Equipment Thermal Ratings

Line thermal ratings have often traditionally been based on a fixed continuous rating and a fixed short-time rating. TransGrid applies probabilistic-based line ratings, which are dependent on the likelihood of coincident adverse weather conditions and unfavourable loading levels. This approach has been applied to selected lines whose design temperature is about 100 degrees Celsius or less. For these lines a contingency rating and a short-time emergency rating have been developed. Typically the short-time rating is based on a load duration of 15 minutes, although the duration can be adjusted to suit the particular load pattern to which the line is expected to be exposed. The duration and level of loading must take into account any requirements for re-dispatch of generation or load control.

TransGrid is presently installing ambient condition monitors on critical transmission lines to enable the application of real-time line conductor ratings in the generation dispatch systems.

Transformers are rated according to their specification. Provision is also made for use of the short-time capability of the transformers during the outage of a parallel transformer or transmission line.

TransGrid owns two 330 kV cables and these are rated according to manufacturer's recommendations that have been checked against an appropriate thermal model of the cable.

The rating of line terminal equipment is based on manufacturers' advice.

A1.7 Reactive Support and Voltage Stability

It is necessary to maintain voltage stability, with voltages within acceptable levels, following the loss of a single element in the power system at times of peak system loading. The single element includes a generator, a single transmission circuit, a cable and single items of reactive support plant.

To cover fluctuations in system operating conditions, uncertainties of load levels, measurement errors and errors in the setting of control operating points it is necessary to maintain a margin from operating points that may result in a loss of voltage control. A reactive power margin is maintained over the point of voltage instability or alternatively a margin is maintained with respect to the power transfer compared to the maximum feasible power transfer.

The system voltage profile is set to standard levels during generator dispatch to minimise the need for post-contingency reactive power support

Reactive power plant generally has a low cost relative to major transmission lines and the incremental cost of providing additional capacity in a shunt capacitor bank can be very low. Such plant can also have a very high benefit/cost ratio and therefore the timing of reactive plant installations is generally less sensitive to changes in load growth than the timing of other network augmentations. Even so, TransGrid aims to make maximum use of existing reactive sources before new installations are considered.

TransGrid has traditionally assumed that all on-line generators can provide reactive power support within their rated capability but in the future intends to align with other utilities in relying only on the reactive capability given by performance standards. Reactive support beyond the performance standards may need to be procured under network support arrangements.

Reactive power plant is installed to support planned power flows up to the capability defined by limit equations, and is often the critical factor determining network capability. On the main network, allowance is made for the unavailability of a single major source of reactive power support in the critical area affected at times of high load, but not at the maximum load level.

It is also necessary to maintain control of the supply voltage to the connected loads under minimum load conditions.

The factors that determine the need for reactive plant installations are:

- In general it has proven prudent and economic to limit the voltage change between the pre and post-contingency operating conditions;
- It has also proven prudent, in general, and economic to ensure that the post-contingency operating voltage at major 330 kV busbars lies above a lower limit;
- The reactive margin from the point of voltage collapse is maintained to be greater than a minimum acceptable level;
- A margin between the power transmitted and the maximum feasible power transmission is maintained; and
- At times of light system load it is essential to ensure that voltages can be maintained within the system highest voltage limits of equipment.

At some locations on the main network relatively large voltage changes are accepted, and agreed with customers, following forced outages, providing voltage stability is not placed at risk. These voltage changes can approach, and in certain cases, exceed 10% at peak load.

On some sections of the network the possibility of loss of load due to depressed voltages following a contingency is also accepted. However there is a preference to install load shedding initiated by under-voltage so that the disconnection of load occurs in a controlled manner.

When determining the allowable rating of switched reactive plant the requirements of the NER are observed.

A1.8 Transmission Line Voltage and Conductor Sizes Determined by Economic Considerations

Consideration is given to the selection of line design voltages within the standard nominal 132 kV, 220 kV, 275 kV, 330 kV and 500 kV range, taking due account of transformation costs.

Minimum conductor sizes are governed by losses, radio interference and field strength considerations.

TransGrid strives to reduce the overall cost of energy and network services by the economic selection of line conductor size. The actual losses that occur are governed by generation dispatch in the market.

For a line whose design is governed by economic loading limits the conductor size is determined by a rigorous consideration of capital cost versus loss costs. Hence the impact of the development on generator and load marginal loss factors in the market is considered. For other lines the rating requirements will determine the conductor requirements.

Double circuit lines are built in place of two single circuit lines where this is considered to be both economic and to provide adequate reliability. Consideration would be given to the impact of a double circuit line failure, both over relatively short terms and for extended durations. This means that supply to a relatively large load may require single rather than double circuit transmission line construction where environmentally acceptable.

In areas prone to bushfire any parallel single circuit lines would preferably be routed well apart.

A1.9 Short-circuit Rating Requirements

Substation high voltage equipment is designed to withstand a maximum design short-circuit duty in accordance with the applicable Australian Standard.

Operating constraints are enforced to ensure equipment is not exposed to fault duties beyond the plant rating.

In general the short circuit capability of all of the plant at a site would be designed to match or exceed the maximum short circuit duty at the relevant busbar. In order to achieve cost efficiencies when augmenting an existing substation the maximum possible short-circuit duty on individual substation components may be calculated and applied in order to establish the adequacy of the equipment.

Short circuit duty calculations are based on the following assumptions:

- All main network generators that are capable of operating, as set out in connection agreements, are assumed to be in service;
- All generating units that are embedded in distribution networks are assumed to be in service;
- The maximum fault contribution from interstate interconnections is assumed;
- The worst-case pre-fault power flow conditions are assumed;
- Normally open connections are treated as open;
- Networks are modelled in full;
- Motor load contributions are not modelled at load substations; and
- Generators are modelled as a constant voltage behind sub-transient reactance.

At power station switchyards allowance is made for the contribution of the motor component of loads. TransGrid is further analysing the impact of the motor component of loads and is assessing the need to include such contributions when assessing the adequacy of the rating of load substation equipment.

A1.10 Substation Switching Arrangements

Substation switching arrangements are adopted that provide acceptable reliability at minimum cost, consistent with the overall reliability of the transmission network. In determining a switching arrangement, consideration is also given to:

- Site constraints;
- Reliability expectations with respect to connected loads and generators;
- The physical location of "incoming" and "outgoing" circuits;
- Maintenance requirements;
- Operating requirements; and
- Transformer arrangements.

TransGrid has applied the following arrangements in the past:

- Single busbar;
- Double busbar;
- Multiple element mesh; and
- Breaker-and-a-half.

In general, at main system locations, a mesh or breaker-and-a-half arrangement is now usually adopted.

Where necessary, the expected reliability performance of potential substation configurations can be compared using equipment reliability parameters derived from local and international data.

The forced outage of a single busbar zone is generally provided for. Under this condition the main network is planned to have adequate capability although loss of load may eventuate. In general the forced outage of a single busbar zone should not result in the outage of any base-load generating unit.

Where appropriate a 330 kV bus section breaker would ordinarily be provided when a second "incoming" 330 kV line is connected to the substation.

A 132 kV bus section circuit breaker would generally be considered necessary when the peak load supplied via that busbar exceeds 120 MW. A bus section breaker is generally provided on the low voltage busbar of 132 kV substations when supply is taken over more than two low voltage feeders.

A1.11 Autoreclosure

As most line faults are of a transient nature all of TransGrid's overhead transmission lines are equipped with autoreclose facilities.

Slow speed three-pole reclosure is applied to most overhead circuits. On the remaining overhead circuits, under special circumstances, high-speed single-pole autoreclosing may be applied.

For public safety reasons reclosure is not applied to underground cables.

Autoreclose is inhibited following the operation of breaker-fail protection.

A1.12 Power System Control and Communication

In the design of the network and its operation to designed power transfer levels, reliance is generally placed on the provision of some of the following control facilities:

- Automatic excitation control on generators;
- Power system stabilisers on generators and SVCs;
- Load drop compensation on generators and transformers;
- Supervisory control over main network circuit breakers;
- Under-frequency load shedding;
- Under-voltage load shedding;
- Under and over-voltage initiation of reactive plant switching;
- High speed transformer tap changing;
- Network connection control;
- Check and voltage block synchronisation;
- Control of reactive output from SVCs; and
- System Protection Schemes (SPS).

The following communication, monitoring and indication facilities are also provided where appropriate:

- Network wide SCADA and Energy Management System (EMS);
- Telecommunications and data links;
- Mobile radio;
- Fault locators and disturbance monitors;
- Protection signalling; and
- Load monitors.

Protection signalling and communication is provided over a range of media including pilot wire, power line carrier, microwave links and increasingly optical fibres in overhead earthwires.

A1.13 Scenario Planning

Scenario planning assesses network capacity, based on the factors described above, for a number of NEM load and generation scenarios. The process entails:

1. Identification of possible future load growth scenarios. These are generally based on the Baseline, High, and Low economic growth scenarios in the most recent TransGrid load forecast for NSW or the Statement of Opportunities, published by AEMO for other states. They can also incorporate specific possible local developments such as the establishment of new loads or the expansion of existing industrial loads.
2. Development of a number of generation scenarios for each load growth scenario. These generation scenarios relate to the development of new generators and utilisation of existing generators. This is generally undertaken by a specialist electricity market modelling consultant, using their knowledge of relevant factors, including:
   - Generation costs;
   - Impacts of government policies; and
   - Impacts of energy related developments such as gas pipeline projects.
3. Modelling of the NEM for load and generation scenarios to quantify factors which affect network performance, including:
   - Generation from individual power stations; and
   - Interconnector flows.
4. Modelling of network performance for the load and generation scenarios utilising the data from the market modelling.

The resulting set of scenarios is then assessed over the planning horizon to establish the adequacy of the system and to assess network and non-network augmentation options.

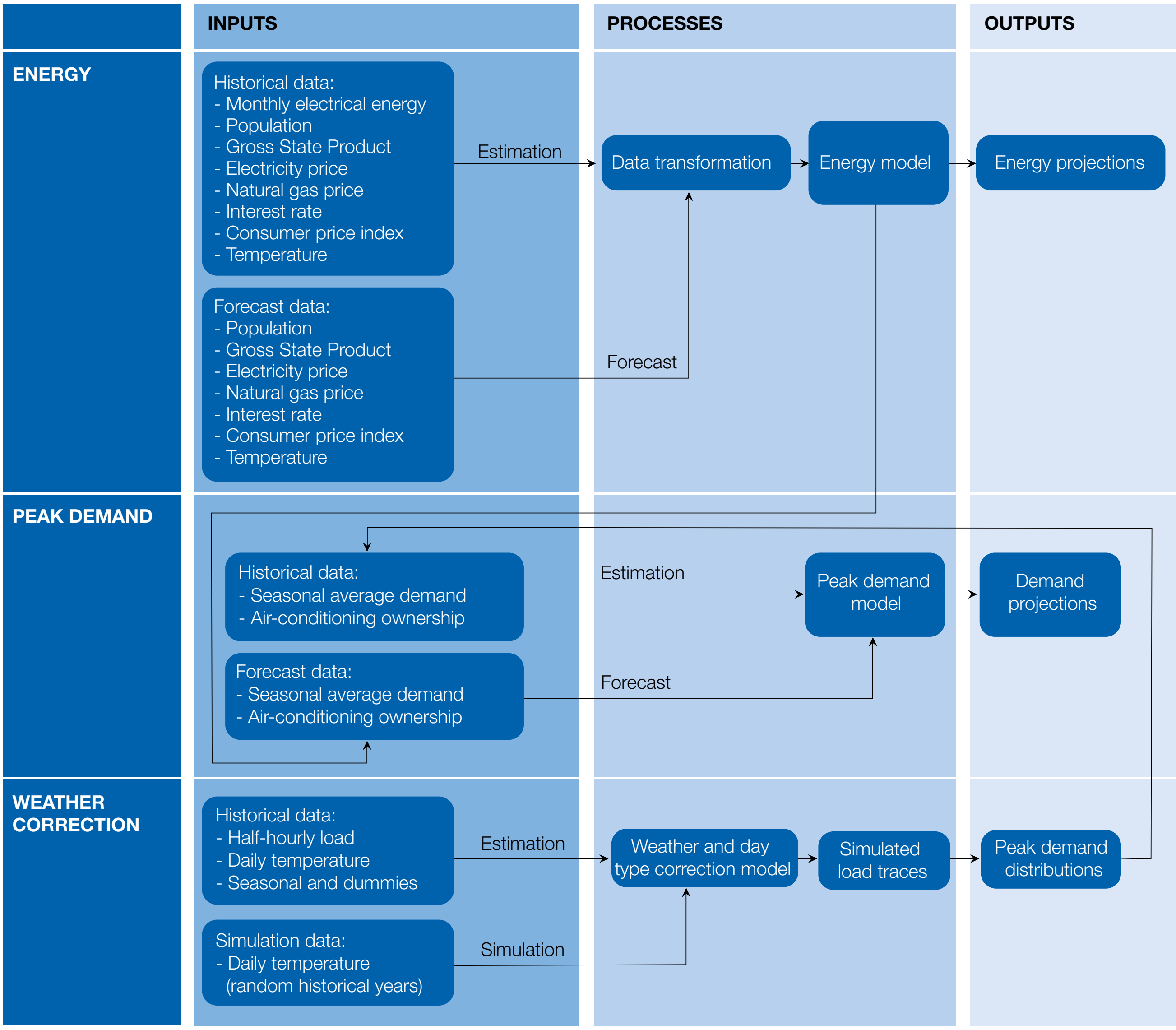
The future planning scenarios developed by TransGrid will take into account AEMO's future scenarios.

Appendix 2
TransGrid's Load Forecasting Process

A2.1 Overview

The process of preparing the energy and demand projections for the NSW region of the NEM is illustrated schematically in Figure A2.1 and the overall process is described below.

Figure A2.1 TransGrid's Load Forecasting Models



The Load Forecasting Reference Group (LFRG) by developing consistent definitions and input assumptions ensures that the regional energy and maximum demand projections throughout the NEM are developed by JPBs for inclusion in the Electricity Statement of Opportunities (ESOO) on a consistent basis.

Inputs to the overall process include the historical data that is used for estimating and testing the various models that are used. Future economic scenarios in these models are based on the information provided by the LFRG. Apart from this, assumptions on the future with regard to other independent variables are then applied to the models to produce the NSW energy and demand projections.

Several statistical models have been developed by TransGrid:

- The energy model relates electrical energy to demographic, economic, weather and day type variables;
- The weather and day type correction model conducts analysis on historical demands, day types and weather conditions to determine probability distributions of summer and winter demands for each year. The 10th, 50th and 90th percentiles of each distribution are selected to create historical series of 90 per cent, 50 per cent and 10 per cent Probability of Exceedance (POE) summer and winter demands. These series are then used to create future projections using peak demand models; and
- The peak demand models relate peak demand at the selected percentiles to average demand and an index of air-conditioning ownership. Therefore the projected demands are implicitly at their respective Probability of Exceedence (POE) level.

Forecasts of summer and winter peak demand at individual connection points are provided by Energy Australia, Integral Energy, Country Energy and ActewAGL for their respective distribution network areas across the NSW region of the NEM. These projections, which represent approximate 50th percentile POE demands, are aggregated by TransGrid incorporating appropriate allowances for network losses and the time diversity of peak demands throughout the NSW region. These aggregates are then compared to the top-down modelled demands for the NSW region produced by TransGrid.

A2.2 Input Assumptions

Information available up to the end of March 2010 was used to prepare the energy and demand projections published in this APR.

The definitions of NSW regional energy and demand used in this APR are the same as the corresponding definitions in the ESOO:

- NSW regional Native energy is defined as the sum of net energy output of Scheduled generators located within the region plus net interconnector energy flows into the region plus energy output from Semi-Scheduled and Non-Scheduled generators within the region; and
- NSW regional Native demand is defined as the half-hourly average of instantaneous loads that are the sum of net power output of Scheduled generators located within the region plus net interconnector power flows into the region plus power output from Semi-Scheduled and Non-Scheduled generators within the region.

These definitions therefore exclude generator and power station auxiliary loads but include all network losses.

KPMG Econtech, commissioned by AEMO, supplied projections of Baseline, High and Low scenarios of Semi-Scheduled and Significant Non-Scheduled generation as well as assumptions for Baseline, High and Low economic growth and price scenarios for each region of the NEM. The scenarios for New South Wales Region are shown in Table A2.1 on the next page.

Historical information regarding demand side participation (DSP) is collected via surveys undertaken by AEMO.

Customer connection point loads are measured at various metering points within TransGrid or customer electrical substations.

Modelling data uses various additional sources including Australian Bureau of Statistics, Bureau of Meteorology, Energy Supply Association of Australia, Australian Gas Association and the Reserve Bank of Australia.

Table A2.1 Economic Scenarios Underlying the 2010 Energy and Demand Projections[5]

	NSW Region Population (number)	NSW Region Gross State Product (2006-07 $m)	Consumer price index (index)	Nominal electricity prices (c/kwh)			Nominal gas price (index)	Standard variable home loan rate (per cent)
				Residential	Business	Total		
Historical data								
2006-07	7,227,775	357,822	156.2	15.7	10.4	11.8	209.1	7.6
2007-08	7,311,435	367,492	160.9	16.9	7.8	10.4	219.7	8.1
2008-09	7,398,615	369,027	165.9	18.4	8.2	11.0	233.2	9.5
Baseline scenario								
2009-10	7,489,519	374,829	168.5	18.5	7.9	10.8	244.8	5.8
2010-11	7,569,821	385,643	170.9	18.8	7.9	10.8	249.1	6.9
2011-12	7,644,602	397,593	175.0	20.3	8.4	11.5	260.0	6.1
2012-13	7,716,094	406,253	179.4	23.4	9.5	13.0	276.3	5.8
2013-14	7,787,907	416,576	183.1	24.0	9.8	13.2	283.8	5.6
2014-15	7,861,804	429,171	186.6	24.6	10.1	13.5	289.8	5.6
2015-16	7,937,937	441,269	191.0	25.4	10.5	13.9	298.5	5.9
2016-17	8,013,804	451,106	196.5	26.3	10.9	14.4	312.3	6.2
2017-18	8,089,287	459,275	202.6	27.3	11.4	14.9	330.0	6.5
2018-19	8,164,355	467,396	208.4	28.3	11.9	15.4	348.0	6.7
2019-20	8,239,017	476,454	213.4	29.3	12.3	15.9	363.3	6.7
High scenario								
2009-10	7,491,284	375,143	168.4	18.5	7.9	10.9	245.0	5.8
2010-11	7,576,590	385,983	169.8	18.7	7.8	10.8	250.1	6.7
2011-12	7,662,909	398,815	171.7	19.9	7.9	11.2	257.2	5.5
2012-13	7,749,411	407,959	173.6	22.6	9.3	12.9	270.3	5.0
2013-14	7,839,786	419,358	174.8	22.9	9.3	13.0	270.7	4.6
2014-15	7,935,878	434,846	175.7	23.2	9.4	13.1	269.4	4.6
2015-16	8,034,695	450,392	177.9	23.7	9.7	13.3	271.9	4.8
2016-17	8,133,728	463,324	181.8	24.3	10.1	13.7	281.0	5.2
2017-18	8,232,848	473,588	186.5	25.1	10.5	14.1	294.6	5.5
2018-19	8,332,012	484,711	191.0	25.8	10.8	14.5	307.7	5.6
2019-20	8,431,213	498,464	194.4	26.3	11.1	14.8	317.1	5.7
Low scenario								
2009-10	7,479,028	374,401	168.5	18.5	7.9	10.8	243.2	5.8
2010-11	7,545,524	384,979	171.3	18.8	7.9	10.7	245.6	6.9
2011-12	7,599,929	396,583	176.0	20.4	8.4	11.4	257.4	6.0
2012-13	7,647,569	405,906	180.5	23.6	9.3	12.6	273.4	5.7
2013-14	7,691,980	416,086	184.3	24.5	9.6	12.9	285.9	5.6
2014-15	7,734,848	426,842	188.4	25.5	10.1	13.4	300.4	5.9
2015-16	7,779,465	435,347	194.4	26.7	10.8	14.1	319.6	6.3
2016-17	7,823,342	440,753	202.9	28.1	11.4	14.8	343.6	6.8
2017-18	7,866,382	444,326	213.2	29.5	12.0	15.5	368.7	7.2
2018-19	7,908,567	449,162	223.8	30.7	12.6	16.1	390.2	7.4
2019-20	7,949,919	455,775	232.9	31.8	13.0	16.6	406.2	7.4

[5] Sources:

1. Estimated resident population is the average of 4 quarters published by ABS, with KPMG projections from their MM2 model.
2. GSP or Gross State Product estimates are sourced from the ABS and KPMG.
3. Sydney CPI is the ABS Consumer price index, Sydney, average of 4 quarters.
4. Nominal electricity and gas prices are from ESAA, “Electricity prices in Australia”, ABS, KPMG and AER.
5. Standard variable home loan interest rate is sourced from the RBA website

A2.3 Energy Model

Electricity is consumed as a consequence of many separate decisions by consumers to utilise electrical appliances. Overall consumption may be related to distinct short and long run consumer behaviour. In the short run the consumption of electrical energy is limited by the total stock of appliances. Economic considerations, such as the price of electricity and disposable income of appliance users are related to the degree of utilisation. For cooling and heating appliances the ambient temperature (or other weather conditions) determines the time, duration and intensity of use. The use of other appliances, such as lights, may be indirectly related to weather conditions due to a broad correlation between daylight hours and the season of the year. However, in the long run electricity consumption changes as a result of the changing stock of appliances where the long run decision to purchase new and different types of appliances depends on new technology and on considerations such as the initial purchase cost, running costs (energy savings) and, where relevant, the cost of alternative fuels.

TransGrid's empirical energy model simulates this real-world behaviour by relating the consumption of electrical energy to broad economic aggregates and separates the short and long run aspects of electricity consumption. The model has been re-estimated using up to date data and has undergone rigorous testing before the 2010 projections were finalised.

The model explains monthly 'Native'[6] energy per capita in New South Wales, net of major industrial loads, in terms of the real electricity price, the real price of natural gas from when it became available, real income per capita, the real interest rate and cooling and heating degree days. The projections are therefore dependent on assumptions about future values of these explanatory variables or their components, including resident population, real gross State product, nominal price and interest rate trajectories, air-conditioning ownership and inflation. The model results have been adjusted ex-post to allow for the phasing out of greenhouse intensive water heaters, introduction of NSW Energy Savings Scheme and phasing out of incandescent light bulbs. Additional allowances have been incorporated for the operation of NSW desalination plant.

The main characteristics of the energy model are shown in Table A2.2 (variables) and Table A2.3 (summary statistics).

Table A2.2 NSW Energy Model Variables

Variable	Type
Per Capita Native Energy Consumption minus directly connected industrial load	Dependent
Estimated resident population of New South Wales and the Australian Capital Territory	Independent
Average retail electricity price divided by the Sydney CPI	Independent
Average retail price of natural gas divided by the Sydney CPI	Independent
Per Capita real Gross State Product for NSW and the ACT	Independent
Standard variable mortgage interest rate minus the yearly change in the Sydney CPI	Independent
The number of working days per month	Independent
The number of hours in the current month	Independent
Index of air-conditioning ownership	Independent
The divergence of daily average temperatures above 21 degrees aggregated over the month	Independent
The divergence of daily average temperatures below 18 degrees aggregated over the month	Independent
Dummy variables representing seasonal effects	Independent

Table A2.3 NSW Energy Model Summary Statistics

Statistic	Value	Statistic	Value
R-squared	0.954	Mean dependent variable	0.001
Adjusted R-squared	0.950	S.D. dependent variable	0.044
S.E. of regression	0.009	Akaike info criterion	-6.348
Sum squared residual	0.036	Schwarz criterion	-6.019
Log likelihood	1354.372	F-statistic	240.5718
Durbin-Watson statistic	1.5	Prob (F-statistic)	0.00

[6] Native energy and demand have been defined by LFRG as the overall regional generation requirement, inclusive of identifiable Semi-Scheduled and Significant Non-Scheduled generators.

A2.4 Weather and Day Type Correction Model

Weather and day type correction consists of adjusting historical demands that were recorded under different weather and day type conditions so that they approximate the demands that would have occurred under standard (weather and day type) conditions. It is a critical preliminary step in the medium to longer term forecasting of peak demand because projected demands implicitly occur under the same standard weather and day type conditions as the historical data upon which they are based. Given the impossibility of forecasting daily weather conditions several years into the future, projected future demands are more useful to planners when they are referenced to standard conditions. In the NEM, regional demand projections are presented on a probabilistic basis. That is, the standard conditions underlying the weather and day type correction process are defined on the basis of specific probabilities of the demands occurring under such conditions. This allows regional demand projections to be provided on the basis of 10 per cent, 50 per cent and 90 per cent probability of exceedence (POE).

The demand for electricity in the NSW region is correlated with prevailing weather conditions as in other parts of the world. The attributes of weather may include ambient temperature, humidity, solar radiation and wind speed, combinations of which can all affect human comfort. This in turn motivates the installation and adjustment of air-conditioning control systems and other electrical cooling and heating appliances within buildings. However, the data for the NSW region suggests that ambient temperature is the most significant attribute of 'weather' in this region for temperature correction purposes. The overall correlation between demand and temperature during the year is also highly non-linear with both very high and very low temperatures resulting in high levels of demand. However these relationships are linear-approximated for load forecasting purposes through separate analysis of high and low temperature effects.

Weather is not the only reason for short term fluctuations in demand although most non-weather influences are attributable to regular daily or seasonal behaviour patterns, different day types or moving holidays. These periodic patterns are amenable to seasonal analysis as part of the weather and day type correction process.

Historically recorded demands are converted to standard conditions using the following steps:

1. An empirical model is estimated of the relationship between demand, weather and seasonal dummy variables; and
2. The estimated model is used to predict what demand would have been at the standard percentiles of its statistical distribution.

The weather and day type correction process underlying the 2010 demand projections used daily maximum demands between November 1991 and March 2010.

The main characteristics of the weather and day type correction model are shown in Table A2.4 (variables) and Table A2.5 (summary Statistics).

Table A2.4 NSW Weather and Day Type Correction Model Variables

Variable	Type
Per Capita Peak Native Demand minus directly connected industrial load	Dependent
Estimated resident population of New South Wales and the Australian Capital Territory	Independent
Average retail electricity price divided by the Sydney CPI	Independent
Average retail price of natural gas divided by the Sydney CPI	Independent
Per Capita real Gross State Product for NSW and the ACT	Independent
Standard variable mortgage interest rate minus the yearly change in the Sydney CPI	Independent
Index of air-conditioning ownership	Independent
The divergence of daily average temperatures above 21 degrees aggregated over the month	Independent
The divergence of daily average temperatures below 18 degrees aggregated over the month	Independent
12 seasonal terms	Independent
Dummy variables for summer, autumn and winter which reflect relative differences to spring	Independent
A dummy variable for the approximately 2-week period from Christmas to 14 January	Independent
Dummy variables for days of the week	Independent
Separate dummy variables for each public holiday	Independent
Autoregressive correction terms which take account of error patterns	Independent

Table A2.5: NSW Weather and Day Type Correction Model Summary Statistics

Statistic	Value	Statistic	Value
R-squared	0.953	Mean dependent variable	1.182
Adjusted R-squared	0.952	S.D. dependent variable	0.181
S.E. of regression	0.039	Akaike info criterion	-3.621
Sum squared residual	10.30	Schwarz criterion	-3.573
Log likelihood	12131.71	Hannan-Quinn criterion	-3.605
F-statistic	2902.569	Durbin-Watson statistic	2.00
Prob (F-statistic)	0.00		

An important consideration in the weather and day type correction model is the choice of weather variable. Since combining temperature with measures of humidity, solar radiation and/or wind speed were shown not to improve the statistical correlation with maximum demand, temperature alone has been used to measure ‘weather’. There is a high degree of collinearity amongst the weather variables themselves, so temperature variation forms a reasonable proxy for most of the variation in other weather variables.

The NSW region demand is generally correlated with temperature measured at Parramatta in summer and at Sydney in winter. Weighted average combinations of the daily mean temperature are used in each case to reflect the lagged effect on the day’s demand of temperatures on that day and immediately preceding days. The construction of these temperature measures is outlined in Table A2.6 below. Cooling and heating degrees were created using the weighted average temperatures shown in this table, with change points of 21 degrees for summer and 18 degrees for winter.

Table A2.6: Construction of Weighted Average Temperature Measures for Summer and Winter

	Bureau of Meteorology observation station	Definition of mean daily temperature	Weights used for current and preceding days
Summer days	Parramatta North (station # 66124)	Maximum to 3pm and minimum to 9am on the same day	0.85 current day 0.15 previous day
Winter days	Sydney Observatory Hill (station # 66062)	Maximum to 3pm and minimum to 9am on the following day	0.65 current day 0.25 previous day 0.10 day before previous

A2.5 Determination of Historical POE Levels

After applying the weather and day type correction model a probabilistic determination of historical POE levels was made. Fifty one different weather scenarios were created using actual weather data from 1959 to 2010 and applied to the period under analysis (1991 to 2010). Using errors from the weather normalisation equation, multiple alternative simulated error patterns were created and applied to each of the weather scenarios resulting in a series of alternative load profiles. Peak summer and winter demands were extracted from the simulations from which the required POE levels were calculated.

The 2010 weather and day type corrected peak demands are compared with actual peak demands in Figures A2.2 and A2.3. The actual summer 2009-10 peak demand was at a 64 per cent POE level (exceeded in 64 out every 100 simulations). The actual winter 2009 peak demand was extremely low compared to last year possibly due to a combination of 'weather effect' (to a larger extent) and the effect of a downturn in the NSW economy (to a lesser extent). The winter actual peak demand was around 99 per cent POE level (exceeded in 99 out every 100 simulations).

Figure A2.2: Historical Summer Peak Demand and Estimated Historical 10%, 50% and 90% POE Summer Demand

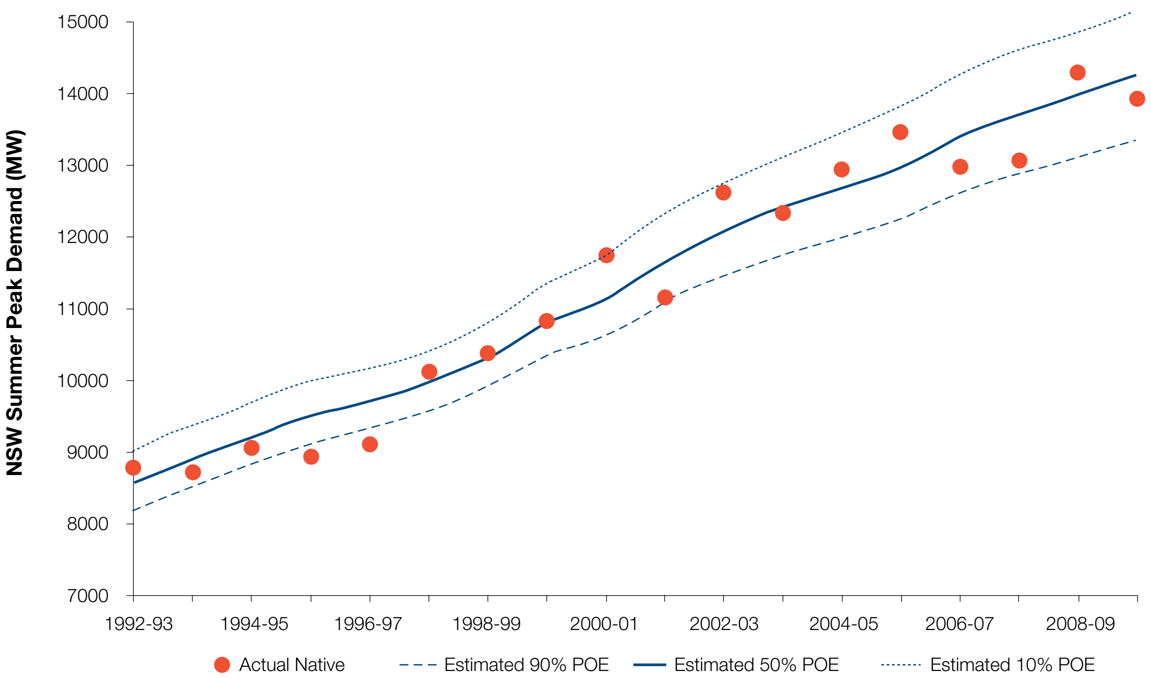
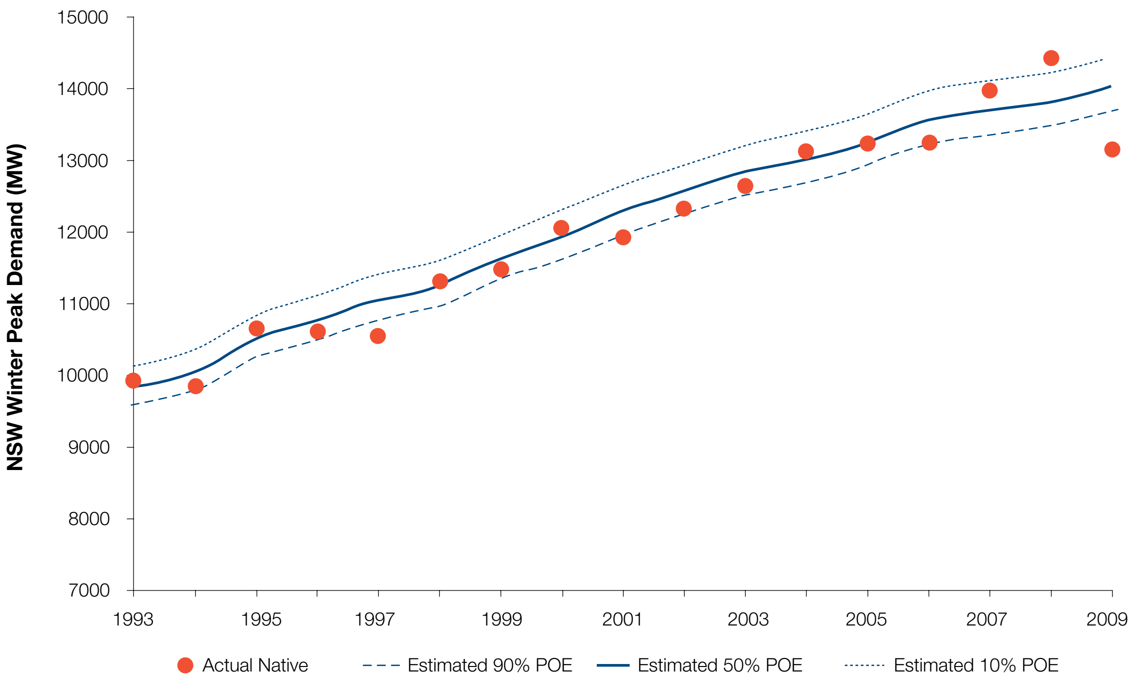


Figure A2.3: Historical Winter Peak Demand and Estimated Historical 10%, 50% and 90% POE Winter Demand



A2.6 Demand Models

Models of peak demand for summer and winter were estimated using each respective 10 per cent, 50 per cent and 90 per cent POE historical series. The models relate each season's peak demand to (weather normalised) average demand throughout the season and an index of air-conditioning. The air-conditioning index, as with the energy and weather normalisation models, is based on actual data supplied by Energy Efficient Strategies[7]. As with the energy model direct transmission-connected industrial loads were excluded from the model estimation and forecasting process but these loads are included in the projections. The results from the modelling have been adjusted ex-post to allow for the phasing out of greenhouse intensive water heaters, introduction of NSW Energy Savings Scheme and phasing out of incandescent light bulbs. Additional allowances have been incorporated for the operation of NSW desalination plant.

The main characteristics of the 2010 summer 10 per cent POE peak demand model are shown in Table A2.7 (variables) and Table A2.8 (summary Statistics).

Table A2.7 NSW Summer Demand Model Variables

Variable	Type
Summer Peak Native Demand minus directly connected industrial load	Dependent
Average Summer Demand	Independent
Index of air-conditioning ownership	Independent

[7] Energy Efficient Strategies (2006) *Status of Air Conditioners in Australia – Updated with 2005* Data, Report for NAEEEC 2005/09 (updated), January, http://www.energyrating.gov.au/library/details200509-ac-aust.html.

Table A2.8: NSW Summer Demand Model Summary Statistics

Statistic	Value	Statistic	Value
R-squared	0.997	Mean dependent variable	10305
Adjusted R-squared	0.996	S.D. dependent variable	2183.1
S.E. of regression	135	Akaike info criterion	12.78
Sum squared residual	329749	Schwarz criterion	12.93
Log likelihood	-131	Hannan-Quinn criterion	12.81
F-statistic	2592	Durbin-Watson statistic	1.4
Prob (F-statistic)	0.00		

A2.7 Out-of-sample Forecasting Performance

Energy Model

The energy model's forecasting performance was tested for out-of-sample forecasting. This involves re-estimating the model using only data that was available six years ago, then producing forecasts from the re-estimated model for the intervening historical period. Actual population, price, economic and weather data were used so that the variations between actual and predicted energy reflect model error only. The results are shown in Figure A2.4 and Table A2.9 where the projections include cumulative error from July 2003.

Figure A2.4 NSW Energy Model Out-of-sample Forecast Performance

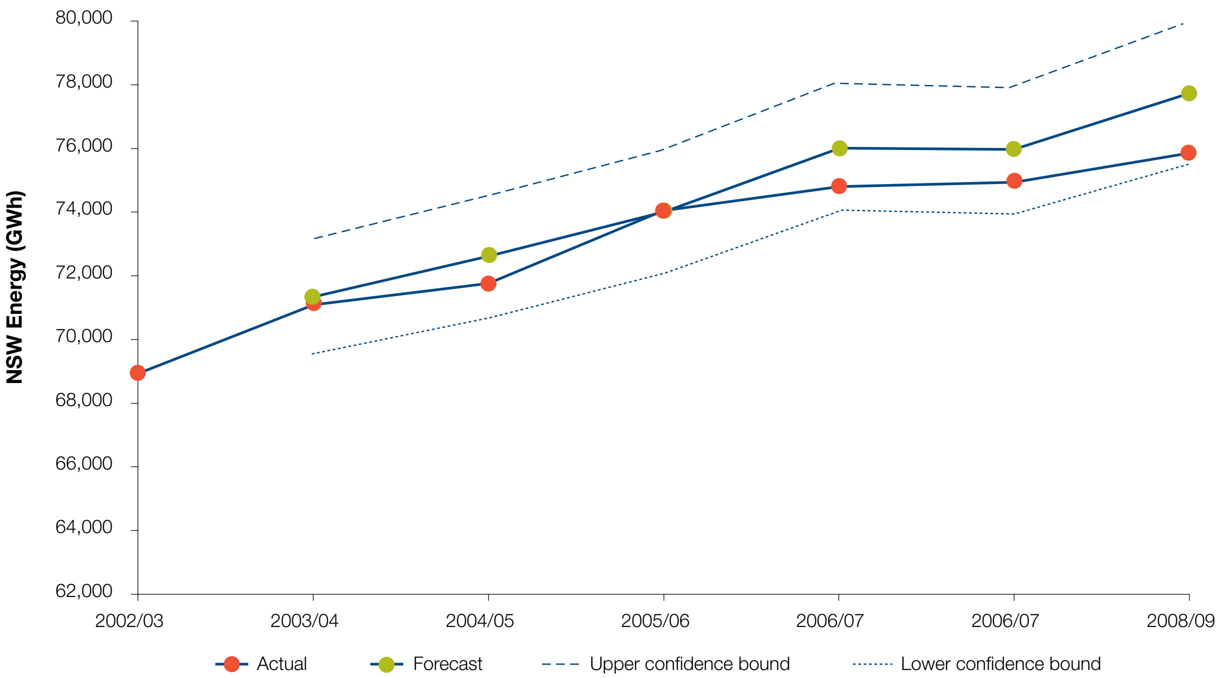


Table A2.9 NSW Energy Model Out-of-sample Forecast Performance Statistics

Performance Indicator	Value
Forecast Identifier	ESO
Forecast sample	2003-04 to 2008-09
Included observations	6
Root Mean Squared Error	1,058
Root Mean Squared Percentage Error	1.43
Mean Absolute Error	862
Mean Absolute Percentage Error	1.16
Theil Inequality Coefficient	0.007
Bias Proportion	0.655
Variance Proportion	0.170
Covariance proportion	0.174

Demand Model

As with the energy model the summer and winter peak demand models were tested for out-of-sample forecasting performance by re-estimating over a shorter time period and producing predictions over the intervening period of history. The results are shown in Figure A2.5, Table A2.10, Figure A2.6, and Table A2.11. The predictions are made commensurate with actual input variable conditions, including weather, so that the variations from actual peak demands reflect modelling errors only.

Figure A2.5 NSW Summer Demand Model Out-of-sample Forecast Performance

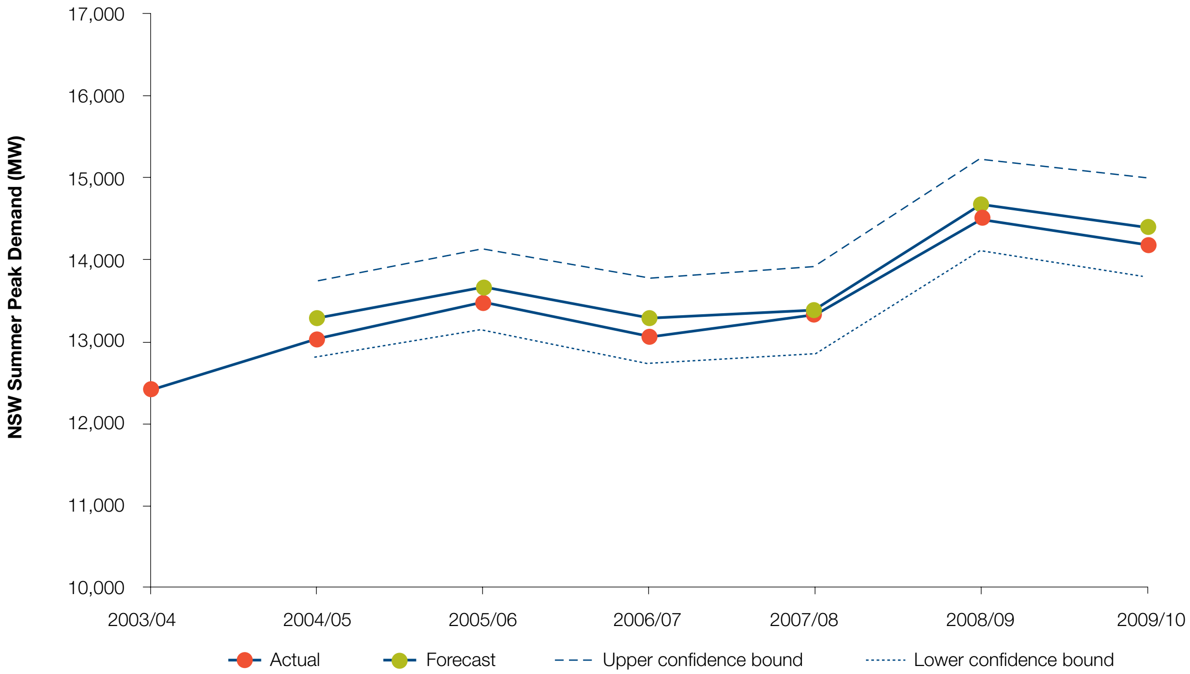


Table A2.10: NSW Summer Demand Model Out-of-sample Forecast Performance Statistics

Performance Indicator	Value
Forecast Identifier	PD(SUMMER)
Forecast sample	2004-05 to 2009-10
Included observations	6
Root Mean Squared Error	174
Root Mean Squared Percentage Error	1.29
Mean Absolute Error	161
Mean Absolute Percentage Error	1.20
Theil Inequality Coefficient	0.006
Bias Proportion	0.857
Variance Proportion	0.000
Covariance proportion	0.143

Figure A2.6 NSW Winter Demand Model Out-of-sample Forecast Performance

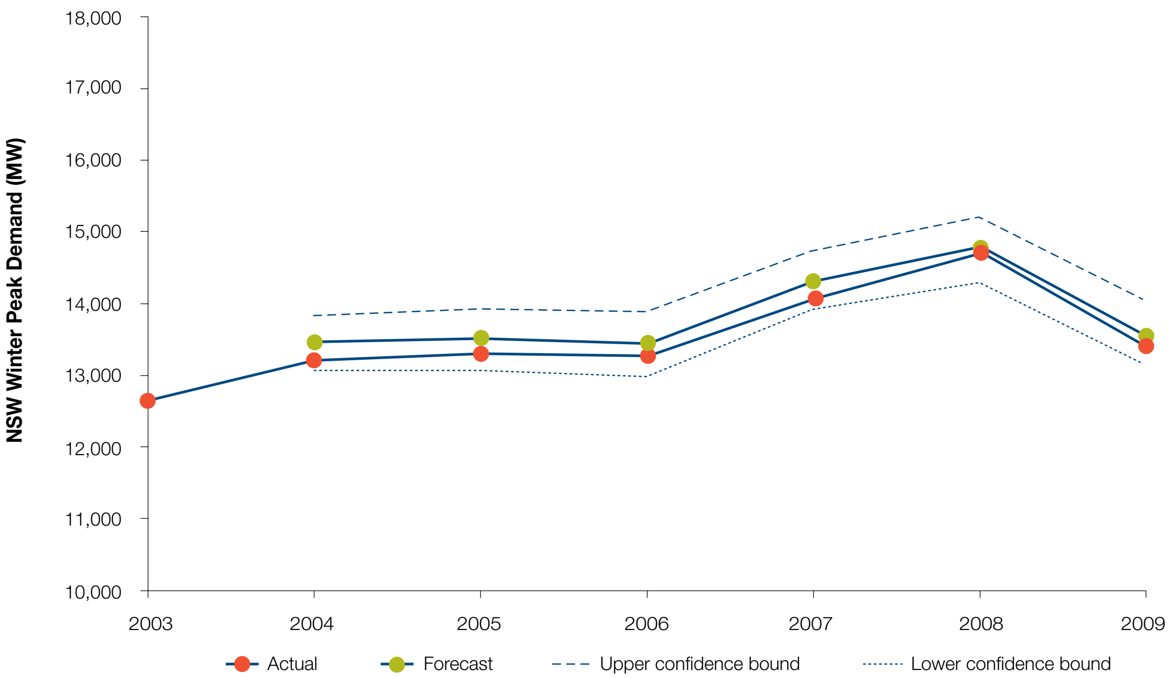


Table A2.11: NSW Winter Demand Model Out-of-sample Forecast Performance Statistics

Performance Indicator	Value
Forecast Identifier	PD(WINTER)
Forecast sample	2004 to 2009
Included observations	6
Root Mean Squared Error	189
Root Mean Squared Percentage Error	1.40
Mean Absolute Error	176
Mean Absolute Percentage Error	1.32
Theil Inequality Coefficient	0.007
Bias Proportion	0.866
Variance Proportion	0.022
Covariance proportion	0.112

A2.8 Compatibility of Modelled Projections and Aggregated Connection Point Forecasts

Projections of summer and winter demand at individual connection points between TransGrid's network and the relevant customer have been provided by either the responsible DNSP or the direct end-use customer. These projections are not necessarily produced on the same basis as the overall NSW projections produced by TransGrid. In particular certain connection point projections:

- May not have been provided on the basis of a reported economic scenario or exact POE condition;
- May have been based on a dataset with a different historical timeframe to that which the overall NSW projections employ;
- Indicate the likely peak at that location, whenever it may occur, rather than the contribution to the overall NSW peak; and
- Generally assume that only Scheduled embedded generation is operating at the time of peak.

Unlike the TransGrid projections of overall NSW peak demand none of the connection point loads include transmission losses or power used by generator auxiliaries (by definition). Despite these drawbacks the individual connection point projections for each season can be aggregated to provide a useful point of comparison with the overall NSW seasonal demand projections. TransGrid therefore attempts to account for some of the aforementioned limitations by:

- Using 50% POE forecasts where they are available and where they are not, assuming that individual connection point projections are likely to have been based on enough historical data to converge towards an approximate 50 per cent POE projection;
- 'Diversifying' individual connection point projections to allow for time diversity observed between historical local seasonal peak demand and NSW peak demand;
- Incorporating loss factors, which are also derived from historical observations, into the aggregate DNSP connection point projections; and
- Adding forecast aggregate industrial loads not included in the DNSP forecasts.

After making adjustments for diversity and network losses TransGrid's 10 per cent POE and 50 per cent POE (Baseline scenario) projections of summer and winter peak demand are compared to the aggregate DNSP (connection point) projections. For the purpose of these comparisons diversity factors have been derived based on historical loads. This allows aggregated connection point peak demand projections to be adjusted to provide a comparison with the NSW region peak demand. Loss factors are estimated by comparing historical NSW regional peak demands against an aggregation of connection point loads that occurred at the same time.

Figure A2.7 TransGrid and Aggregate DNSP Projections of NSW Summer Peak Demand

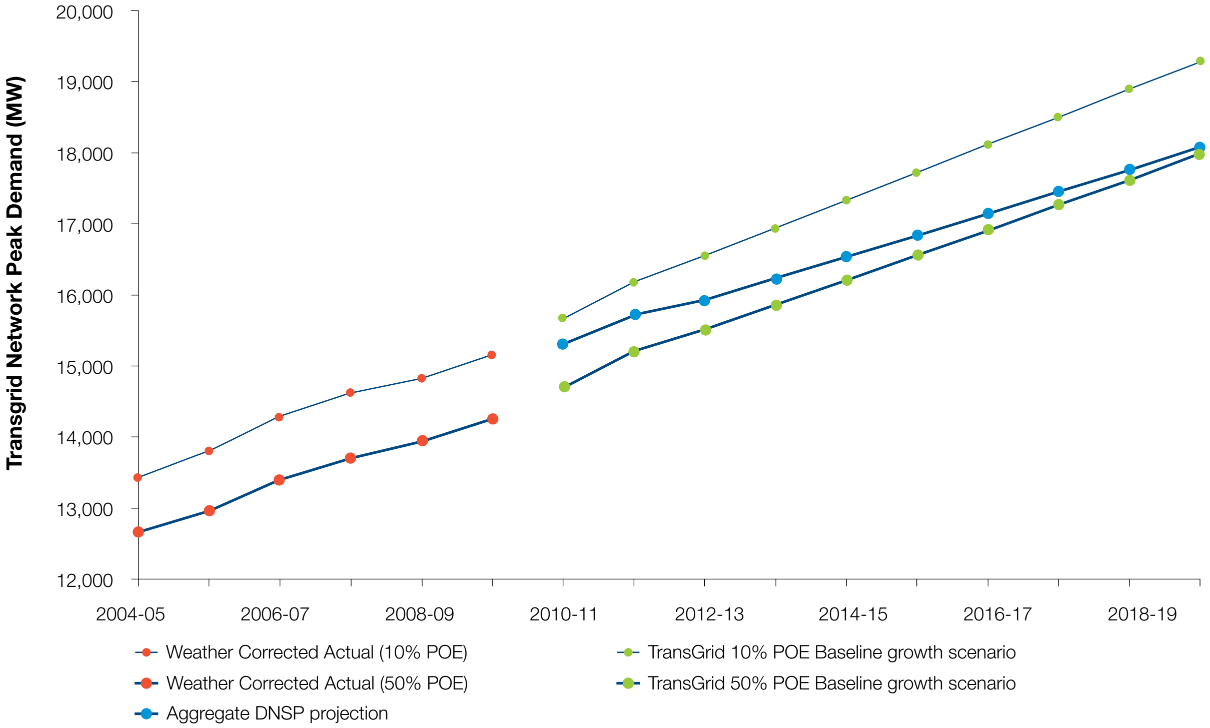


Figure A2.7 shows the NSW Summer DNSP projection, aggregated as described above, and TransGrid's 10 per cent and 50 per cent POE projections. The chart shows the aggregate DNSP projection growing at a lower rate on average than the TransGrid projections for NSW over the forecast horizon. The DNSP projections grow at a slightly higher rate in the initial years of the forecast period but align with TransGrid's 50 per cent POE level Baseline scenario projection in the later years. This may in part arise from changing load diversity and losses. However, it may also be attributable to the fundamental difference in approach between TransGrid's top-down econometric demand forecast and the methodologies adopted by each of the DNSPs in developing their individual connection point forecasts. Therefore these two different approaches can produce different results.

Figure A2.8 TransGrid and Aggregate DNSP Projections of NSW Winter Peak Demand

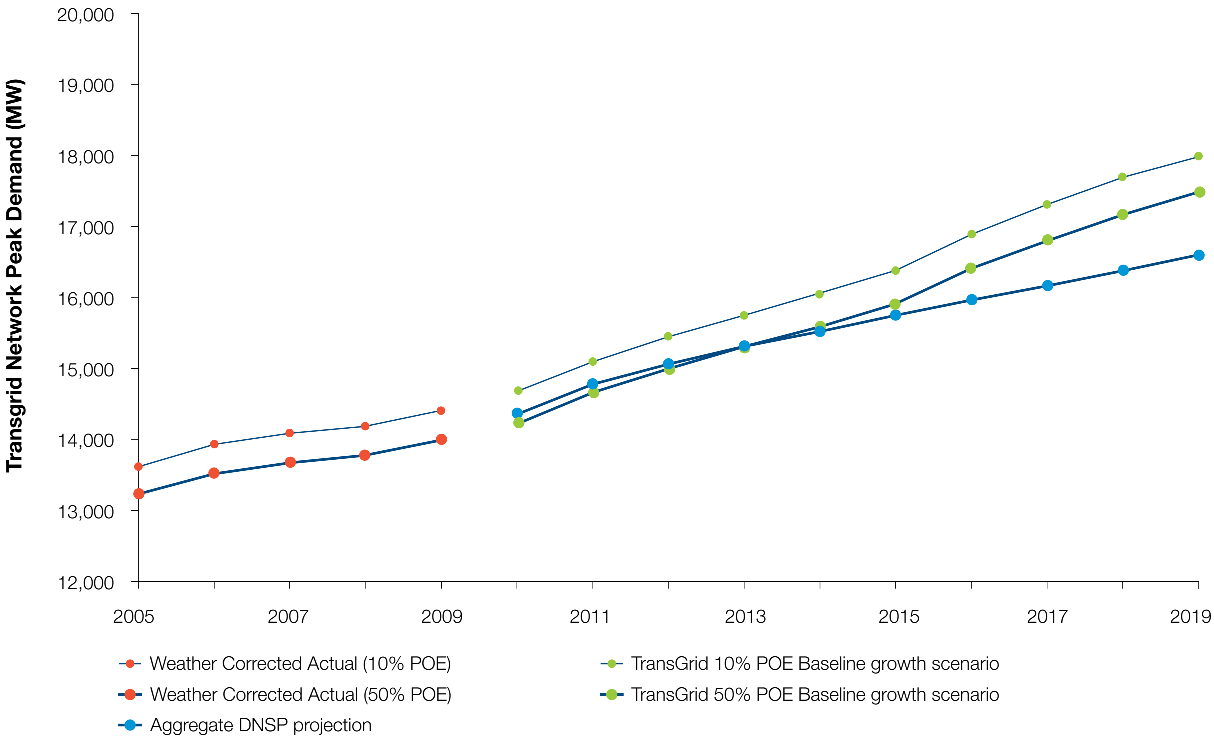


Figure A2.8 shows the NSW Winter DNSP projection, aggregated as described above, and TransGrid's 10 per cent and 50 per cent POE projections. The chart shows the aggregate DNSP projection lying within TransGrid's 10% and 50% POE band in the initial forecast years and slowing down in the later forecast years. The differences as mentioned above stem from a divergence in approaches between TransGrid's top-down econometric demand forecast and the methodologies adopted by each of the DNSPs in developing their individual connection point forecasts.

Table A2.12 presents the average annual growth rates for the summer and winter peak demand projections. The growth rates for the top down forecasts developed by TransGrid are slightly higher than those of the aggregated DNSP results for both summer and winter. The differences might be due to a variance in economic assumptions adopted by TransGrid compared to those of the individual DNSPs. However, TransGrid's future growth rates of summer and winter peak demand align well with the actual historical growth rates. (See Summer and Winter Peak Demand Tables in Appendix 3).

Table A2.12 Comparisons of TransGrid and Aggregate DNSP Peak Demand Projections (Average Annual Growth)

	DNSP 50% POE		TransGrid 50% POE		TransGrid 10% POE	
	MW	%	MW	%	MW	%
Summer	309	1.9%	365	2.3%	401	2.3%
Winter	247	1.6%	359	2.3%	370	2.3%

Appendix 3
Detailed Energy, Demand and Individual Connection Point Projections

TransGrid is responsible for producing aggregate Native energy and peak demand projections for the NSW region of the NEM, which includes the state of New South Wales and the ACT. These projections result from the process outlined in Appendix 2. Baseline scenario projections are detailed in Tables A3.1 to A3.3 of this appendix.

In Table A3.1 “End-use Sales” attempts to measure electricity sold by retailers for end-use consumption in NSW and the ACT. Actual data is from ESAA. The “End-use Sales” energy projection is not separately modelled but calculated as follows:

End-use Sales = [Energy Supplied at connection points (Scheduled generation only)] / 1.03

+ Embedded Scheduled and Non-Scheduled generation

Where 1.03 is a distribution loss factor.

Tables A3.2 and A3.3 provide summer and winter maximum demand projections for the Baseline scenario.

Tables A3.4 and A3.5 provide the High and Low scenarios of the NSW Region Semi-scheduled and Non-scheduled generation – historical and projected capacity, Demand at time of NSW Region peak and Energy. The Baseline scenario of these tables is presented in Chapter 4.

TransGrid’s customers have also provided peak demand projections, in terms of both MW and MVAr, for individual connection points between the NSW transmission network and the relevant customer’s network. These projections are produced using various methodologies which are likely to have been tailored according to several factors including the degree of local knowledge and availability of historical data. These projections are contained in Tables A3.6 to A3.15 of this appendix.

Certain large and relatively stable industrial loads that TransGrid isolates for its own modelling purposes have also been removed from the connection point projections and aggregated. This impacts the projections shown for the Dapto, Newcastle and Waratah West connection points. Aggregate projections for all identified major industrial loads are presented in Tables A3.16 and A3.17.

Note that Tables A3.6 to A3.17 represent projections of maximum demand occurring during a particular season at a particular connection point (or group of connection points) to the NSW transmission network. They do not represent projections of demand contributions at these connection points to the overall NSW region peak demand.

Table A3.1: NSW Region Energy Projections (Baseline Scenario)

Financial year		As generated at power stations (GWh)	Excluding power station auxilliaries (GWh)	Excluding transmission losses (GWh)	End-use sales (GWh)
1998-99	actual	65,602	62,723	59,418	59,544
1999-00	actual	67,784	63,861	61,532	60,949
2000-01	actual	69,529	66,283	63,352	61,761
2001-02	actual	70,541	67,331	63,587	62,162
2002-03	actual	72,269	68,931	65,424	63,781
2003-04	actual	74,599	71,127	67,514	65,204
2004-05	actual	75,428	71,727	68,012	67,199
2005-06	actual	77,929	74,041	70,607	68,910
2006-07	actual	79,130	74,790	71,744	70,710
2007-08	actual	79,447	74,992	71,942	70,910
2008-09	actual	80,075	75,857	73,216	72,160
2009-10	estimated	79,952	75,421	72,717	71,679
2010-11	projection	82,142	77,720	74,473	73,398
2011-12	projection	84,531	80,098	77,097	75,994
2012-13	projection	85,710	81,187	78,330	77,190
2013-14	projection	86,319	81,657	78,796	77,648
2014-15	projection	88,022	83,241	80,548	79,390
2015-16	projection	89,972	84,983	82,409	81,211
2016-17	projection	91,526	86,389	83,805	82,577
2017-18	projection	92,754	87,468	84,825	83,557
2018-19	projection	94,100	88,705	86,032	84,735
2019-20	projection	96,476	90,962	88,329	87,002
2000-01 to 2009-10		1.6%	1.4%	1.5%	1.7%
2010-11 to 2019-20		1.8%	1.8%	1.9%	1.9%
2005-06 to 2010-11		1.1%	1.0%	1.1%	1.3%
2010-11 to 2015-16		1.8%	1.8%	2.0%	2.0%

Table A3.2: NSW Region Summer Demand Projections (Baseline Scenario)

Year	Actual (MW)	90% POE Projection (MW)	50% POE Projection (MW)	10% POE Projection (MW)
1999-00	10,826			
2000-01	11,739			
2001-02	11,155			
2002-03	12,621			
2003-04	12,311			
2004-05	12,946			
2005-06	13,462			
2006-07	12,981			
2007-08	13,071			
2008-09	14,288			
2009-10	14,051			
2010-11		13,767	14,687	15,657
2011-12		14,209	15,169	16,169
2012-13		14,504	15,504	16,544
2013-14		14,807	15,847	16,927
2014-15		15,122	16,202	17,322
2015-16		15,434	16,554	17,714
2016-17		15,751	16,911	18,101
2017-18		16,073	17,273	18,493
2018-19		16,394	17,624	18,884
2019-20		16,716	17,976	19,266
2000-01 to 2009-10	2.0%			
2010-11 to 2019-20		2.2%	2.3%	2.3%
2005-06 to 2010-11	1.8%			
2010-11 to 2015-16		2.3%	2.4%	2.5%

Table A3.3: NSW Region Winter Demand Projections (Baseline Scenario)

Year	Actual (MW)	90% POE Projection (MW)	50% POE Projection (MW)	10% POE Projection (MW)
2000	12,064			
2001	11,927			
2002	12,321			
2003	12,641			
2004	13,107			
2005	13,186			
2006	13,166			
2007	13,985			
2008	14,368			
2009	13,091			
2010		13,877	14,236	14,655
2011		14,278	14,648	15,077
2012		14,629	14,999	15,448
2013		14,914	15,293	15,742
2014		15,187	15,586	16,045
2015		15,501	15,900	16,369
2016		16,002	16,411	16,900
2017		16,388	16,807	17,316
2018		16,749	17,178	17,697
2019		17,030	17,469	17,988
2020		17,421	17,870	18,409
2001 to 2010	2.0%			
2011 to 2020		2.2%	2.2%	2.2%
2006 to 2011	1.5%			
2011 to 2016		2.3%	2.3%	2.3%

Table A3.4: NSW Region Semi-Scheduled and Non-scheduled Generation: Historical and Projected Capacity, Demand at time of NSW Region Summer Peak and Energy (High Scenario)

	Capacity (MW)		Demand at time of NSW Summer Peak (MW)		Energy (GWh)	
	Wind (Semi-scheduled)	Non-scheduled	Wind (Semi-scheduled)	Non-scheduled	Wind (Semi-scheduled)	Non-scheduled
2006-07	0	363	0	105	0	904
2007-08	0	577	0	131	0	913
2008-09	0	585	0	187	0	1,192
2009-10	0	806	0	285	0	1,629
2010-11	159	841	8	460	403	1,704
2011-12	875	886	44	506	2,222	1,820
2012-13	998	886	50	506	2,536	1,820
2013-14	1,067	886	53	506	2,711	1,820
2014-15	1,587	915	79	534	4,030	1,881
2015-16	1,891	915	95	534	4,804	1,881
2016-17	2,059	915	103	534	5,230	1,881
2017-18	2,059	918	103	536	5,230	1,887
2018-19	2,095	918	105	536	5,322	1,887
2019-20	2,537	923	127	542	6,444	1,898

Table A3.5: NSW Region Semi-Scheduled and Non-scheduled Generation: Historical and Projected Capacity, Demand at time of NSW Region Summer Peak and Energy (Low Scenario)

	Capacity (MW)		Demand at time of NSW Summer Peak (MW)		Energy (GWh)	
	Wind (Semi-scheduled)	Non-scheduled	Wind (Semi-scheduled)	Non-scheduled	Wind (Semi-scheduled)	Non-scheduled
2006-07	0	363	0	105	0	904
2007-08	0	577	0	131	0	913
2008-09	0	585	0	187	0	1,192
2009-10	0	805	0	285	0	1,625
2010-11	142	840	7	459	360	1,700
2011-12	631	879	32	498	1,604	1,799
2012-13	716	879	36	498	1,820	1,799
2013-14	785	879	39	498	1,995	1,799
2014-15	1,201	895	60	515	3,051	1,834
2015-16	1,396	895	70	515	3,547	1,834
2016-17	1,486	895	74	515	3,775	1,834
2017-18	1,486	897	74	516	3,775	1,838
2018-19	1,511	897	76	516	3,839	1,838
2019-20	1,788	900	89	519	4,542	1,843

Table A3.6: EnergyAustralia Connection Point Summer Peak Demand[8]

	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Beaconsfield West	466	131	480	145	493	153	467	154	489	166	496	172	506	179	516	192	526	198	535	201
Rookwood Rd	0	0	0	0	0	0	413	136	443	150	452	157	461	163	470	175	480	181	489	184
Haymarket	555	156	585	177	601	186	576	190	600	203	612	213	619	219	627	234	636	239	647	243
Liddell	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11
Munmorah	177	69	186	76	166	70	170	76	173	78	178	91	182	95	185	96	188	100	192	102
Muswellbrook	252	75	255	77	258	79	261	81	265	83	268	85	272	87	275	90	279	92	282	93
Newcastle	679	144	695	155	686	158	699	162	714	173	730	185	745	197	761	209	780	222	794	226
Sydney East	787	370	796	380	811	390	831	370	844	374	854	412	864	417	876	426	888	447	904	455
Sydney North	1213	324	1264	363	1298	382	1213	381	1193	384	1230	406	1254	422	1278	452	1308	467	1331	476
Sydney South	1533	410	1579	453	1607	473	1422	446	1461	471	1482	489	1512	509	1541	545	1562	558	1590	568
Tomago	187	20	196	24	247	28	257	31	266	35	275	39	286	42	297	47	306	51	312	52
Tuggerah	238	124	243	131	251	138	248	139	254	149	259	154	263	155	269	163	274	165	279	167
Vales Point	128	26	133	28	153	32	156	33	159	34	162	35	166	37	169	38	172	41	175	41
Waratah West	212	65	215	70	204	73	208	74	212	76	217	77	221	78	226	80	230	81	234	83

Table A3.7: EnergyAustralia Connection Point Winter Peak Demand[9]

	2010		2011		2012		2013		2014		2015		2016		2017		2018		2019	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Beaconsfield West	419	96	436	93	446	98	454	102	429	98	437	102	442	105	449	109	455	116	462	123
Rookwood Rd	0	0	0	0	0	0	0	0	379	86	394	92	401	95	407	99	413	105	419	111
Haymarket	492	112	512	109	535	117	545	123	521	119	530	123	535	127	542	132	550	140	559	148
Liddell	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11	35	11
Munmorah	160	49	165	51	172	57	163	56	167	62	169	65	173	70	175	73	178	73	180	76
Muswellbrook	199	28	210	32	212	33	214	34	216	35	218	36	220	37	222	39	229	40	227	41
Newcastle	737	66	590	74	599	73	589	66	597	71	607	77	616	83	626	92	635	99	648	107
Sydney East	871	251	885	271	894	284	911	292	931	281	945	300	956	301	968	317	980	324	993	344
Sydney North	1075	233	1120	227	1154	240	1177	252	1081	234	1097	242	1116	251	1128	260	1141	277	1153	291
Sydney South	1492	323	1562	317	1612	335	1630	349	1463	317	1485	328	1506	339	1524	351	1542	374	1561	394
Tomago	0	0	154	16	162	19	202	22	210	24	216	26	223	27	230	29	238	31	244	34
Tuggerah	238	68	243	80	247	89	254	95	249	96	252	100	255	103	258	107	262	115	265	120
Vales Point	129	20	132	20	135	22	155	26	158	28	160	29	163	30	166	31	168	32	170	33
Waratah West	124	41	172	42	176	43	167	46	170	47	173	48	176	50	180	51	184	52	187	54

8 Zone substation projections aggregated to TransGrid bulk supply points using agreed load flow models.

9 Zone substation projections aggregated to TransGrid bulk supply points using agreed load flow models.

Table A3.8: Integral Energy Connection Point Summer Peak Demand[10]

	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Dapto	620	133	652	140	636	136	642	138	650	140	660	142	670	144	682	146	694	149	706	151
Ingleburn	136	40	139	34	141	35	144	36	148	36	151	37	154	38	157	39	161	40	164	41
Liverpool	368	83	380	85	396	89	410	92	426	96	441	99	456	102	470	106	485	109	500	112
Macarthur	248	73	253	74	258	75	263	76	268	77	273	79	278	80	284	81	289	82	295	84
Marulan	74	26	75	27	76	27	78	28	79	28	80	29	82	29	83	30	84	30	86	31
Mount Piper	38	17	38	17	38	17	38	17	38	17	38	17	38	17	38	17	39	17	39	17
Regentville	274	71	277	71	280	72	283	73	287	74	290	75	294	76	297	77	301	78	304	79
Sydney North	36	20	37	20	38	20	38	21	39	21	40	22	40	22	41	22	42	23	42	23
Sydney West	1784	443	1821	452	1729	429	1778	441	1827	453	1878	466	1930	479	1985	492	2041	506	2097	520
Vineyard	274	102	320	120	379	141	386	144	394	147	402	150	411	154	421	157	430	161	440	164
Wallerawang	44	14	44	14	45	14	45	14	45	14	45	14	46	14	46	14	46	14	46	14

Table A3.9: Integral Energy Connection Point Winter Peak Demand

	2010		2011		2012		2013		2014		2015		2016		2017		2018		2019	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Dapto	708	116	742	121	757	124	768	125	776	127	784	128	799	130	810	132	820	134	831	135
Ingleburn	156	23	127	19	129	19	130	19	132	20	133	20	134	20	136	20	137	20	139	21
Liverpool	367	47	318	41	332	42	350	45	365	47	381	49	396	51	410	52	423	54	435	55
Macarthur	59	4	229	52	233	53	237	51	243	53	251	54	259	56	268	58	277	61	287	63
Marulan	88	35	92	36	93	37	94	37	94	37	95	37	96	38	97	38	97	38	98	39
Mount Piper	37	18	37	18	37	18	37	18	37	18	37	18	37	18	37	18	37	19	37	19
Regentville	256	67	259	68	246	65	249	66	252	66	255	67	258	68	261	69	264	70	267	70
Sydney North	35	16	35	16	35	16	35	16	35	16	35	16	35	16	35	16	35	16	35	16
Sydney West	1546	61	1528	60	1541	61	1476	58	1497	59	1519	60	1539	60	1558	61	1577	62	1596	63
Vineyard	223	35	231	36	249	39	368	57	386	60	398	62	410	64	423	66	437	68	451	70
Wallerawang	82	23	83	24	83	24	84	24	85	24	85	24	86	24	86	25	87	25	88	25

[10] Individual projections extended for an additional year using linear interpolation.

Table A3.10: Country Energy (North) Connection Point Summer Peak Demand

	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Armidale	33	14	33	14	34	14	35	15	35	15	36	15	37	16	37	16	38	16	39	16
Boambee South	16	4	17	4	17	4	18	5	19	5	19	5	20	5	20	5	21	5	22	5
Casino	31	8	32	8	33	8	34	8	35	9	36	9	36	9	37	9	38	10	39	11
Coffs Harbour	75	25	77	16	80	16	83	17	86	17	88	18	90	18	93	19	95	19	97	19
Dorrigo	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	5	2	6	2
Dunoon	7	2	7	2	8	2	8	2	8	2	8	2	9	2	9	3	9	3	9	3
Glen Innes	12	3	13	3	13	3	13	3	13	3	13	3	13	3	14	3	14	3	14	3
Gunnedah	26	13	27	8	27	8	28	8	28	8	28	8	29	8	29	9	30	9	31	9
Hawks Nest	10	3	11	4	11	4	12	4	12	4	13	4	14	4	14	5	15	5	16	5
Herons Ck	0	0	0	0	16	4	17	4	17	4	18	4	18	5	19	5	20	5	21	5
Inverell	34	9	35	9	35	9	36	9	36	9	37	9	37	9	38	9	38	10	38	11
Kempsey 33kV	33	10	34	10	35	10	35	10	36	11	37	11	38	11	39	11	40	12	41	13
Kempsey 66kV	2	0	2	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1
Koolkhan	64	19	65	19	67	20	69	20	71	21	73	21	75	22	77	22	79	23	81	24
Lismore	125	31	130	33	135	34	140	35	145	36	148	37	152	38	156	39	160	40	164	41
Macksville	9	2	9	2	10	2	10	2	10	2	10	2	11	2	11	2	11	2	11	2
Moree	26	7	27	7	27	7	27	7	28	7	28	7	28	7	29	7	29	7	29	7
Mullumbimby	37	14	39	14	40	14	41	15	43	16	44	16	45	16	46	17	47	17	48	17
Nabiac	0	0	38	11	39	11	41	12	42	12	43	13	45	13	46	13	48	14	50	15
Nambucca	12	5	12	5	12	5	13	5	13	5	13	5	14	5	14	5	14	6	14	7
Narrabri	46	15	56	18	56	18	56	18	57	19	59	19	59	19	60	20	60	20	60	20
Port Macquarie	72	15	75	15	78	16	81	16	84	17	86	17	88	18	90	18	92	19	94	20
Raleigh	12	3	13	3	13	3	13	3	14	3	14	3	14	3	15	3	15	3	15	3
Stroud	36	6	37	6	38	7	39	7	40	7	41	7	42	7	43	8	44	8	45	8
Tamworth	119	37	122	38	125	39	128	40	131	41	135	42	138	43	141	44	145	45	149	46
Taree 33kV	35	15	36	15	36	16	37	16	38	16	39	17	40	17	41	17	41	18	41	19
Taree 66kV	71	28	36	14	22	7	22	7	23	8	24	8	25	8	26	8	26	9	26	10
Tenterfield	5	2	5	2	5	2	5	2	6	2	6	2	6	2	6	2	6	2	6	2
Terranora	107	19	111	19	115	20	119	21	123	22	127	22	130	23	134	23	137	24	140	25

Table A3.11: Country Energy (North) Connection Point Winter Peak Demand

	2010		2011		2012		2013		2014		2015		2016		2017		2018		2019	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Armidale	43	13	44	13	44	13	45	13	46	13	47	14	48	14	48	14	49	14	50	15
Boambee South	16	4	16	4	17	4	17	4	18	4	18	5	19	5	19	5	19	5	20	5
Casino	26	7	27	7	27	7	28	7	28	7	29	7	30	7	30	8	31	8	32	8
Coffs Harbour	74	15	75	15	77	11	79	11	81	11	83	12	84	12	86	12	88	13	90	13
Dorrigo	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	5	1
Dunoon	8	2	8	2	8	2	9	2	9	2	9	2	9	2	9	2	10	2	10	2
Glen Innes	16	3	16	3	16	3	17	3	17	3	17	3	17	4	18	4	18	4	18	4
Gunnedah	26	10	27	10	27	7	27	7	28	7	28	7	28	7	29	7	29	7	29	7
Hawks Nest	0	0	11	4	11	4	11	4	12	4	12	4	13	4	13	4	14	5	14	5
Herons Ck	0	0	0	0	0	0	16	4	16	4	17	4	17	4	18	5	19	5	19	5
Inverell	33	7	33	7	34	7	34	7	34	7	35	7	35	7	36	7	36	7	36	7
Kempsey 33kV	37	9	38	9	38	10	39	10	40	10	40	10	41	10	42	11	43	11	43	11
Kempsey 66kV	2	0	2	0	2	0	3	1	3	1	3	1	3	1	3	1	3	1	3	1
Koolkhan	59	15	60	15	61	15	62	16	63	16	64	16	65	16	66	17	67	17	68	17
Lismore	117	34	120	35	123	36	126	37	129	38	132	38	135	39	138	40	141	41	145	42
Macksville	10	2	10	2	10	2	11	2	11	2	11	2	11	2	12	2	12	2	12	2
Moree	34	9	34	9	35	9	35	9	36	9	36	9	36	9	37	9	37	9	38	9
Mullumbimby	40	8	41	8	42	9	43	9	44	9	45	9	46	9	47	10	48	10	50	10
Nabiac	0	0	0	0	42	11	43	11	44	11	45	11	46	12	48	12	49	12	50	13
Nambucca	12	2	12	3	13	3	13	3	13	3	14	3	14	3	14	3	15	3	15	3
Narrabri	44	14	47	15	56	18	56	19	56	19	57	19	59	19	59	19	59	19	59	19
Port Macquarie	85	17	87	18	89	18	91	18	93	19	96	19	98	20	101	20	103	21	106	21
Raleigh	11	2	11	2	11	2	12	2	12	2	12	2	13	3	13	3	13	3	13	3
Stroud	29	5	30	5	30	5	31	5	31	5	32	6	32	6	33	6	33	6	34	6
Tamworth	103	30	105	26	107	27	108	27	110	28	112	28	114	28	115	29	117	29	119	30
Taree 33kV	27	11	33	13	33	13	34	13	35	14	35	14	36	14	37	14	37	15	38	15
Taree 66kV	84	25	82	24	44	13	29	8	29	9	30	9	31	9	32	9	32	9	33	10
Tenterfield	6	2	6	2	6	3	6	3	7	3	7	3	7	3	7	3	7	3	7	3
Terranora	113	16	117	17	120	17	124	18	128	18	131	19	135	19	138	20	142	20	146	21

Table A3.12: Country Energy (Central) Connection Point Summer Peak Demand

	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Beryl	63	19	65	20	67	20	68	22	68	22	69	22	70	22	71	23	71	23	72	23
Cowra	32	10	32	10	33	10	33	10	34	10	34	10	34	10	35	10	35	10	36	10
Forbes	34	5	34	5	34	5	34	5	35	5	35	5	35	5	35	6	35	6	35	6
Manildra	11	4	11	4	11	4	11	4	12	4	12	4	12	4	12	4	13	4	13	4
Molong	5	1	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2
Mudgee	24	9	25	9	25	9	26	10	27	10	27	10	28	10	29	10	29	11	30	11
Orange 66kV	50	28	50	28	50	28	50	28	50	28	50	28	51	28	51	28	51	28	51	28
Orange 132kV	90	41	91	41	92	42	93	42	93	42	94	43	95	43	96	43	96	44	97	44
Panorama	74	34	75	35	76	35	77	36	78	36	80	37	81	38	82	38	83	39	85	39
Parkes 66kV	25	10	25	10	25	10	25	10	25	10	25	11	26	11	26	11	26	11	26	11
Parkes 132kV	29	13	29	14	29	14	30	14	30	14	30	14	30	14	30	14	30	14	30	14
Wallerawang 66kV	5	1	5	2	5	2	5	2	5	2	5	2	5	2	5	2	5	2	5	2
Wallerawang 132kV	25	16	25	16	25	17	25	17	25	17	25	17	25	17	25	17	25	17	25	17
Wellington 66kV	12	5	12	5	12	5	12	5	12	5	13	5	13	5	13	5	13	6	14	6
Wellington 132kV	162	24	164	24	167	25	169	25	171	26	174	26	176	26	179	27	182	27	184	27

Table A3.13: Country Energy (Central) Connection Point Winter Peak Demand

	2010		2011		2012		2013		2014		2015		2016		2017		2018		2019	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Beryl	54	15	63	16	65	17	66	18	67	18	67	18	68	19	68	19	69	19	70	19
Cowra	26	2	26	2	26	2	26	2	27	2	27	2	27	2	27	2	27	2	27	2
Forbes	26	1	26	1	26	1	26	1	26	1	26	1	26	1	26	1	26	1	26	1
Manildra	10	4	10	4	10	4	11	4	11	4	11	4	11	4	11	4	12	4	12	4
Molong	5	1	5	1	5	1	5	1	6	1	6	1	6	1	6	1	6	1	6	1
Mudgee	23	5	23	5	23	5	24	5	24	5	24	5	24	6	25	6	25	6	25	6
Orange 66kV	68	23	69	23	69	24	70	24	70	24	71	24	72	24	72	25	73	25	74	25
Orange 132kV	88	34	90	35	95	39	95	39	96	40	97	40	98	40	99	41	100	41	101	42
Panorama	76	25	77	25	78	25	78	25	79	26	80	26	81	26	81	26	82	27	83	27
Parkes 66kV	20	4	20	4	20	4	20	4	21	4	21	4	21	4	21	4	21	4	21	4
Parkes 132kV	29	11	29	11	30	11	30	11	30	11	30	11	30	11	30	11	30	11	31	11
Wallerawang 66kV	6	2	6	2	7	2	7	2	7	2	7	2	7	2	7	2	7	2	7	2
Wallerawang 132kV	25	16	25	16	25	16	25	16	25	16	25	16	25	16	25	16	25	16	25	16
Wellington 66kV	10	2	11	2	11	2	11	2	11	2	11	2	12	2	12	2	12	2	12	3
Wellington 132kV	144	20	144	20	145	20	146	20	147	20	147	20	148	20	149	20	149	20	150	21

Table A3.14: Country Energy (South and Far West) and ActewAGL Connection Point Summer Peak Demand

	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Albury	136	55	138	56	141	57	143	58	146	59	149	60	152	61	155	62	157	63	160	65
Balranald	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1
Broken Hill	33	16	34	16	34	16	35	16	35	16	35	17	36	17	36	17	37	17	37	18
Canberra	566	307	578	313	588	319	598	325	609	330	619	336	630	342	641	347	652	353	663	359
Coleambally	12	8	12	9	12	9	13	9	13	9	13	9	13	9	13	9	14	10	14	10
Cooma 11kV	11	3	11	3	11	3	11	3	11	3	12	3	12	3	12	3	12	3	12	3
Cooma 66kV	13	4	13	4	13	4	13	4	13	4	14	4	14	5	14	5	14	5	14	5
Cooma 132kV	42	10	42	11	42	11	43	11	43	11	43	11	44	11	44	11	44	11	45	11
Darlington Pt	15	4	15	4	15	4	15	4	15	4	15	4	15	4	16	4	16	4	16	4
Deniliquin	44	16	44	16	44	16	44	16	44	16	44	16	44	16	44	16	44	16	44	16
Finley	20	7	20	7	20	7	20	7	20	7	20	7	21	8	21	8	21	8	21	8
Griffith	82	33	84	33	86	33	88	33	90	34	92	34	95	34	97	35	100	35	102	35
Marulan	41	19	42	19	43	19	44	20	45	20	46	21	47	21	48	22	49	22	50	23
Munyang	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	4
Murrumbateman	4	1	5	1	5	1	5	1	5	1	5	1	6	2	6	2	6	2	6	2
Murrumburrah	43	23	44	24	45	24	46	25	47	25	47	26	48	26	49	27	50	27	51	28
Queanbeyan	87	41	89	41	91	43	94	44	96	45	98	46	100	46	103	48	104	49	106	49
Snowy Adit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tumut	37	15	38	16	38	16	39	16	39	16	40	17	41	17	41	17	42	17	42	18
Wagga 66kV	100	62	103	62	105	63	108	63	111	63	113	64	116	64	119	64	122	64	125	65
Wagga 132kV	56	5	56	5	57	5	57	5	57	5	58	5	58	5	59	5	59	5	60	5
Wagga North	26	15	26	14	26	15	27	15	27	15	28	15	28	16	29	16	29	16	30	17
Yanco	42	20	43	21	44	21	45	22	46	22	47	23	48	23	49	24	50	24	51	25
Yass	13	5	13	5	14	5	14	5	14	5	15	5	15	5	16	5	16	6	17	6

Table A3.15: Country Energy (South and Far West) and ActewAGL Connection Point Winter Peak Demand

	2010		2010		2010		2013		2014		2015		2016		2017		2018		2019	
	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr	MW	MVAr
Albury	95	30	96	30	96	30	97	30	97	30	98	31	98	31	99	31	99	31	100	31
Balranald	3	0	3	0	3	0	3	0	3	0	3	0	3	0	3	0	3	0	3	0
Broken Hill	30	8	30	8	31	8	31	8	31	8	32	8	32	8	32	8	33	8	33	8
Canberra	510	203	501	200	495	197	489	195	484	193	480	191	478	190	477	190	477	190	478	190
Coleambally	8	4	8	4	8	4	8	4	8	4	8	4	8	5	8	5	9	5	9	5
Cooma 11kV	17	4	17	4	17	4	17	4	17	4	17	4	17	4	17	4	17	4	18	4
Cooma 66kV	28	6	29	6	29	6	30	7	31	7	31	7	32	7	33	7	33	7	34	7
Cooma 132kV	50	7	51	7	52	7	53	8	54	8	55	8	56	8	57	8	58	8	59	8
Darlington Pt	14	2	14	2	14	2	14	2	14	2	15	2	15	2	15	2	15	2	15	2
Deniliquin	32	5	32	5	33	5	33	5	33	5	33	5	33	5	33	5	33	5	33	5
Finley	15	2	15	2	16	2	16	2	16	2	16	2	16	2	16	2	16	2	16	2
Griffith	53	17	54	17	55	17	56	17	57	18	58	18	59	18	60	19	61	19	62	19
Marulan	46	14	47	14	48	14	49	14	50	14	51	15	51	15	52	15	53	15	54	16
Munyang	31	20	32	21	32	21	32	21	33	22	33	22	34	22	34	22	34	23	35	23
Murrumbateman	6	1	6	1	6	1	6	1	6	1	7	1	7	1	7	1	7	1	7	1
Murrumburrah	37	13	38	13	38	13	39	13	39	14	40	14	40	14	41	14	41	14	42	14
Queanbeyan	99	32	99	32	101	32	101	32	103	33	105	33	106	33	107	34	109	34	111	35
Snowy Adit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tumut	36	10	36	11	36	11	36	11	36	11	36	11	36	11	37	11	37	11	37	11
Wagga 66kV	91	26	82	22	83	19	85	19	86	20	87	20	88	20	89	21	90	21	92	21
Wagga 132kV	57	5	58	5	58	5	59	5	60	5	60	5	61	5	61	5	62	5	63	5
Wagga North	15	6	24	11	24	11	24	11	24	11	24	11	24	11	24	12	24	12	24	12
Yanco	34	11	34	12	34	12	35	12	35	12	35	12	36	12	36	12	36	12	36	12
Yass	13	3	14	3	14	3	14	3	14	3	15	4	15	4	15	4	15	4	16	4

Table A3.16: Major Industrial Customers - Sum of Individual Summer Peak Demands[11]

	2011 MW	2012 MW	2013 MW	2014 MW	2015 MW	2016 MW	2017 MW	2018 MW	2019 MW	2020 MW
Industrial Loads	1679	1679	1679	1679	1679	1679	1679	1679	1679	1679

Table A3.17: Major Industrial Customers - Sum of Individual Winter Peak Demands[12]

	2010 MW	2011 MW	2012 MW	2013 MW	2014 MW	2015 MW	2016 MW	2017 MW	2018 MW	2019 MW
Industrial Loads	1663	1663	1663	1663	1663	1663	1663	1663	1663	1663

[11] Includes loads originally identified in EnergyAustralia and Integral Energy projections.

[12] Includes loads originally identified in EnergyAustralia and Integral Energy projections.

Appendix 4
Connection Point Proposals

The NER requires the Annual Planning Report to set out planning proposals for future connection points. These can be initiated by generators or customers or arise as the result of joint planning with a Distributor.

In the following table, proposals for augmentations to the capacity of existing connection points are included with proposals for new connection points.

Table 4.1 Connection Point Proposals

Proposal	Purpose	Proposed Service Date	APR 2010 Section
Vineyard 3rd 330/132 kV transformer	Increase transformer capacity	2010/11	5.3.9
Holroyd and Rookwood 330/132 kV substations	New 132 kV connection points	Late 2013	5.3.3
Southern Supply to the ACT	Increase reliability and capacity of connections to Williamsdale	Mid 2012	5.3.5
Supply to Lake Munmorah	Connection to Lake Munmorah zone substation	2012	5.3.6
Supply to the Tomerong/Nowra Area	New 132 kV connection point	2014	6.2.6
Hawks Nest 132 kV substation	New 132 kV connection point	2011/12	5.3.7
Nabiac 132 kV substation	New 132 kV connection point	2011/12	6.2.4
Herons Creek 132 kV substation	New 132 kV connection point	2012/13	6.2.5
Lismore 132 kV switchbay	New 132 kV connection to Casino	Late 2012	5.3.11
Tamworth 66 kV switchbay	New 66 kV connection to Quirindi	Late 2012	5.3.11
Newcastle 330/132 kV substation	New 132 kV connection to Argenton	Late 2011	5.3.11
Cooma 132/66 kV substation	New 132 kV switchbay connection	2011	5.3.11

Appendix 5
New Small Transmission Network Asset Proposals

This appendix details proposals for new small transmission network assets including the need and options considered.

A5.1 Beaconsfield West 132 kV Capacitors

The Sydney inner metropolitan area is supplied via a 132 kV network emanating from Sydney North, Sydney South, Beaconsfield West and Haymarket 330/132 kV substations. Beaconsfield West and Haymarket are supplied via 330 kV cables from Sydney South.

On outage of the Sydney South – Haymarket 330 kV cable and one of a number of EnergyAustralia 132 kV cables, the rating of the Sydney South – Beaconsfield West 330 kV cable can be exceeded. Provision of 132 kV capacitors at Beaconsfield West would reduce the reactive power flows on that 330 kV cable and would also help to support voltages in the inner metropolitan area.

Consequently, it is proposed to install two 160 MVAr 132 kV capacitors at Beaconsfield West at an estimated cost of $7 million. Those capacitors would be installed as part of the redevelopment of Beaconsfield West substation (refer to Section 5.2).

As provision of 132 kV capacitors at Haymarket is not possible due to space limitations, their installation at Beaconsfield West is the only option and consequently it is the highest ranked feasible option.

A5.2 Reinforcement of Voltage Control in Northern NSW

Existing Supply Arrangement

The northern NSW loads are supplied by 330/132 kV substations at Muswellbrook, Tamworth, Armidale, Coffs Harbour and Lismore as shown in Figure A5.1. The 330 kV transmission system comprises two 330 kV lines between Liddell and Armidale via Muswellbrook and Tamworth with a radial 330 kV line to Lismore via Coffs Harbour. The 330/132 kV substations connect to the underlying 132 kV supply network. The peak load in the northern system is approaching 1,000 MW and the northern system contains some of the more rapidly growing load areas in the state.

The 330 kV system extends north beyond Armidale to Dumaresq and forms part of the interconnection with Queensland over QNI. Lismore is also connected via Directlink to the Queensland Gold Coast area. The power transfer capability between NSW and Queensland (total of QNI and Directlink) ranges from relatively small levels for NSW export to about 1,300 MW for NSW import.

The power transfer capability north from Liddell, to supply the northern loads and power transfer between NSW and Queensland, is partly governed by line thermal ratings and voltage control limitations. The power transfer over this system, and ultimately between NSW and Queensland, is also subject to transient stability limitations which are system-wide limitations.

An example of the power transfer limitations at times of high northern NSW load, expressed as an export capability from NSW to Queensland, is shown in Table A5.1.

Table A5.1 Example of Power Transfer Limits

Limitation	NSW export capability
Line thermal rating	470 MW
Transient stability	300 MW
Voltage control	170 MW

Voltage Control Limitation

At present voltage control is the most constraining limitation on the NSW export capability to Queensland under a wide range of operating conditions. The NSW main system planning criteria, set out in the APR, requires allowance to be made for the trip of a critical generator on the system. The voltage control capability is governed by the adequacy of the voltage conditions at Tamworth, Armidale and Dumaresq in anticipation of a contingent trip of the largest generating unit in Queensland. The trip of a large unit will result in an immediate rise in the power transferred north of Liddell. The system must be operated in anticipation of the unit trip, allowing for the automatic operation of voltage control devices across the system.

The Kogan Creek unit is now operating with an output of around 750 MW which is the largest output from a single unit in the Queensland system. The trip of the unit and step change to the Queensland area demand by the order of 750 MW imposes a significant rise in the power transfer north of Liddell and hence the pre-contingent power flow must be maintained at a relatively low level. Part of the low pre-contingent power flow must go towards supplying the power flow to the NSW northern loads.

The NSW export capability declines by about 0.63 MW for every 1 MW load increase in the Armidale, Coffs Harbour or Lismore area and also declines by about 0.23 MW for every 1 MW load increase in the Tamworth area.

The increasing northern load is gradually eroding the power transfer capability north from Liddell to the point where, with the present load forecast, by about summer 2013/14 there will need to be a forced import from Queensland over QNI/Directlink to provide a reliable supply to the northern area loads.

Hence it would be necessary to rely on there being a surplus of Queensland generation over Queensland load at time of high loads in northern NSW.

The normal pattern of power flow between the regions of the NEM is from a region of lower pool price towards one of higher price (setting aside loss impacts). Hence it would also be necessary to arrange the NEM generation dispatch systems to force the power flow towards NSW whilst avoiding pool price distortions where pool prices may otherwise determine a different power flow pattern.

The Electricity Statement of Opportunities 2009 shows that the Queensland power supply will fall short of the necessary margin over demand by summer 2014/15 and hence additional generation in Queensland or import from NSW will be required in subsequent years.

At the times when the supply/demand balance situation in Queensland is tight (excluding any contribution that may be available from NSW) Queensland may be unable to export power and hence the Queensland generation will not be able to support the northern NSW load. At the times of high Queensland load it is expected that the NSW northern loads would also be relatively high due to the common weather patterns affecting south east Queensland and north east NSW.

The situation is shown in stylised form in Figure A5.2a. If the border between NSW and Queensland was ignored then the situation appears as shown in Figure A5.2b. The issue with supply to the northern NSW loads is equivalent to any limitation on other parts of the system where there is a limited capability to transfer power to an area of the system. It is normal practice to ignore state borders, regional boundaries and ownership boundaries when considering the need for reinforcement of supply to an area of the system and when identifying reinforcement options.

It is expected that a voltage control limitation in northern NSW will emerge around 2013/14.

Figure A5.1 – Northern NSW Supply System

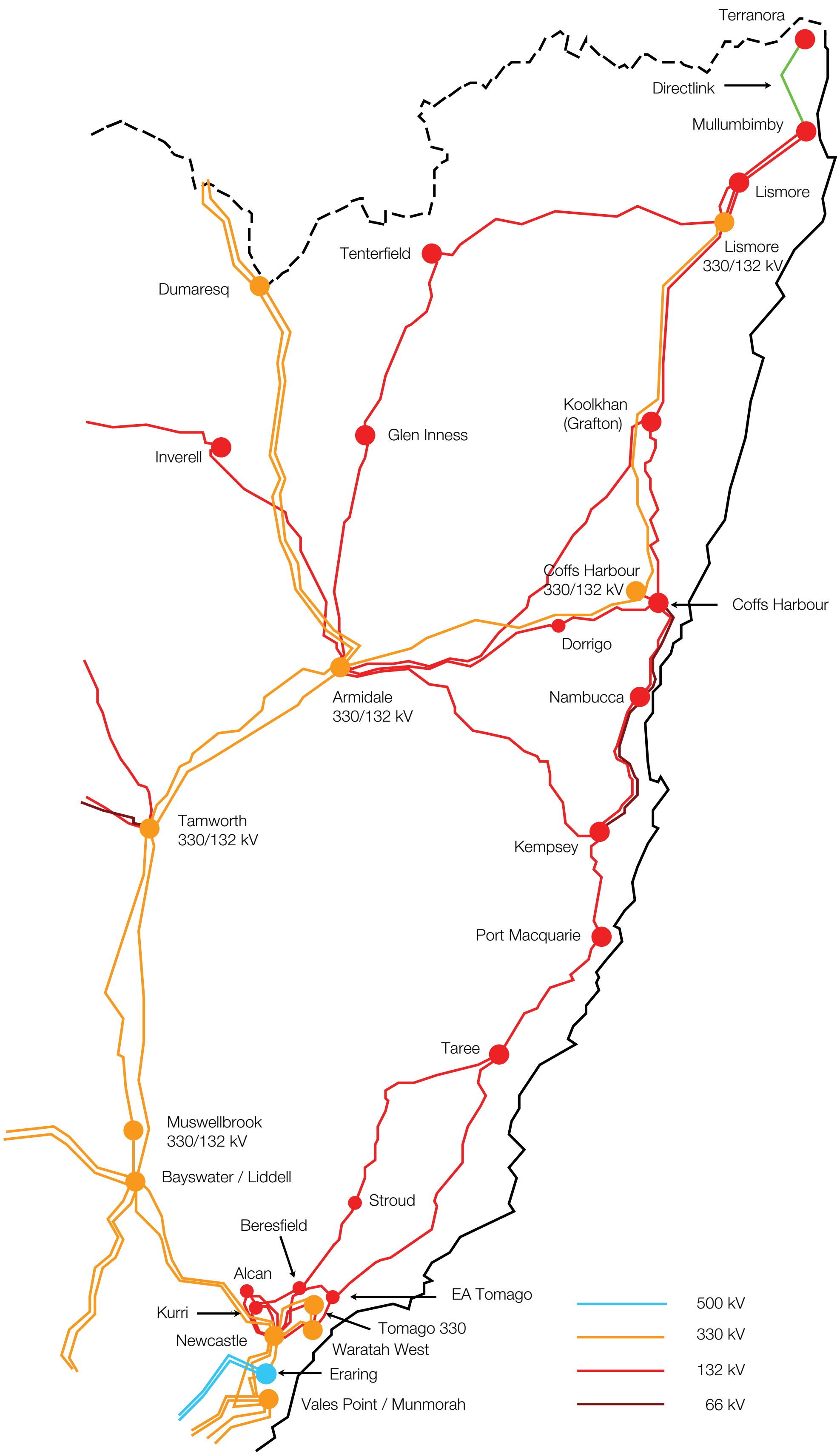
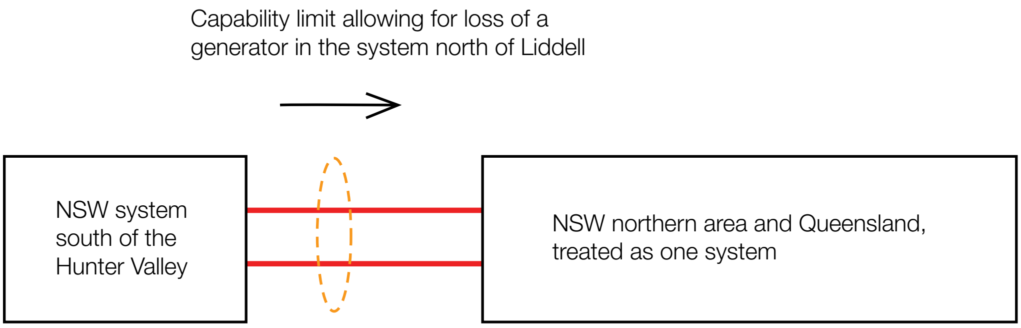


Figure A5.2a – NSW northern area needs to be supplied from the south

Figure A5.2b – Limited ability to support northern NSW and Queensland



Network reinforcement options

The possible network options that have been considered are as follows:

1. **Extension of the range of the existing Armidale SVC**

   This option would apply the rapid switching of reactive plant controlled by the existing Armidale SVC. The option involves the development of control and communication systems from the Armidale SVC and the installation of two 330 kV 200 MVAr capacitor banks at Armidale.

   The cost of the control and communication systems is expected to be approximately $1 million and the cost of the switched shunt capacitors is expected to be about $9 million. The total cost is of the order of $10 million.

   This option would relieve the voltage control limitation and would improve the northward power transfer capability of QNI by about 120 MW. It would not significantly affect the transient stability capability.

2. **Second Armidale SVC**

   A second Armidale SVC is expected to cost about $50 million. Additional land is expected to be required at Armidale and special consideration would need to be given to controlling the audible noise from the installation.

   The installation of a second SVC with the same characteristics as the existing plant would relieve the voltage control limitation and would also improve the northward power transfer capability of QNI by about 100 MW.

3. **New 330 kV line development between Liddell and Armidale**

   A new 330 kV line development from the Hunter Valley would improve the power transfer capability to support the northern NSW loads and export over QNI. The cost of such an option would be several hundred million dollars. Whilst TransGrid is planning the longer-term extension of the 330 kV or 500 kV north from the Hunter Valley the development of a new line is not a credible immediate solution. Consequently, it will not be considered as a means to relieve the voltage limitation.

4. **Line series compensation**

   Series compensation of the 330 kV lines from Liddell to Armidale would improve the power transfer capability of the system. At least two installations would be required with a cost of the order of $40 million.

Non-network development options

The need for reinforcement of the system would be offset by the management of demand or by the development of new generation north of the Hunter Valley.

There is no committed new gas-fired or wind farm generators in NSW north of Liddell. Gas-fired generation would directly offset the need for the reactive support.

Wind farm generation is dependent on the prevailing wind conditions and due to the variability of the wind TransGrid makes the assumption that 7%[13] of the total wind farm installed capacity across the State would be available to meet peak

[13] There is only one new large wind farm and a few small wind farms in NSW and hence there is insufficient history with wind farm operation to establish reliable statistics for NSW. Hence the 7% figure is based on the South Australian experience where there is a greater experience with wind farm operation.

load conditions. Within a smaller geographical area, such as northern NSW, it is likely that an even smaller proportion of wind generation could be relied upon to be operating at times of high area load.

Therefore substantial wind farm development would be required to remove the need for additional reactive support. Wind farm generation development could however delay the need for reactive support.

Market benefits of the options

The present formulation of the Regulatory Test specifically precludes consideration of market benefits for reliability driven projects. However, the improvement of the power transfer capability between Liddell and Armidale also generally increases the NSW export capability to Queensland. Hence it is expected that the options would provide market benefits. While they cannot be considered in the Regulatory Test, information on the market benefits is provided below for completeness.

The potential benefits of various options for upgrading QNI have been investigated in the ANTS 2008[14], the NTS 2009 and the TransGrid – Powerlink joint investigation of 2008[15] using market modelling over different market development scenarios. The options covered are shown in Table A5.2.

Table A5.2 – Options Covered

	Options
ANTS 2008	• Series compensation of the Armidale – Dumaresq – Bulli Creek 330 kV lines • Northern NSW SVC
NTS 2009	• Series compensation of the Armidale – Dumaresq – Bulli Creek 330 kV lines
TransGrid – Powerlink investigation 2008	• Series compensation of the Armidale – Dumaresq – Bulli Creek 330 kV lines • Northern NSW SVC • System protection schemes • High voltage Direct Current Back-to-back link • Second HVAC interconnector between Bulli Creek and the Hunter Valley

The ANTS 2008 identified benefits over costs for the two options considered.

The NTS 2009 assumed that the second SVC (option 2) was a routine augmentation from summer 2013/14. The line series compensation option provided positive market benefits under the market development scenarios examined with a timing varying from 2013/14 to 2017/18.

In the TransGrid – Powerlink investigation the SVC option provided benefits exceeding $100 million except for a negative NPV under a scenario of low economic growth using "realistic" generator bidding behaviour. The timing varied to 2016/17. The line series compensation option showed positive benefits apart from one scenario with an optimal timing to 2015/16 and beyond. The other options were only investigated over a limited number of scenarios and did not show significant market benefits.

The different investigations carried out show a range of market benefits and optimal timings for the SVC, line series compensation and line development options. It is considered that more investigation is required to determine the optimal timing and scope of upgrade for QNI, including the application of the SVC. These investigations are part of a joint TransGrid – Powerlink project and will be reported to the market in 2010/11.

Material Inter-network Impact

Each of the options would change the capability for power transfer between NSW and Queensland and would have a material inter-network impact.

Assessment of Options

The Regulatory Test was applied to the three feasible options under the base case and a number of sensitivities. The base case and sensitivity test parameters are shown in Table A5.3 and the results in Table A5.4.

Table A5.3 – Base Case and Sensitivity Test Parameters

Parameter	Base Case	Sensitivity Test
Real Discount Rate	9%	6% and 12%
O&M Cost	2% of capital cost	1% and 3%
Asset Life, years	30	20 and 40
Commissioning Date[16]	2013/14	2012/13 and 2015/16

[14] AEMO / NEMMCO 2008 – part of the Statement of Opportunities.

[15] TransGrid – Powerlink "Potential Upgrade of Queensland/ NSW Interconnector (QNI) – Assessment of Optimal Timing and Net Market Benefits", 13 October 2008 – see TransGrid's website.

[16] Changes to the commissioning date could arise due a number of factors, including changes in forecasts, generation developments within the area and changes in the Queensland supply / demand balance.

Table A5.4 – Ranking of Options

	Option 1 NPV of Costs ($M)	Rank	Option 2 NPV of Costs ($M)	Rank	Option 3 NPV of Costs ($M)	Rank
Base Case	6.5	1	32.7	3	26.1	2
Low Discount Rate	6.8	1	34.0	3	27.2	2
High Discount Rate	6.1	1	30.7	3	24.5	2
High Cost	8.3	1	41.5	3	33.2	2
Low Cost	4.8	1	23.8	3	19.1	2
High O&M	7.0	1	35.1	3	28.1	2
Low O&M	6.1	1	30.3	3	24.2	2
Short Life	7.0	1	35.2	3	28.2	2
Long Life	6.3	1	31.4	3	25.1	2
Late Commissioning	5.0	1	25.0	3	20.0	2
Early Commissioning	7.4	1	37.0	3	29.6	2

Conclusion

Option 1 involving an extension to the range of the existing Armidale SVC with switched shunt reactive plant has the least cost of all feasible options. It is the highest ranked option in all cases and consequently satisfies the Regulatory Test.

Subject to the agreement of other affected TNSPs, TransGrid intends to proceed with Option 1 which can be implemented relatively simply at a cost of the order of $10 million with a lead-time of about two years.

TransGrid and Powerlink are presently reviewing the market benefits associated with various options to increase the capacity of QNI. Should the QNI upgrade proceed at some time after 2013/14 the works associated with Option 1 would complement that development. Hence the works of Option 1 would not be wasted.

A5.3 Quality of Supply Monitoring

The National Electricity Rules (NER) require a TNSP to design and operate its network to ensure that the quality of the voltages supplied to its customers (i.e. Generators, Distribution Network Service Providers and large industrial consumers) meets the defined System Standards and levels specified in connection agreements. The relevant requirements are defined in the Sections S5.1a.4 to S5.1a.7 of the NER.

TransGrid intends to progressively install supply quality monitors at points of supply to customers throughout the network.

This project is not an augmentation and has been included in the APR for information only.

A5.4 Real-Time Line Rating Installations

In the APR 2009 TransGrid identified its plans for the roll out of real-time line rating installations. TransGrid intends installing real-time line rating systems on a number of lines to allow the maximum power transfer capability of the system (where it is governed by line thermal ratings) to be available for use by market participants.

Real-time line ratings may provide additional capability above TransGrid's present line ratings at times of favourable ambient conditions. TransGrid's present ratings take into account the probabilistic nature of weather and line loading conditions and it should be noted that there is a risk that the real-time line ratings may be less than the present ratings under certain unfavourable weather conditions.

The real-time line rating installations involve weather monitors at selected locations along each line, communication systems to stream the monitor data to TransGrid control centres to enable ratings to be calculated and IT systems to interface the rating information with NEM dispatch systems.

Monitors are presently being installed on the Marulan – Avon and Marulan – Dapto 330 kV lines. TransGrid expects to continue these installations across other critical 330 kV and 132 kV lines throughout NSW.

The cost of each installation is about $200,000 depending on communication requirements and the number of monitors depends on the terrain crossed by the line and line construction details. For example in the case of the Marulan – Avon and Marulan – Dapto lines it has been found that about six monitors would serve both lines due to the proximity of their routes.

The cost of the installations on each line is expected to be below $1 million on average.

The installations are expected to be commissioned progressively every few months from 2010 to 2014.

As the real time line ratings may be less than the present ratings under unfavourable weather conditions, this is not an augmentation. Nonetheless, it is described here for completeness.

Appendix 6
Glossary

Term	Explanation/Comments
AEMO	The Australian Energy Market Operator. AEMO commenced operation on 1st July 2009. AEMO took over all of NEMMCO's functions and has an expanded transmission planning role.
AER	The Australian Energy Regulator.
AEMC	The Australian Energy Market Commission.
Annual National Transmission Statement (ANTS)	A document produced annually by NEMMCO until 2008 which focuses on the status and options for development of Major National Transmission Flow Paths.
Annual Planning Review	The annual planning process covering transmission networks in New South Wales.
Annual Planning Report (APR 200X)	A document that sets out issues and provides information to the market that is relevant to transmission planning in New South Wales. This document is the APR 2010.
CBD	Central Business District.
Constraint	An inability of a transmission system or distribution system to supply a required amount of electricity to a required standard.
CPRS	The federal government's proposed Carbon Pollution Reduction Scheme.
DNSP (Distributor)	Distribution Network Service Provider. A body that owns controls or operates a distribution system in the NEM.
DM	Demand management. A set of initiatives that is put in place at the point of end-use to reduce the total and/or peak consumption of electricity.
GWh	A unit of energy consumption equal to 1,000 Megawatt hours. One Megawatt hour is the amount of energy consumed in one hour at a rate of one Megawatt.
IPART	Independent Pricing and Regulatory Tribunal of NSW
IRPC	The Inter-Regional Planning Committee (now defunct) that was convened by NEMMCO and had representation from all jurisdictions of the NEM.
Jurisdictional Planning Body (JPB)	The organisation nominated by a relevant minister as having transmission system planning responsibility in a jurisdiction of the NEM.
kV	Operating voltage of transmission equipment. One kilovolt is equal to one thousand volts.
Local Generation	A generation or cogeneration facility that is located on the load side of a transmission constraint.
MRET	Mandatory Renewable Energy Target.
MVAr	A unit of reactive power. One "Mega-VAr" is equal to 1,000,000 VAr.

Term	Explanation/Comments
National Electricity Rules (NER or "the Rules")	The rules of the National Electricity Market that have been approved by participating State governments under the National Electricity Law. The NER supersedes the National Electricity Code (NEC or "the Code") and is administered by the AEMC.
National Transmission Statement (NTS)	A one-off document produced by AEMO in 2009 and based on past ANTS's. The 2009 NTS is a transitional document to the future NTNDP.
Native energy (demand)	Energy (demand) that is inclusive of Scheduled, Semi-Scheduled and Non-Scheduled generation.
NEM	The National Electricity Market.
NEMMCO	National Electricity Market Management Company. The company that administered and operated the National Electricity Market. From 1st July 2009 NEMMCO became part of AEMO.
NTFP	National Transmission Flow Path.
NTNDP	National Transmission Network Development Plan replaces NTS from 2010.
new small transmission network asset	An augmentation of the transmission network that is expected to cost between $5 million and $20 million.
new large transmission network asset	An augmentation of the transmission network that is expected to cost more than $20 million.
Regulatory Test	A test promulgated by the AER that is required by the NER to be applied when determining the relative economic merits of options for the relief of transmission constraints.
Registered Participant	A person registered with AEMO as an NER participant.
RIT-T	Regulatory Investment Test – Transmission, will replace the Regulatory Test from 1st August 2010
SVC	Static VAr Compensator. A device that provides for control of reactive power.
Statement of Opportunities (SOO) or Electricity Statement of Opportunities (ESOO)	A document produced by AEMO that focuses on electricity supply demand balance in the NEM.
the Minister	The New South Wales Minister for Energy.
TNSP	Transmission Network Service Provider. A body that owns controls and operates a transmission system in the NEM.

Appendix 7
Contact Details

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